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Knowledge, expectations, and inductive reasoning within conceptual hierarchies

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Abstract

Previous research (e.g. *Cognition 64* (1997) 73) suggests that the privileged level for inductive inference in a folk biological conceptual hierarchy does not correspond to the "basic" level (i.e. the level at which concepts are both informative and distinct). To further explore inductive inference within conceptual hierarchies, we examine relations between knowledge of concepts at different hierarchical levels, expectations about conceptual coherence, and inductive inference. In Experiments 1 and 2, 5- and 8-year-olds and adults listed features of living kind (Experiments 1 and 2) and artifact (Experiment 2) concepts at different hierarchical levels (e.g. *plant*, *tree*, *oak*, *desert oak*), and also rated the strength of generalizations to the same concepts. For living kinds, the level that showed a relative advantage on these two tasks differed; the greatest increase in features listed tended to occur at the life-form level (e.g. *tree*), whereas the greatest increase in inductive strength tended to occur at the folk-generic level (e.g. *oak*). Knowledge and induction also showed different developmental trajectories. For artifact concepts, the levels at which the greatest gains in knowledge and induction occurred were more varied, and corresponded more closely across tasks. In Experiment 3, adults reported beliefs about within-category similarity for concepts at different levels of animal, plant and artifact hierarchies, and rated inductive strength as before. For living kind concepts, expectations about category coherence predicted patterns of inductions; knowledge did not. For artifact concepts, both knowledge and expectations predicted patterns of induction. Results suggest that beliefs about conceptual coherence play an important role in guiding inductive inference, that this role may be largely independent of specific knowledge of concepts, and that such beliefs are especially important in reasoning about living kinds.

Keywords: Knowledge; Expectations; Inductive reasoning; Conceptual hierarchies; Living kinds; Artifacts

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1. Introduction

Concepts are mental representations of classes of individuals sharing important commonalities. These can be thought of as the building blocks of human cognition. Organizing individual objects into groups of like kinds allows us to deal handily with the otherwise bewildering array of information constantly assaulting our senses. Moreover, concepts have systematic relations to other concepts. One such conceptual relation is a hierarchy, wherein concepts are organized into levels, or ranks, related to each other via class inclusion. Research in a number of disciplines converges on the finding that particular levels of conceptual hierarchies are psychologically privileged, or most useful and informative for many purposes.

Researchers studying systems of folk biological classification among traditional peoples (e.g. Atran, 1995; Berlin, 1992; Brown, 1984; Bulmer, 1967; Hays, 1983; Hunn, 1977; Malt, 1995) argue that living things are universally organized into ranked hierarchies. Not only are categories related to each other via class inclusion, but categories at a given level also share taxonomic, linguistic, biological, and psychological properties. In these systems, the psychologically privileged level, according to Berlin (1992), corresponds to the *folk-generic* rank (e.g. *oak*, *robin*). According to Berlin, folk-generic categories are perceptually salient and identifiable without close study. Generic names are the first offered and most used in everyday discourse, and tend to be simple and non-analyzable. Among the traditional societies studied by Berlin and colleagues, folk-generic concepts may be among the first learned by children (Stross, 1973). Going upwards in the system, most folk-generics are included in *life-form* categories (e.g. *tree*, *bird*). Like folk-generics, most life-forms are named by primary lexemes; biologically, members of a life-form are diverse; psychologically, members of a life-form share a small number of readily-perceptible biological characteristics (e.g. wings). The most general rank is the *folk-kingdom* (e.g. *plant*, *animal*). Although such categories are often not explicitly named, they nevertheless represent the broadest divisions of the biological world. Moving downward in the taxonomy, folk-generics may be further subdivided into *folk-specifics*. These are often named with secondary lexemes (“red oak”, “rainbow trout”), compound names which render hierarchical relations transparent. Rarely, an extremely important folk-specific will be differentiated into *folk-varietals* (e.g. “Northern rainbow trout”). In general, whether a folk-generic is further differentiated depends on the cultural significance of the organisms involved (Berlin, 1992; Brown, 1984; Hunn, 1982). In sum, ethnobiologists find that traditional peoples organize categories of living things into ranked hierarchies, and folk-generic categories are the psychologically privileged core of those hierarchies.

Rosch, Mervis, Gray, Johnson, and Boyes-Braem (1976) sought to examine experimentally the notion of psychological privilege within conceptual hierarchies, and found a remarkable convergence of experimental measures which pointed to one level as being psychologically “basic”. They identified the basic level as the level above which much information about the commonalities between category members was lost, and below which little further information was gained. For instance, the “basic level” is the most inclusive level at which (1) many common features are listed for categories, (2) consistent actions are described for interacting with category members, (3) category members have similar shapes, and (4) an average shape is recognizable. Subsequent experimental evidence strongly supports the existence of a privileged hierarchical level for categorization and organization of knowledge (see Murphy, 2002 for a review). However, the actual level Rosch et al. found to be basic for biological hierarchies (*bird*, *fish*, *tree*) is superordinate to the level that Berlin argues is privileged in traditional folk knowledge systems (*sparrow*, *trout*, *oak*). This may well be an effect of expertise; traditional people studied by ethnobiologists have a high degree of interaction with and knowledge of local plant and animal species, on which they depend for survival, in contrast with Rosch's Berkeley undergraduates. Indeed, more recent work suggests that expertise increases the privileged status of subordinate hierarchical levels (e.g. Johnson & Mervis, 1997; Tanaka & Taylor, 1991). In sum, although the actual privileged level may differ, both experts and novices find a particular level of conceptual hierarchy especially useful and salient for organizing knowledge.

One explanation for the basic level phenomenon is that basic level categories are most *differentiated* (Murphy & Lassaline, 1997). Differentiation draws on the notions of *informativeness* and *distinctiveness*. The informativeness of a concept is how much information is associated with the concept – how many things you know to be true given that an object is a member of that particular category. Distinctiveness refers to how different a concept is from other concepts at the same level of abstraction within a superordinate. Highly differentiated concepts are both informative and distinct. For example, *bird* is an informative concept for US undergraduates. Given something is a bird, it probably flies, has feathers, has two wings and two legs and a beak, lays eggs, is relatively small and light, etc. *Bird* is also a distinct concept for this population; birds are very different from fish, reptiles, mammals, etc. Hence, the privileged status of *bird*. Note, however, that in principle subordinate concepts are always more informative; knowing that something is a robin tells you more about it than knowing that it is a bird. But subordinate concepts also lose distinctiveness (robins are not terribly different from martins or sparrows). So concepts at intermediate levels like *bird* may be privileged not because they are the most informative, but because they are somewhat informative while retaining distinctiveness. On this view, expertise increases the psychological usefulness of subordinate levels (e.g. folk-generics among traditional subsistence agriculturists) because greater knowledge and experience leads to greater differentiation of concepts at these levels (see Tanaka & Taylor, 1991).

In addition to organizing existing knowledge, conceptual hierarchies can aid in the extension of new knowledge by guiding the projection of newly-learned information. Most obviously, class-inclusion hierarchies support deductive reasoning through property inheritance from parent concepts. Given that *all birds have hearts*, and *robins are birds*, we can conclude with great certainly that *robins have hearts* (but see Sloman, 1998 for limitations on deductive inferences about nested categories). An equally important function of conceptual hierarchies in reasoning is their role in guiding inductive generalizations from specific to more general concepts. So, given that *robins have omenta* and *robins are birds*, we may be willing to endorse the generalization that *all birds have omenta*. What is the relation between psychologically privileged, or "basic" levels in a hierarchy, and inductive inference? Rosch et al. (1976) propose that "in the real world information-rich bundles of perceptual and functional attributes occur that form natural discontinuities and that basic cuts in categorization are made at these discontinuities" (p. 385). If so, then a plausible prediction is that these information-rich bundles will also constitute loci for projection of new information; it is reasonable to suppose that highly differentiated concepts may well be privileged for inductive inference.

Coley, Medin, and Atran (1997) examined inductive inference within living kind hierarchies by developing a set of stimuli consisting of plant and animal concepts from five different ethnobiological ranks: folk-kingdom (e.g. *plant*), life-form (e.g. *tree*), folk-generic (e.g. *oak*), folk-specific (e.g. *red oak*) and folk-varietal (e.g. *Northern red oak*). Although both US undergraduate and Itza' Maya of lowland Guatemala participated in the study, we focus here on the US population. Participants were asked to rate the relative strength of inferences from concepts of one rank to concepts of the next higher rank (e.g. "All *trout* have enzyme X. How likely is it that all *fish* have enzyme X?"). Properties involved unspecified enzymes, proteins, and disease. Students rated the likelihood of the arguments on a scale of 1 (not very likely) to 9 (extremely likely). Results showed that the strength of inferences increased with the specificity of the conclusion category, and that the increase in inductive strength was greatest moving from life-form to folk-generic categories. Inferences to folk-generic concepts (e.g. *trout*, *oak*) were consistently rated stronger than inferences to life-form concepts (e.g. *bird*, *tree*) or folk-kingdom concepts (e.g. *plant*, *animal*), and no weaker than inferences to folk-specific concepts (e.g. *rainbow trout*, *red oak*). Coley et al. (1997) interpreted this as showing that with respect to induction, folk-generic categories were inductively privileged for US undergraduates. This was surprising; if inductive potential was a function of differentiation, then concepts at the life-form level (e.g. *bird*, *tree*, *fish*), which have been shown to be most differentiated for US students, should be inductively privileged as well. Thus, these results can be taken to suggest a discrepancy between the privileged level with respect to differentiation of knowledge and the level that shows a relative advantage for induction.

One potential explanation for this discrepancy is that inductive inferences may be driven by informativeness alone rather than differentiation; a concept that shares known properties may be thought likely to share novel ones as well, independent of its distinctiveness (e.g. Heit, 1998). Support for this notion comes from evidence that making inferences about category members promotes attention to both the featural and abstract/relational similarities within a category (see Markman & Ross, 2003 for a review). Thus, *oak* might be inductively powerful for US students because it is more informative than *tree*, despite the fact that it is less differentiated. Alternatively, Coley et al. (1997) argue that this discrepancy indicates the importance of expectations about underlying commonalities in guiding inductive inferences about living kinds. There may well be more to conceptual structure than an organization of facts; relatively abstract and inchoate beliefs about what causes living kinds to exhibit certain properties may lead to the expectation of shared features despite little specific knowledge of what those features might actually be (e.g. Gelman, Coley, & Gottfried, 1994; Gelman & Hirschfeld, 1999; Keil, 1989, 1994). For instance, even though *oak* might not be an informative concept in the absolute sense that undergraduate students could list many features of oaks, they might nevertheless *believe* that oaks share an underlying biological nature which gives rise to observable properties, and therefore believe *oak* to be an inductively useful concept;

what's true of one oak is likely to be true of all oaks because they share essential properties. In short, inductive potential may reflect beliefs or expectations about informativeness rather than knowledge per se.

To summarize the argument, results of Coley et al. (1997) suggest that if conceptual differentiation drives basic level effects, then the inductively privileged level of a conceptual hierarchy does not correspond to the most differentiated level. It is still an open question whether induction is driven by knowledge (i.e. informativeness) or expectations. In the present studies we directly examine the degree to which the informativeness and expected informativeness of concepts at different hierarchical levels correspond to patterns of inductive inference. If inductive inference is a function of informativeness alone, then measures of inductive strength should correspond to measures of knowledge. However, if (as argued by Coley et al., 1997) induction is driven in part by relatively abstract expectations about conceptual coherence, then measures of inductive strength may correspond more closely to *expected* informativeness. We also explore developmental changes in relations between knowledge and inductive inference; if informativeness drives induction, then developmental changes in knowledge of concepts at different hierarchical levels should be reflected in developmental changes in the inductive potential of those concepts. In contrast, if expectations drive induction, then inductive potential may show patterns of change independent of acquired knowledge. Finally, we extend the domain of inquiry to concepts of human-made artifacts. The findings of Coley et al. (1997) were confined to folk biological categories; examining hierarchical induction among artifact categories is an important extension of this work. If participants expect folk-generic concepts to share many (albeit unknown) properties because of a shared underlying biological nature, then such expectations should play a diminished role in guiding inferences about artifacts.

In the following studies we measured *informativeness* by asking participants to list known features for concepts at different hierarchical levels; we take this as a index of knowledge. We measured *expected informativeness* by collecting ratings of perceived similarity among category members at different levels; we take this as an index of beliefs about conceptual coherence. And finally, we measured inductive strength by asking participants to rate the likelihood that a novel property would be true of a concept given that it was true of an immediately subordinate concept. We are primarily interested in relations among these indices relative to conceptual hierarchies, and therefore throughout the paper we seek to identify the hierarchical level at which each shows a relative advantage, which we term the "privileged level". As described above, Rosch et al. characterize "basic" categories as those that are much more informative than superordinate categories, and not much less informative than subordinate categories. Extending this definition to our measures, we will define the "privileged level" as the level that shows the largest significant increase (in features listed, inductive strength, or similarity) relative to an immediate superordinate. It is important to point out that our definition of "privileged level" reflects a relative advantage rather than an absolute qualitative distinction. Therefore, for our purposes, the absolute location of the privileged level on a given task is less important than whether concepts at the same level of abstraction show a relative advantage across tasks.

2. Experiment 1

In this study we examined the correspondence between the location of the psychologically privileged rank in two conceptual tasks: feature listing and inductive inference. Adults, and 5- and 8-year-old children were asked to list all of the features that they believed were shared by category members at each level in two biological hierarchies (plants and animals). The same subjects were also asked to make inferences about the generalization of a novel property across adjacent levels in the hierarchies. As outlined above, the psychologically privileged level was defined as that level that shows the largest significant increase in informativeness relative to an immediate superordinate. For feature listing informativeness was measured in terms of the total number of features generated at each level; induction was measured by the strength of the belief that a feature of a subordinate premise category would generalize to the members of the immediate superordinate category. Following Rosch et al. (1976) we predicted that for adults the life-form level (e.g. *tree*, *fish*) would show psychological privilege in the feature listing task. In a task requiring inductive judgments about unfamiliar features, however, Coley et al.'s (1997) findings suggest that a more specific hierarchical level (e.g. the folk-generic level) will show privilege.

The inclusion of 5- and 8-year-old children provided a further test of the prediction that the privileged levels would diverge for feature listing and induction. If different principles (e.g. informativeness vs. expected informativeness) guide feature listing and induction then we would expect responses on these tasks to follow different developmental trajectories. Hence, we should observe different age-related changes in the location of the privileged level for informativeness and for induction. We targeted these age groups in part because children have demonstrated increasing sophistication in biological reasoning across this age span, including a growing belief that properties of living kinds may be explained by an underlying biological nature (e.g. Carey, 1985; Keil, 1989; Ross, Medin, Coley, & Atran, 2003). Thus, we might expect a corresponding increase in the expectation that folk-generic concepts are inductively potent, independent of specific knowledge of those concepts.

Studies of young children's understanding of conceptual hierarchies show that they, like adults, favor intermediate level ranks in tasks such as oddity matching (Rosch et al., 1976) and acquisition of object names (Horton & Markman, 1980; McDonough, 2002). Relatively little is known, however, about age-related changes in the location of the privileged level. In the biological domain adults and older school-age children have a better understanding than young children of the causal mechanisms that give rise to observable features (Carey, 1985; Springer, 1999). In a relative sense then, older children and adults could be seen as biological "experts" and younger children as biological "novices" (Bedard & Chi, 1992). Given that expertise has previously been associated with shifts towards more subordinate levels of psychological privilege (e.g. Johnson & Eilers, 1998; Johnson & Mervis, 1997; Tanaka & Taylor, 1991) we expected that older children and adults would generally show more specific privileged levels than young children. More importantly though, if different kinds of information are required for feature listing and induction the timing of such changes in the location of the privileged level is likely to occur at different points in development.

2.1. Method

2.1.1. Participants

Participants were 36 5-year-olds (range: 5 years to 6 years 9 months; $M = 5$ years 9 months), 36 8-year-olds (range: 8 years 1 month to 9 years 8 months; $M = 8$ years 9 months) and 36 undergraduate students (range: 18 years to 53 years 7 months; $M = 24$ years 4 months) from the University of Newcastle, Australia. Children were recruited from private primary schools in the Newcastle region of Australia and were from diverse socio-economic backgrounds. Undergraduates participated for course credit.

2.1.2. Materials

One category of plants (*trees*) and two of animals (*birds*, *fish*) were used in this experiment. These relatively broad classes of organisms were chosen because they correspond to taxa of the life-form rank as discussed by Berlin (1992) and Brown (1977, 1979). These three life-forms were used in Rosch et al.'s (1976) studies of feature listing, and Coley et al.'s (1997) induction studies. Following the methods used by Coley et al. (1997), we selected three subclasses for each of the life-form classes (e.g. *bird*; *sparrow*, *cockatoo*, *crow*) that correspond to taxa of the folk-generic rank (Berlin, 1992). For each folk-generic class we also selected a folk-specific subclass (e.g. *palm cockatoo*, *rainbow trout*). Finally, for each folk-specific class a folk-varietal subclass was constructed (e.g. *Australian palm cockatoo*, *Northern rainbow trout*). To generate the required number of folk-varietal items adjectival prefixes were added to many of the folk-specific labels. For animals, these were "common", "Australian", "Northern" or "brown". For plants, they were "Indian", "golden", "Northern", "Eastern" and "Western".[1] A list of all categories used is given in Appendix A.

The induction task involved four types of inferences: *folk-varietal to folk-specific* (Vr-Sp), *folk-specific to folk-generic* (Sp-Gn), *folk-generic to life-form* (Gn-Lf), and *life-form to folk-kingdom* (Lf-Kg). The stimuli in Appendix A were used to generate three parallel sets containing three of each of the inference types, a total of 12 items per subject. Presentation of the sets was counterbalanced within each age group so that stimuli at each level of the hierarchy were presented on an equal number of occasions. Twelve blank properties, made up of fictional two syllable words, were used to construct arguments for the inductive inference task. These properties were presented in a way that suggested they were biologically-based properties intrinsic to the organism in question (e.g. "All sparrows have heptal inside").

Color photographs mounted on white cardboard with approximate dimensions of 297×210 mm were used to depict the premise of each argument in the inductive inference task. Each photograph showed a single example of an organism from the folk-specific level. The same photograph was used to represent organisms at both the folk-generic and

[1] All folk-generic and folk-specific taxa used in this and the following experiments are real. Because of the relative scarcity of taxa at the folk-varietal level, we used prefixes to transparently denote subclasses of folk-specific taxa. Coley et al. (1997) pretested this method of generating subclasses and found that undergraduate participants accepted the fictitious folk-varietals as legitimate. Also note that folk-varietal concepts were only used as premises for Vr-Sp inferences. We never asked participants to project a property to a folk-varietal, nor were participants asked to list features for folk-varietals.

folk-varietal levels. For life-form premises a photograph of a familiar member of that category not otherwise used in the study was presented. The photographs were collected from books, magazines and the internet, scanned into a Pentium IBM compatible personal computer, and edited using Adobe PhotoShop v4.0 to equate their size and orientation.

2.1.3. Procedure

All participants were tested individually in a quiet room, either at their school or at the University of Newcastle campus. The feature listing task preceded the inductive inference task for all participants.

2.1.3.1. Feature listing. In this task adults were told that they would be asked some questions about their knowledge of plants and animals, and children were given a cover story that explained the task as one of describing the features of terrestrial plants and animals to an extraterrestrial observer. A practice item was then administered to all participants. The purpose of the feature listing task was to determine the total number of features that the subject believed were shared by members of a given category at a given hierarchical level. The presentation order of items for feature listing moved from the most general level of the hierarchy (i.e. folk-kingdom) through to the most specific level (i.e. folk-specific). Each feature listing item took the following form: "Now I want to know about Xs. Can you tell me things that are true of all Xs?", where X represented the target category. Participants had one minute within which to respond for each item. If they stopped before the end of the allotted time, they were prompted with "Can you think of any more things that are true of all Xs?". When the participant could not think of any more features or after expiration of the response period the experimenter proceeded with the next item.

For adults, 23 stimuli (two folk-kingdom, three life-form, nine folk-generic, and nine folk-specific) from Appendix A were used in feature listing. Pilot testing indicated that children became fatigued when listing features for this large stimulus set. Hence, each child was presented with a total of 11 items (two folk-kingdom, three life-form, three folk-generic, and three folk-specific) with the presentation of alternate folk-generic and folk-specific stimuli counterbalanced within the 5- and 8-year-old groups. For any given child, folk-specific items always corresponded with the folk-generic item that was administered (e.g. a child who was asked to list features for a *sparrow* would also list features for a *house sparrow*).

Feature listing responses were recorded on audio-tape, transcribed and scored. For each level of a given hierarchy the number of new features listed at that level was added to the features listed at superordinate ranks to give a feature listing total. If two features with the same meaning were given (e.g. "has a backbone" and "has a vertebrae") only a single feature was counted. When multiple adjectives or adverbs were used in the same phrase (e.g. "has a long, thin, snout") each discrete descriptor was counted as a separate feature. Features that involved category membership (e.g. "is a kind of bird") were not counted. The reliability of this coding scheme was checked by randomly selecting feature lists from 25% of each of the age groups. These were then scored by one of the authors and an independent rater. Agreement between the two raters on the number of new features listed was high (scores differed by no more than one in 93% of cases). Following the scoring procedures used by Rosch et al. (1976, Experiment 1) features had to satisfy a minimal consensual criterion to be counted in feature lists. For adults a feature was counted at a given level of the hierarchy if it was mentioned by five or more participants (14% of the age sample who saw the item). This same rule applied to features listed for the folk-kingdom and life-form ranks by children. For the folk-generic and folk-specific ranks, where children saw fewer items than adults, the criterion for feature counting was adjusted to two or more participants (17% of the age sample who saw the item).

2.1.3.2. Inductive inference. This task commenced immediately after feature listing. Subjects first completed a practice item involving inferences across ranks for a familiar category (*dog*). All participants were then presented with 12 induction items. Within this set equal numbers of the four inference types were administered; folk-varietal to folk-specific (Vr-Sp), folk-specific to folk-generic (Sp-Gn), folk-generic to life-form (Gn-Lf), and life-form to folk-kingdom (Lf-Kg). For each item a photograph representing the premise category was shown and an inductive argument with the following form was presented: "This is an X, which is a type of Y. All Xs have [blank property; e.g. heptal] inside them. Do you think that all Ys would have [blank property] inside them?" For each item, the premise category X was the category at the more subordinate rank (e.g. *trout*), and Y was its immediate superordinate (e.g. *fish*). If the response to the item was "yes" an inductive strength score of two was awarded. If the response was "no" or "don't know" a follow-up question was administered, "Do you think that some Ys would have [blank property] inside them?" If the response was "yes" a score of one was awarded. If the response was "no" then a score of zero was awarded.

A different blank property was used for each induction item. The assignment of properties to particular items and the order of presentation of items for each participant were both randomized. Inductive strength for each level of induction was determined by adding scores for each of the four inference types for plants and animals and dividing by the number of inferences, giving a final score ranging between zero and two.

2.2. Results

2.2.1. Feature listing

Feature listing patterns for plants and animals were examined separately. For plants feature list totals were entered into a 3 (age) × 4 (level in hierarchy: folk-kingdom, life-form, folk-generic, folk-specific) mixed ANOVA with repeated measures on the last factor. For animals an additional life-form (birds, fish) within subjects factor was added to the design. In this and in all following experiments, reported differences for follow-up comparisons between means are significant at $P < 0.05$ by Tukey's HSD test. Mean features listed by age and hierarchical level appear in Fig. 1.

2.2.1.1. Plants. Overall adults listed more tree features than the 8-year-olds, who in turn listed more features than the 5-year-olds ($F(2, 105) = 52.98$, MSe = 726.53, $P < 0.001$). The number of features listed varied across levels of the hierarchy ($F(3, 105) = 329.98$, MSe = 576.28, $P < 0.001$), although the pattern of change differed by age ($F(6, 105) = 43.72$, MSe = 76.34, $P < 0.001$). Fig. 1 shows that all age groups listed more features at the life-form level (*tree*) than at the folk-kingdom level (*plant*).

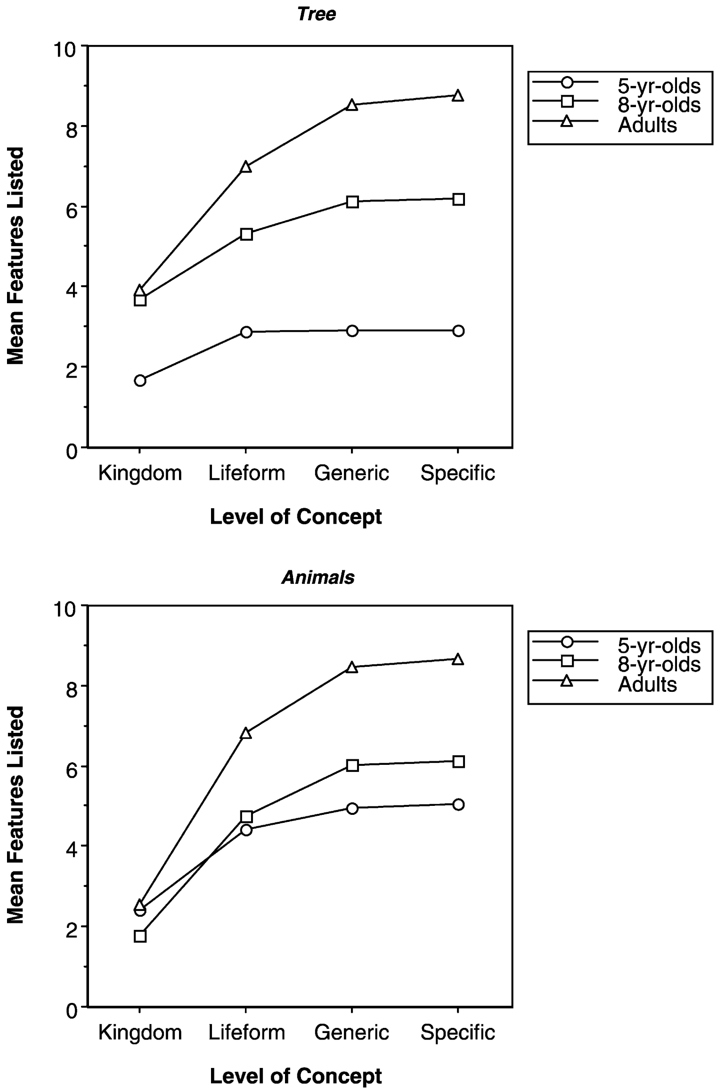

Fig. 1. Mean features listed as a function of age and hierarchical level in Experiment 1.

Eight-year-olds and adults, but not 5-year-olds, also listed more features for the folk-generic than for the life-form level, but showed no differences in feature listing for the folk-specific and folk-generic levels. For all age groups the largest significant increase in the number of features occurred between the folk-kingdom and life-form levels. Hence, we concluded that the life-form level was privileged with respect to feature listing for *tree*.

2.2.1.2. Animals. Adults listed more features for animals than did 5- and 8-year-olds ($F(2, 105) = 16.42$, MSe $= 470.63$, $P < 0.001$). The 5- and 8-year-olds did not differ in the number of features listed. As shown in Fig. 1 the number of features listed increased for more specific levels of the hierarchy ($F(3, 105) = 953.37$, MSe $= 2678.68$, $P < 0.001$). These effects were qualified by a two-way interaction between age and hierarchical level ($F(6, 105) = 51.31$, MSe $= 144.16$, $P < 0.001$). Adults listed more features than children at the life-form, folk-generic and folk-specific levels but not at the folk-kingdom level. All age groups listed more features at the life-form level (*bird* or *fish*) than at the folk-kingdom level (*animal*). As with *tree*, 8-year-olds and adults, but not the 5-year-olds, also listed more features for the folk-generics than for life-forms, but features for folk-generic and folk-specific levels did not differ. For both *birds* and *fish* the largest significant increase in features occurred between the folk-kingdom and life-form levels. Hence, we concluded that the life-form level was privileged with respect to feature listing for animals.

2.2.2. Inductive inference

The strength of each type of inductive inference was scored as 2 ("all" members of the superordinate would have the property), 1 ("some others" would have the property), or 0 ("no others" would have the property). Mean scores for each age and inference type are given in Fig. 2. Patterns of change in inductive strength were examined separately for plants and animals. For plants feature list totals were entered into a 3 (age) × 4 (inference type: Vr-Sp, Sp-Gn, Gn-Lf, Lf-Kg) mixed ANOVA with repeated measures on the last factor. For animals an additional life-form (birds, fish) within subjects factor was added to the design.

2.2.2.1. Plants. Fig. 2 shows that for all age groups inductive strength increased with the level of specificity of the conclusion category ($F(3, 105) = 23.95$, MSe $= 14.69$, $P < 0.001$). Tukey's HSD tests revealed that for all age groups the most specific levels of inference (Vr-Sp and Sp-Gn) received higher strength ratings than inferences at more general levels, but that these levels did not differ from one another in inference strength. The largest significant breakpoint in inductive strength for this hierarchy occurred between the folk-generic and life-form levels, indicating that the folk-generic level was privileged for inferences about *trees*.

2.2.2.2. Animals. Across age groups and animal types (*birds*, *fish*) inductive strength increased with the level of specificity of the conclusion category ($F(3, 105) = 74.44$, MSe $= 51.81$, $P < 0.001$). However, as shown in Fig. 2, the pattern of change in inductive strength across levels varied with age ($F(6, 105) = 11.04$, MSe $= 7.68$, $P < 0.001$). A significant three-way interaction between age, life-form and hierarchical level was also found ($F(6, 105) = 2.26$, MSe $= 0.31$, $P < 0.05$).

Fig. 2 shows that, for 5-year-olds, the magnitude of change in inference strength across adjacent levels of the conceptual hierarchies of *birds* and *fish* was small. Tukey's HSD comparisons failed to find a significant breakpoint in inference strength for any of these kinds, although the largest (albeit non-significant) increase in inductive strength occurred at the life-form level.

For the 8-year-olds, Vr-Sp and Sp-Gn inferences received higher ratings than all other inferences in this hierarchy, but did not differ from each other. From here, the patterns diverged for the two animal life-forms. For *birds*, the largest significant breakpoint in

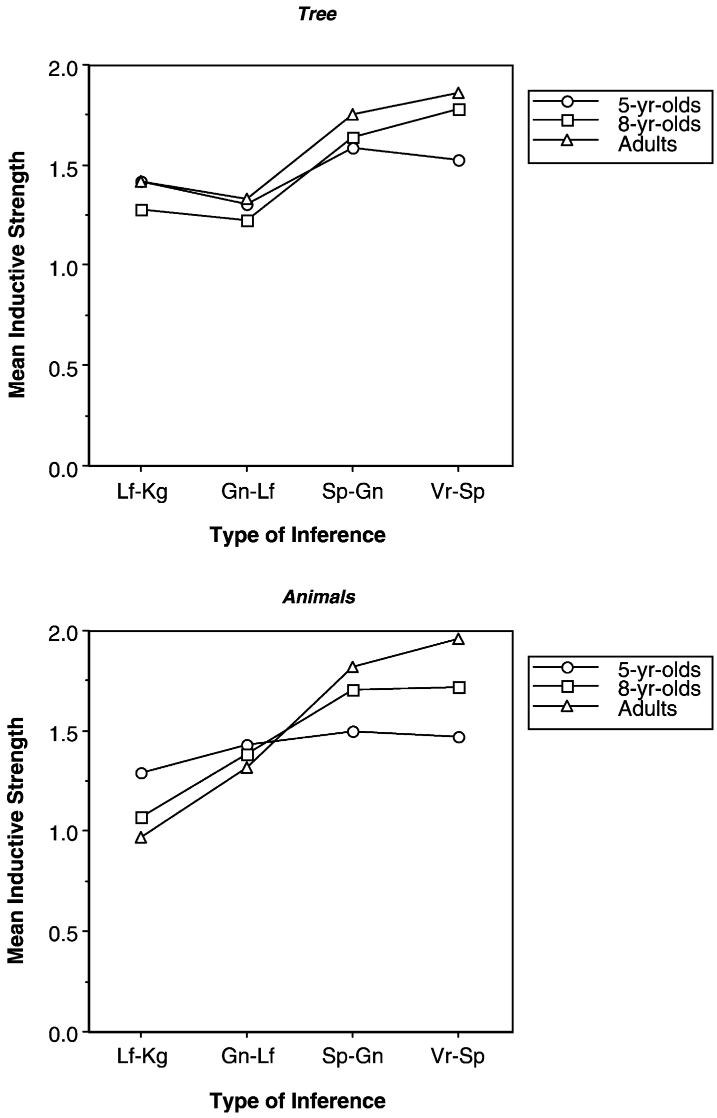

Fig. 2. Mean inductive strength as a function of age and type of inference in Experiment 1.

inductive strength was observed between the folk-generic and life-form levels, indicating that folk-generics were inductively privileged. There was no significant difference between the inductive strength scores for the life-form and folk-kingdom levels. For *fish*, no difference in inductive strength was found between the folk-generic and life-form levels. The significant breakpoint in inductive strength for this hierarchy was found between life-form and folk-kingdom, indicating that the life-form level was privileged with respect to induction.

Table 1
Location of the privileged level by life-form and conceptual function in Experiments 1–3

Life-form	Experiment 1: 5-year-olds (knowledge/ induction)	Experiment 1: 8-year-olds (knowledge/ induction)	Experiment 1: adults (knowledge/ induction)	Experiment 2 (knowledge/ induction)	Experiment 3 (expectation/ induction)
Bird	LF/LF*	LF/FG	LF/FG	LF/FG	FG/LF
Fish	LF/LF*	LF/LF	LF/FG	LF/FG	FG/LF
Mammal	–	–	–	FG/FG	FG/FG
Reptile	–	–	–	FG/FG	
Tree	LF/FG	LF/FG	LF/FG	LF/FG	FG/FG
Bush	–	–	–	LF/FG	FG/FG
Flower	–	–	–	LF/FG	FG/FG
Grain	–	–	–	LF/LF	
Herb	–	–	–	LF/FG	
Tool	–	–	–	FG/FG	FG/FG
Clothing	–	–	–	LF/LF	FG/LF
Furniture	–	–	–	LF/FG	FG/LF

FG, the largest significant increase occurred at the folk-generic level; LF, the largest significant increase occurred at the life-form level. * indicates that the largest increase occurred at that level, but that the difference was not statistically significant.

For adults, once again the folk-generic level was privileged with respect to inferences about animals. Vr-Sp and Sp-Gn inferences did not differ, but were rated as stronger than Gn-Lf and Lf-Kg inferences. The largest significant breakpoint in inductive strength occurred between the folk-generic and life-form levels. The location of the privileged level for each life-form tested is summarized in Table 1.

2.3. Discussion

There is an impressive consistency in our findings concerning the location of the privileged level for feature listing and induction in adults. For all three biological hierarchies the number of features listed as common to category members declined sharply as adults moved from the life-form to the folk-kingdom level. This replicates the Rosch et al. (1976) finding that the privileged level for feature listing involving biological kinds occurs at a relatively superordinate level in the conceptual hierarchy. It is notable that Rosch et al. did not examine people's featural knowledge of stimuli above the life-form rank and therefore were unable to make definitive statements about the location of the privileged level in biological hierarchies. Our data provide more conclusive evidence that, for tasks tapping adults' knowledge of the features of biological kinds, the life-form level (e.g. *tree*, *fish*, *bird*) shows a relative advantage.

In contrast, when asked to make judgments about the generalization of a novel property across the same stimulus set, adults consistently found folk-generic taxa (e.g. *trout*, *sparrow*, *oak*) to be more informative. At higher levels of abstraction, ratings of inductive strength decreased markedly. Inferences at more specific levels (i.e. folk-varietal to folk-specific) were no stronger than those to the folk-generic level. Hence, the folk-generic level showed a relative advantage with respect to induction.

These findings extend those of Coley et al. (1997) by providing direct evidence that, within a single biological hierarchy, different ranks may be privileged with respect to induction and knowledge-based tasks such as feature listing. They support the view that different kinds of beliefs or expectations guide responses on feature listing and induction tasks.

The developmental data, although somewhat less uniform, provide further corroboration of the divergence between privileged levels in feature listing and induction. Feature listing and inductive inferences varied across ranks in the *tree* hierarchy for 5-year-olds, and in all hierarchies for the 8-year-olds. In the majority of these cases (i.e. *trees* for both 5- and 8-year-olds, *birds* for the 8-year-olds) the pattern concerning privileged levels ran parallel to the adult findings, such that the life-form level was privileged for feature listing, but the folk-generic level was privileged for induction. These data reinforce the conclusion that, for biological hierarchies, the conventional view of a single level being privileged for all categorical tasks (e.g. Johnson & Eilers, 1998; Rosch et al., 1976) is incorrect. Like adults, children often make use of more subordinate-level information when making inductive inferences as opposed to retrieving information about exemplar features (cf. Waxman, Lynch, Casey, & Baer, 1997).

More generally, a comparison of the adult and child data provides some interesting insights into the effects of age, and presumably experience with biological hierarchies, on psychological privilege. We predicted that with age the location of the privileged level for induction would shift towards a more subordinate rank. In general, our induction results support this prediction. This finding is significant because it draws a clear parallel between the effects of age and domain expertise (e.g. Johnson & Eilers, 1998; Tanaka & Taylor, 1991) on the location of the psychologically privileged level. In both cases increasing experience and familiarity with the contents of conceptual hierarchies are associated with a more subordinate level of privilege. Second, the result extends previous work on expertise-related changes in psychological privilege to show that such changes extend to tasks involving inductive inferences.

In the feature listing task there was an age-related increase in knowledge about shared features at the life-form and folk-generic levels of plant and animal hierarchies. Notably, however, this trend did not extend to the more subordinate levels of the hierarchy (e.g. folk-specific). Even adults seemed to have relatively little detailed knowledge of animals and plants at this level. Moreover, no developmental change was found in the location of the privileged level for feature listing. This may imply that the level showing a relative advantage for knowledge-based tasks remains stable across childhood and early adulthood. We cannot entirely rule out the possibility that these findings reflect a ceiling effect since life-form was the most abstract level that could be identified as privileged for feature listing using the current procedures. However, given the highly abstract knowledge nature of the features shared by members of the next level in the hierarchy ("living things") it seems reasonable to assume that children (and probably many adults) would have been unlikely to generate many new features at this level.

The most important point here is that in the context of a developmentally stable privileged level for feature listing, we found marked developmental shifts in the location of the privileged level for induction. Although adults clearly know more about biological categories than children our data suggest a second, and even more fundamental developmental trend in children's understanding of category structure. We have shown that over the elementary school years children gradually acquire more differentiated expectations about which biological features will be shared by exemplars at different levels of a conceptual hierarchy. This suggests that children's understanding of hierarchical structure develops somewhat independently of their knowledge of specific exemplars. We will return to this important finding in Section 5. For now though, it serves to reinforce the view that feature listing and induction tasks are tapping different kinds of intuitions about biological categories.

3. Experiment 2

Experiment 1 consistently showed that for adults and in most cases for 8-year-old children, the level which showed a relative advantage for knowledge in biological taxonomies was superordinate to the level which showed a relative advantage for induction. The largest significant increase in features occurred for life-form concepts (*bird*, *tree*), but the largest significant increase in inductive strength consistently occurred at the generic level (*robin*, *oak*). This suggests a decoupling of knowledge about concepts and expectations about inductive potential. In Experiment 2 we examined the generality of these findings in several ways. First, additional plant and animal life-forms were used to supplement those from Experiment 1. Second, a different measure was used to evaluate inductive judgments. Because the inductive strength task in Experiment 1 was designed with young children in mind, it constrained adults' responses to a very narrow range – i.e. all, some, or no conclusion items have property P. This may have reduced the sensitivity of the analysis of induction responses. In Experiment 2 we use the same nine-point likelihood scale used in previous studies with adults (e.g. Coley et al., 1997), allowing adults to make a much broader range of ratings of inductive potential, and permitting greater sensitivity to subtle patterns of induction.

Third, and most importantly, the present study examined knowledge and induction about artifact concepts as well as plants and animals. As most work to date has focused on inferences within taxonomies of living kinds, examining artifacts will directly address the degree to which findings to date are specific to folk biological thought. Folk biological concepts exhibit rich clusters of correlated features, and folk theories may be particularly important in explaining such concepts. If so, then expectations about conceptual coherence that go beyond specific knowledge may play a larger role in inductive reasoning about folk biological kinds than in induction about artifact kinds, which may be more closely linked to actual knowledge. This would lead to differences in the relation between knowledge and induction in the two domains. In contrast, if the location of an inductively privileged level is driven by more domain-general assumptions about patterns of nomenclature and the significance of unique names, then relations between knowledge and induction should be similar for artifacts and living kinds.

As in Experiment 1, participants completed a feature listing task and an induction task. The specific objectives of Experiment 2 were (1) to test the generality of results from Experiment 1 by examining more items using a more sensitive measure of inductive potential, and (2) to examine relations between knowledge and induction for biological vs. artifact hierarchies.

3.1. Method

3.1.1. Participants

Sixty male and female undergraduate students at Northeastern University participated for class credit. Thirty-six participants completed the induction task, and 24 different participants served as subjects for the feature listing task.

3.1.2. Materials and design

As in Experiment 1, stimuli consisted of category names selected to form hierarchically-related taxonomies of plants, animals, and human-made artifacts. The living kind categories included two folk-kingdoms: *plant* and *animal*. Five life-forms were chosen from the plant kingdom: one was used in Experiment 1 (*tree*), and four were new (*bush*, *grain*, *flower*, *herb*); likewise four animal life-forms were chosen: two from Experiment 1 (*bird*, *fish*) and two new ones (*mammal*, *reptile*). From each life-form, we selected three folk-generics (e.g. for tree: *oak*, *maple*, *pine*), and for each folk-generic, we selected a folk-specific subclass (e.g. *red oak*). Finally, as in Experiment 1, we used adjectival prefixes to construct a folk-varietal subclass of each folk-specific. As reported in Coley et al. (1997), pretesting shows that participants perceive these as valid subkinds of folk-specific categories.

A taxonomy of human-made artifacts was compiled for comparison with the living kind taxonomies. Although artifact taxonomies do not appear to show the same regularities as biological taxonomies, and it is not clear whether the concept of rank applies to these taxonomies, we chose concepts to be comparable to the folk biological terms used with respect to class inclusion and patterns of nomenclature (see Brown, Kolar, Torrey, Truong-Quang, & Volkman, 1976). The folk-kingdom equivalent for this taxonomy was *object*. Life-form equivalents were *furniture*, *clothing*, and *tool*. As with the folk biological taxonomies, three generic equivalents were used for each life-form (e.g. *hammer*, *saw*, *screwdriver*), and specific and varietal equivalents were chosen for each generic equivalent (*flathead screwdriver*, *electric flathead screwdriver*). For clarity's sake, we will refer to these as life-forms, generics, etc., although we do not mean to equate living kind and artifact ranks a priori. A complete list of stimuli is presented in Appendix B.

3.1.3. Procedure

3.1.3.1. Feature listing task. For the feature listing task, three sets of stimuli were created. Each set included all three kingdom items, all 12 life-form items and one folk-generic and folk-specific from each life-form, for a total of 39 items. Each participant saw one stimulus set; the three sets (and thus all items) were presented with equal frequency across all participants. Within each set, the folk-specific items were always subclasses of the folk-generic items. As in Experiment 1, presentation order moved from most general (kingdom) to most specific (folk-specific). For example, after being asked to list features for *animal*, then *fish*, a participant may be asked to list features for *bass*, followed by *largemouth bass*. Life-form items were presented in random order within each kingdom.

Participants were asked to say everything they thought was "true of all Ps", where P represented a concept at a given level. Ten seconds after they finished listing attributes, participants were asked "Can you think of anything else true of all Ps?" If so, participants proceeded to list more features. Once a participant listed features for a folk-specific item, the next life-form within the same kingdom was then presented. After being presented with all life-form items within a kingdom, the next kingdom was then introduced, and items were presented in the same fashion. This task lasted approximately 30 minutes. The scoring procedure for feature listing was identical to that used with adults in Experiment 1 except that no consensual criterion was applied. All features were tallied regardless of how frequently they were mentioned across the sample.

3.1.3.2. Induction task. The induction task involved the same types of inference questions used in Experiment 1: Vr-Sp, Sp-Gn, Gn-Lf, and Lf-Kg. The only difference was the inclusion of artifact items and additional plant and animal life-forms. Stimuli were used to generate three stimulus sets containing one type of inference for each of the 12 life-forms, for a total of 48 inferences per participant. Twelve participants were given each set. For each participant, a different folk-generic term appeared in each type of inference for each life-form (e.g. for fish, the specific item might ask about *trout*, the generic item might ask about *bass*, and the life-form item might ask about *shark*). The logic was the same for artifacts (e.g. for tool, the specific item might ask about *hammer*, the generic item might ask about *saw*, and the life-form item might ask about s*crewdriver*). This was counterbalanced across subjects so that each generic appeared in each kind of inference the same number of times. Finally, each question set was presented in random order with the constraint that no questions about the same life-form appeared consecutively.

Each question was accompanied by a photograph of the premise item mounted on a 5×8 inch note card. All pictures represented folk-specific items. Sp-Gn inferences involved a picture of the folk-specific (e.g. *hammerhead shark* > *shark* was accompanied by a picture of a hammerhead shark). For Gn-Lf inferences, the relevant folk-specific picture was shown and participants were given the appropriate generic label for the premise item (e.g. for *trout* > *fish*, participants were shown a picture of a rainbow trout). Similarly, Lf-Kg inferences involved the remaining folk-generic photograph (e.g. for *fish* > *animal*, participants were shown a picture of a largemouth bass). Participants were tested individually. Questions were presented verbally. The general form of each question was "If all As have property P, how likely is it that all Bs have property P?", where A was always a subset of B. The property queried in each question was a novel word consisting of two syllables (e.g. "If all hammers have sarca, how likely is it that all tools will have sarca?"). A total of 24 novel words were randomly used twice within each session. Participants indicated their responses to each item by responding to a scale represented by 1 (all Bs are "very unlikely" to have P) to 9 (all Bs are "very likely" to have P). This task lasted approximately 20 minutes.

3.2. Results

3.2.1. Feature listing

As in Experiment 1, all features listed for folk-kingdom, life-form, folk-generic and folk-specific categories were counted as an index of knowledge of the concepts at various hierarchical levels; the level at which the largest increase in features was observed was considered privileged. One-way ANOVAs examining differences in features listed as a function of level were run separately for each plant, animal, and artifact life-form. Mean numbers of features listed for all three taxonomies are presented in Fig. 3; the locations of privileged levels for each life-form are presented in Table 1.

3.2.1.1. Plants. The number of features listed differed by level for all five plant life-forms: *tree*, $F(3, 23) = 73.54$, $\text{MSe} = 9.77$, $P < 0.0001$; *bush*, $F(3, 23) = 79.73$, $\text{MSe} = 2.21$, $P < 0.0001$; *flower*, $F(3, 23) = 84.88$, $\text{MSe} = 5.42$, $P < 0.0001$; *grain*, $F(3, 23) = 56.34$, $\text{MSe} = 8.86$, $P < 0.0001$; *herb*, $F(3, 23) = 56.38$, $\text{MSe} = 4.02$, $P < 0.0001$. For each life-form, more features were listed at the folk-generic level than at the life-form level, and more features were listed at the life-form level than at the folk-kingdom level. For all plant life-forms, the largest significant increase in features occurred at the life-form level.

3.2.1.2. Animals. The number of features listed differed by level for all animal life-forms: *mammal*, $F(3, 23) = 86.75$, $\text{MSe} = 8.61$, $P < 0.0001$; *bird*, $F(3, 23) = 66.76$, $\text{MSe} = 9.99$, $P < 0.0001$; *reptile*, $F(3, 23) = 77.82$, $\text{MSe} = 10.83$, $P < 0.0001$; *fish*, $F(3, 23) = 57.75$, $\text{MSe} = 16.66$, $P < 0.0001$. For *mammal*, *reptile*, and *fish*, more features were listed at the folk-generic level than at the life-form level, and more features were listed at the life-form level than at the folk-kingdom level. For *bird*, the only significant difference was that more features were listed at the life-form level than at the folk-kingdom level. Finally, for *mammal* and *reptile* the largest significant increase in features occurred at the folk-generic level, whereas for *bird* and *fish* the largest significant increase in features occurred at the life-form level. Fig. 3 shows that the total number of animal features listed by adults in this study was considerably greater than in Experiment 1. There are several possible explanations for this. First, different stimuli were used, most notably including relatively familiar mammals, which may have led to more features being listed. Second, this study employed more liberal rules for counting features than the first study. In this regard it is notable that the two scoring systems produced the same pattern of feature listing across levels of the hierarchy, with the life-form level generally privileged in each case.

3.2.1.3. Artifacts. The number of features listed also differed by level for all artifact “life-forms”: *tool*, $F(3, 23) = 86.51$, $\text{MSe} = 8.98$, $P < 0.0001$; *clothing*, $F(3, 23) = 117.58$, $\text{MSe} = 6.47$, $P < 0.0001$; *furniture*, $F(3, 23) = 94.56$, $\text{MSe} = 7.91$, $P < 0.0001$. Unlike living kinds, the number of features listed increased significantly for each level of the hierarchy for all three artifact “life-forms”. In other words, only for artifacts were more features listed at the “folk-specific” level (e.g. *rocking chair*) than at the “folk-generic” level (e.g. *chair*). For *tool*, the largest significant increase occurred at the “folk-generic”

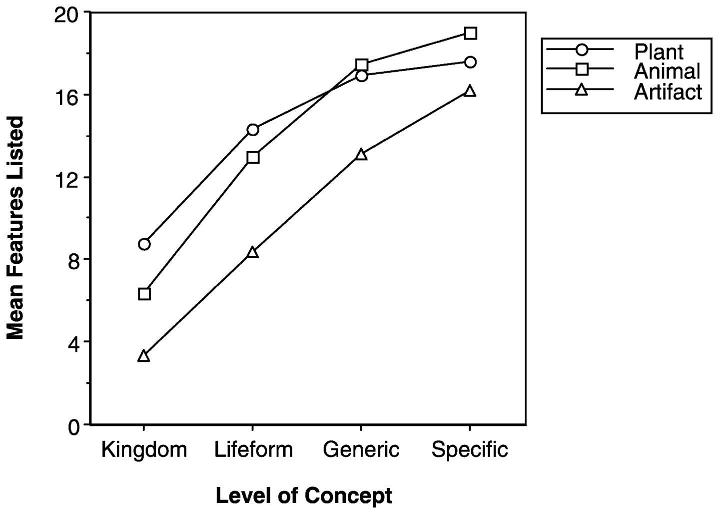

Fig. 3. Mean features listed as a function of domain and hierarchical level in Experiment 2.

level, whereas for *clothing* and *furniture*, the largest significant increase occurred at the "life-form" level.

3.2.2. Inductive inference

Likelihood ratings were averaged across each kind of inference (Vr-Sp, Sp-Gn, Gn-Lf, Lf-Kg). As before, the level at which the largest significant increase in inductive strength was observed was deemed privileged for induction. Patterns of induction for all three taxonomies are shown in Fig. 4; the location of the privileged level for each life-form is given in Table 1.

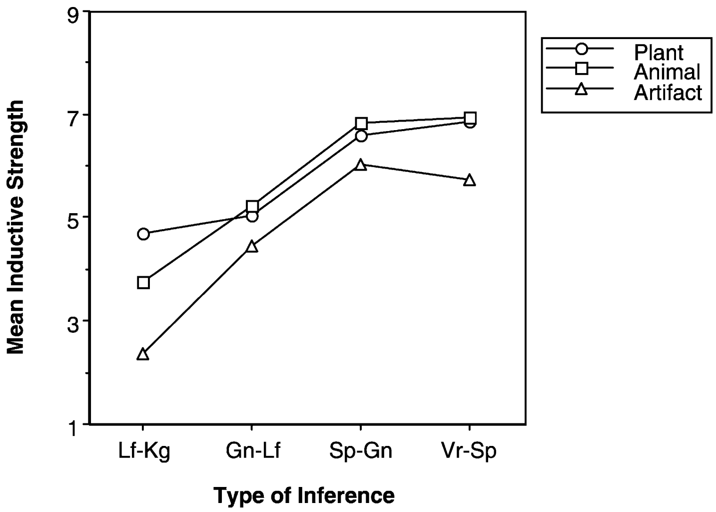

Fig. 4. Mean inductive strength as a function of domain and type of inference in Experiment 2.

3.2.2.1. Plants. A 5 (life-form) × 4 (inference type: Vr-Sp, Sp-Gn, Gn-Lf, Lf-Kg) ANOVA revealed a main effect of inference type ($F(3, 525) = 92.95$, MSe = 2.28, $P < 0.0001$); inferences to folk-generic concepts were no weaker than to folk-specific concepts, but were significantly stronger than inferences to life-form and folk-kingdom concepts. There was also an interaction between life-form and inference type ($F(12, 525) = 4.28$, MSe = 2.28, $P < 0.0001$). For *tree*, *flower*, *herb*, and *bush*, the largest significant breakpoint in inductive strength occurred at the folk-generic level, indicating folk-generic inductive privilege. In contrast, for *grain* the largest significant break occurred at the life-form level.

3.2.2.2. Animals. A 4 (life-form) × 4 (inference type) ANOVA showed that inferences to folk-generic concepts were stronger than to life-form concepts, which were significantly greater than to folk-kingdom concepts ($F(3, 420) = 137.15$, MSe = 2.38, $P < 0.0001$). These results were qualified by an interaction between life-form and inference type ($F(9, 420) = 4.9$, MSe = 2.38, $P < 0.0001$). For all animal life-forms, the largest significant breakpoint in inductive strength occurred at the folk-generic level – indicating folk-generic inductive privilege – although a smaller significant break occurred at the life-form level for *bird*, *fish* and *reptile*.

3.2.2.3. Artifacts. A 3 (life-form) × 4 (inference type) ANOVA revealed that overall, inferences to "folk-generics" were greater than inferences to "life-forms", which were in turn greater than inferences to the "folk-kingdom" level ($F(3, 315) = 85.06$, MSe = 3.52, $P < 0.0001$). There was also an interaction between life-form and inference type ($F(6, 315) = 3.98$, MSe = 3.52, $P = 0.0007$). For *furniture* and *tool*, the largest significant breakpoint occurred at the "folk-generic" level, and a smaller significant break occurred at the "life-form" level. In contrast, for *clothes*, the only significant break in inductive strength occurred at the "life-form" level.

3.3. Discussion

The results for living kinds mirror those from Experiment 1. As seen in Table 1, concepts at the life-form level showed the largest gain in informativeness for 7/9 living kinds (*bird*, *fish*, *tree*, *bush*, *flower*, *grain*, *herb*), replicating the finding of Rosch et al. (1976) that *bird*, *tree*, and *fish* are "basic level" concepts, and extending this finding more generally to living kind concepts at the life-form level. In contrast, for *mammal* and *reptile*, the largest gains in informativeness occurred at the folk-generic level (*tiger*, *deer*, *squirrel*, *snake*, *turtle*, *crocodile*). This may reflect greater salience or familiarity of these species for our population. Alternatively, it may also reflect the diversity of species within each life-form. Subjectively, or perhaps even objectively, kinds of reptiles or mammals may differ more than kinds of birds and fish, thereby making it more difficult to list features generally true of *mammal* or *reptile*. Although the life-form level for living kinds showed a relative advantage for knowledge, the largest gain in inductive strength for 8/9 living kinds occurred at the folk-generic level, suggesting that folk-generic concepts were relatively advantaged for induction. As in Experiment 1, these results suggest that for living kinds, the privileged level for induction does not correspond to the privileged level for informativeness.

Experiment 2 also extended the domain of inquiry to artifact kinds. Concepts at the "life-form" level showed the greatest gain in informativeness for 2/3 artifacts (*clothing*, *furniture*); for *tool*, the greatest gain in informativeness occurred at the "folk-generic" level (*hammer*, *saw*, *screwdriver*). This pattern of results is somewhat discrepant with Rosch et al.'s (1976) findings, which suggest that the basic level for artifacts occurs at what we have called the "folk-generic" level (e.g. *shirt*, *chair*, *hammer*). This discrepancy may stem in part from the fact that we employed an additional conceptual level (*object*) which is superordinate to Rosch et al.'s most abstract hierarchical level (e.g. *tool*). Having participants list features for *object* enabled us to measure the increase in informativeness for "life-form" artifact concepts relative to the "folk-kingdom" concept. Indeed, if we consider only features listed for the levels queried by Rosch et al., our findings mirror theirs; the largest increase occurs at the "folk-generic" level (their "basic level"). Our results also show that relatively specific artifact concepts are more informative than their living kind counterparts; all artifact kinds showed a significant increase in informativeness from the "folk-generic" to the "folk-specific" level, whereas no living kinds showed this pattern.

Inference patterns were remarkably similar for both artifact and living kind taxonomies. Concepts at the folk-generic level were privileged for induction for 8/9 living kinds and 2/3 artifacts. However, there is a suggestion of a domain difference in relations between knowledge and induction; the level showing relative advantage for knowledge and induction corresponded for 2/3 artifact "life-forms" but for only 2/9 living kind life-forms. Although conclusions based on three artifact "life-forms" must be tentative, these findings raise the possibility that induction and knowledge may be more tightly associated for artifacts, and that expectations about conceptual coherence may play a larger role in guiding inferences about living kinds. We address this question more directly in Experiment 3.

4. Experiment 3

Results of Experiments 1 and 2 indicate some independence of knowledge and inductive potential; the level at which concepts show relative advantage for organizing knowledge need not coincide with the level at which concepts show relative advantage for inductive inference. This independence seems especially pronounced for living kinds. Given this lack of correspondence between informativeness and inductive potential, in Experiment 3 we sought to examine relations between inductive strength and *beliefs* or *expectations* about informativeness. To do so, we argue that knowledge of features shared by category members does not exhaust knowledge about concepts. Rather, we may have beliefs or expectations about conceptual structure that go beyond the facts we know about specific category members (see Ahn et al., 2001; Medin & Ortony, 1989 for further discussion).

In Experiment 3 we seek to index expectations about conceptual structure by measuring beliefs about similarity. Whereas feature listing depends on specific knowledge, similarity judgments may be informed by less concrete beliefs. For instance, we may expect that sugar maples and silver maples are similar, and both different in important ways from oaks, even if we were unable to identify actual members of these categories, and know little more than that they are "kinds of trees" (see Coley, Medin, Proffitt, Lynch, & Atran, 1999). When viewed this way, beliefs about within-category similarity (e.g. "How similar are oaks to each other?") may be taken as an index of *expected informativeness* because they reflect the degree to which members of a category are thought to share properties, regardless of what those properties actually are. Mervis and Crisafi (1982) also looked at within-category similarity, but they did so by eliciting similarity ratings among individual category members rather than judging the similarity of the category as a whole. In contrast, our measure is intended to index beliefs or expectations about how similar category members are, rather than specific knowledge. Expectations about informativeness may be based on beliefs that are not directly tapped in a feature listing task (e.g. "I believe that all maples are basically alike even though I couldn't pick one out of a line-up."). Moreover, such beliefs may be related to inductive potential, which may depend more on judgments of plausibility that category members will share properties than on actual knowledge of shared features. If so, expected informativeness may be more predictive of inductive potential than knowledge is. The primary goal of Experiment 3 is to examine relations between expected informativeness and inductive potential in living kind and artifact hierarchies.

A secondary goal was to examine the degree to which the findings reported in Coley et al. (1997) and in Experiments 1 and 2 were due to the properties used in the inductive inferences. It is possible that folk beliefs about proteins, enzymes, diseases, and internal substances pinpoint these properties as being shared most strongly among folk-generic groups. If so, then Coley et al.'s results might have more to do with the properties chosen than with any assumptions of special inductive potential for folk-generic categories. To address this question, in the present experiment we ask for generalizations about completely unspecified properties.

4.1. Method

4.1.1. Participants

A total of 114 male and female undergraduate psychology majors at Northwestern University participated in this experiment as part of a class research requirement. Three groups of 16 participants completed the similarity measures, and 66 participants completed the induction measures. Of these 66, 36 completed induction items for plants and animals, and an additional 30 completed artifact items.

4.1.2. Materials and design

As in Experiment 1, stimuli consisted of category names selected to form hierarchically-related taxonomies of plants, animals, and human-made artifacts. Nine life-forms were chosen from the plant, animal, and artifact hierarchies used in Experiment 2: *tree*, *bush*, *flower*, *mammal*, *bird*, *fish*, *furniture*, *clothing*, *tool*. Generics, specifics, and varietals for these life-forms were the same as used in Experiment 2. Items used in Experiment 3 are noted in Appendix B.

4.1.3. Procedure

4.1.3.1. Similarity. In order to measure expected informativeness, we asked participants to rate within-category similarity, i.e. beliefs about similarity among category members for concepts at various hierarchical levels. Three groups of 16 participants each rated similarity for one domain (plants, animals, artifacts). Each participant rated 22 concepts (one kingdom, three life-forms, nine generics, and nine specifics) which were the same target concepts listed in Appendix B. Items were presented in random order, and the participant was asked to rate how similar members of the target concept are to each other, e.g. "How similar are *oaks* to each other?" Participants were tested in small groups, and given written instructions. Items were presented in booklets and participants indicated their response on a nine-point scale (1 = VERY DISSIMILAR, 9 = VERY SIMILAR), and provided a short written justification for why they responded as they did.

4.1.3.2. Induction task. As in Experiments 1 and 2, the task involved four types of inferences: Vr-Sp, Sp-Gn, Gn-Lf, and Lf-Kg. Participants either responded to questions about living kinds (plants and animals) or artifacts. In both cases, three question sets were developed, each of which contained one question of each of the four types presented for each of the six life-forms, for a total of 24 inferences per participant. For each set, a different folk-generic term appeared in each type of inference for each life-form (e.g. in one set for *fish*, the specific item might ask about *trout*, the generic item might ask about *bass*, and the life-form item might ask about *sharks*). This was counterbalanced across subjects so that each generic appeared in each kind of inference the same number of times. Finally, each question set was presented in random order with the constraint that no questions about the same life-form appeared consecutively.

The property queried in each question was literally, "Property X", where a letter of the alphabet replaced X. A different letter was used for each item. Participants were tested in groups of three to five. Questions were presented in written form. Participants indicated their responses to each item by circling a number on a likelihood scale ranging from 1 (all Bs are "very unlikely" to have P) to 9 (all Bs are "very likely" to have P). All participants were given as much time as they needed to complete the tasks.

4.2. Results

In the following, we identify privileged levels in conceptual hierarchies for expected informativeness and for inductive reasoning. As before, we define the privileged level as the level at which the largest significant increase in similarity or inductive strength occurs. The privileged levels for expected coherence and induction by life-form are summarized in Table 1. We also directly examine relations among knowledge, expectation, and induction.

4.2.1. Expected informativeness

Similarity ratings were averaged across items within each level (specific, generic, life-form, kingdom) and were analyzed separately for each domain using a one-way repeated-measures ANOVA (see Fig. 5). For animals and artifacts, similarity among category

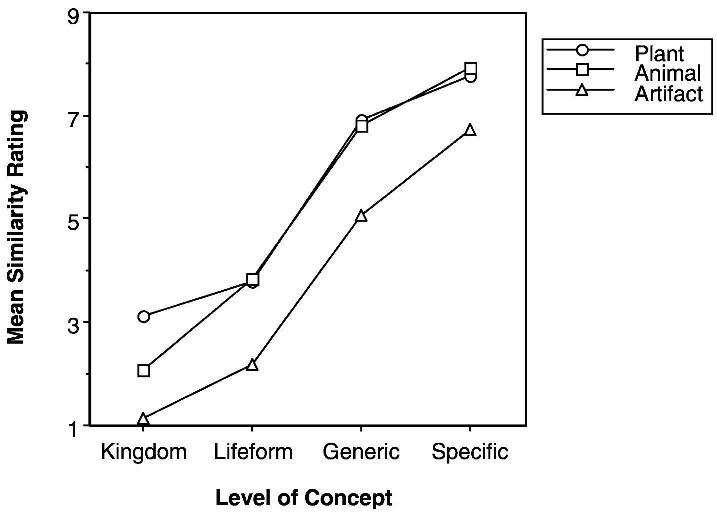

Fig. 5. Mean within-category similarity as a function of domain and hierarchical level in Experiment 3.

members at each level was significantly higher than for the immediately superordinate level; for both, the largest significant increase in perceived similarity was at the folk-generic level (animals: $F(3,15) = 157.50$, MSe $= 0.74$, $P < 0.0001$; artifacts: $F(3,15) = 322.74$, MSe $= 0.33$, $P < 0.0001$). For plants, the only significant difference between adjacent levels occurred at the folk-generic level ($F(3,15) = 76.44$, MSe $= 1.10$, $P < 0.0001$). Thus, similarity ratings suggest that expected informativeness increases with specificity. Moreover, the largest gain in expected informativeness occurs uniformly at the folk-generic level, in contrast to the feature listing data reported in Experiments 1 and 2, which showed a relative advantage at the life-form level.

4.2.2. Inductive inference

Patterns of inferences for animals, plants, and objects were examined separately using 3 (life-form) × 4 (inference type) within-subject ANOVAs. Results are presented in Fig. 6.

4.2.2.1. Plants. Overall, Vr-Sp inferences were no stronger than Sp-Gn inferences; Sp-Gn inferences were much stronger than Gn-Lf inferences which did not differ from Lf-Kg inferences ($F(3,105) = 66.88$, MSe $= 2.32$, $P < 0.0001$). This pattern was qualified by a life-form by inference type interaction ($F(6,210) = 5.04$, MSe $= 0.87$, $P < 0.0001$). For *tree* and *flower*, Gn-Lf inferences were stronger than Lf-Kg inferences; this was not true for *bush*. In all cases, however, the largest significant increase in inductive strength occurred at the folk-generic level.

4.2.2.2. Animals. Overall, Vr-Sp inferences were no stronger than Sp-Gn inferences. Sp-Gn inferences, however, were rated stronger than Gn-Lf inferences, which in turn were rated stronger than Lf-Kg inferences ($F(3,105) = 93.26$, MSe $= 2.60$, $P < 0.0001$). This pattern was qualified by a life-form by inference type interaction ($F(6,210) = 17.36$, MSe $= 0.68$, $P < 0.0001$). For *mammal*, the only significant increase in inductive strength

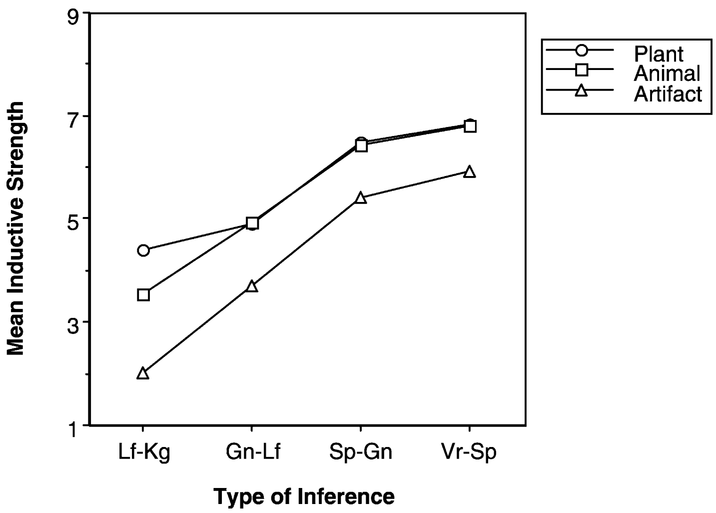

Fig. 6. Mean inductive strength as a function of domain and type of inference in Experiment 3.

occurred at the folk-generic level. For *bird* and *fish*, inductive strength increased significantly at the life-form level and again at the folk-generic level; for these two life-forms, the largest significant increase occurred at the life-form level.

4.2.2.3. Artifacts. Overall, artifact inductions patterned like those for animals. Vr-Sp inferences were no stronger than Sp-Gn inferences; Sp-Gn inferences were much stronger than Gn-Lf inferences, which in turn were stronger than Lf-Kg inferences ($F(3, 87) = 90.10$, MSe $= 3.13$, $P < 0.0001$). Again, this pattern differed somewhat for different "life-forms" ($F(6, 174) = 2.21$, MSe $= 1.08$, $P = 0.04$). For *tool* and *clothing*, inductive strength increased significantly at the "life-form" level and again at the "folk-generic" level; for *furniture*, inductive strength increased significantly at each adjacent level. For *tool*, the largest significant increase occurred at the "folk-generic" level, whereas for *clothing* and *furniture*, the largest significant increase occurred at the "life-form" level.

4.2.3. Knowledge and expectations as predictors of inductive inference

Up to this point, we have examined relations among knowledge, expected informativeness and inductive potential by comparing the hierarchical level at which concepts are "privileged" – i.e. show a relative advantage–on each index. Therefore, our findings so far depend in part on our definition of "privilege". Although our definition is consistent with the notion of "basic level" employed by Rosch and others, the definition is in some sense arbitrary, and the advantage is indeed relative rather than absolute.

To directly examine the relative contributions of knowledge and expectations to inductive inferences in a way that circumvents this issue, we ran item-wise multiple regressions separately for each domain, with features and similarity as predictors and inductive strength as the outcome measure. To index *expected informativeness*, we averaged similarity ratings for each item from Experiment 3. To index *inductive strength*,

Table 2
Regression results predicting inductive strength from knowledge and expectation (using data from Experiments 2 and 3)

	Plants	Animals	Artifacts	All items
F value for regression	68.31**	107.67**	18.33**	114.39**
R^2	0.878	0.919	0.659	0.784
Standardized regression coefficient				
Knowledge (mean features listed)	0.036	−0.017	0.434*	0.184*
Expectation (mean similarity rating)	0.924**	0.971**	0.469*	0.760**

*$P < 0.02$, **$P < 0.0001$.

we averaged likelihood ratings for arguments with the item as a conclusion (i.e. mean likelihood of generalizations about the target item) from Experiment 3. Knowledge was not measured in Experiment 3, but the items in Experiment 3 were a subset of those used in Experiment 2. Therefore, we indexed *knowledge* by utilizing data from Experiment 2 and computing the mean number of features listed for each item used in Experiment 3. Thus, each concept was given a score on all three variables. Employing these continuous measures allows us to directly examine relations among knowledge, expectations, and induction without making categorical decisions about "privileged" hierarchical levels.

The regression analysis confirmed that relations among these measures differed strikingly by domain (see Table 2 for details of the regression analysis). For all domains, the overall regression was reliable, although variance explained was higher for plants and animals than for artifacts. More strikingly, for plants and animals, the only significant predictor of inductive strength was expected informativeness; knowledge explained no unique variance. In contrast, for artifacts, both knowledge and expected informativeness explained unique variance.

4.3. Discussion

The pattern of results observed in Experiment 3 is very straightforward. As measured by ratings of within-category similarity, concepts at the folk-generic level were privileged with respect to expected informativeness, independent of variations in specific knowledge of those concepts displayed in Experiments 1 and 2. Taken together with the results of Experiments 1 and 2, this suggests a dissociation of knowledge and expectations about conceptual structure.

In Experiment 3, the level showing an inductive advantage was more variable than in Experiments 1 and 2, and was almost evenly split between the folk-generic and life-form levels. For living kinds, 4/6 life-forms were privileged at the folk-generic level, whereas for artifacts, 2/3 were privileged at the life-form level for induction. Despite this variability, multiple regression analyses clearly show different relations among knowledge, expectations, and induction for living kinds vs. artifact concepts. Specifically, both knowledge and expectations predicted inferences about artifacts, whereas inferences about living kinds were driven by expectation alone, and were independent of knowledge of the concepts in question. Importantly, this result holds independent of any notion of a "privileged level". These results clearly suggest a domain-specific dissociation between knowledge and induction; for living kinds, inductions are driven more by beliefs about conceptual coherence than by specific knowledge of the concepts themselves.

5. General discussion

Across the three experiments presented here the results are remarkably consistent; expectations about the informativeness of a concept play a critical role in determining the likelihood of generalizations about that concept, and this role is largely independent of the actual knowledge participants possess about category members. The degree to which participants are willing to generalize to all members of a category is as much or more determined by relatively abstract expectations about how similar those category members are than by specific knowledge of properties shared by category members. Moreover, our results indicate clear domain differences in relations between knowledge, expectations, and inductive strength. For living kinds, induction seems driven almost completely by expectations, and is unrelated to how informative concepts at different levels actually are. In contrast, for artifact kinds, expectations play a weaker role, and actual knowledge is also predictive of patterns of inductive inference.

To facilitate comparisons across experiments, we have computed the average increase at each hierarchical level relative to its immediate superordinate for each of three critical measures across the three experiments, and standardized these change scores within each measure for comparability. These are presented in Fig. 7. "Knowledge" represents the change in informativeness of concepts at each level as indicated by mean number of features listed for concepts at that level minus mean number of features listed for concepts at the immediately superordinate level, computed across Experiments 1 and 2 (for living kinds) or Experiment 2 (for artifacts). "Induction" represents the change in inductive strength for concepts at each level as indicated by mean likelihood for inferences to concepts at that level minus mean likelihood for inferences to concepts at the immediately superordinate level, computed across Experiments 2 and 3. "Expectation" represents the change in expected informativeness of concepts at each level as indicated by mean similarity ratings for concepts at that level minus mean similarity ratings for concepts at the immediately superordinate level, computed from Experiment 3. As is clear from Fig. 7, knowledge and expected informativeness stand in different relations to inductive inference for living kind vs. artifact concepts. These findings have implications for the issue of domain specificity, and also for broader theories of conceptual structure and inductive reasoning.

5.1. Relations among knowledge, expectation, and inductive inference

Our primary findings are that relatively abstract expectations about category informativeness play a critical role in guiding inductive inferences, and that relations among knowledge, expectations, and inductive strength differ for living kinds vs. artifact kinds. Inductive inferences about living kind concepts were driven entirely by expectations about how informative concepts were; these expectations were independent

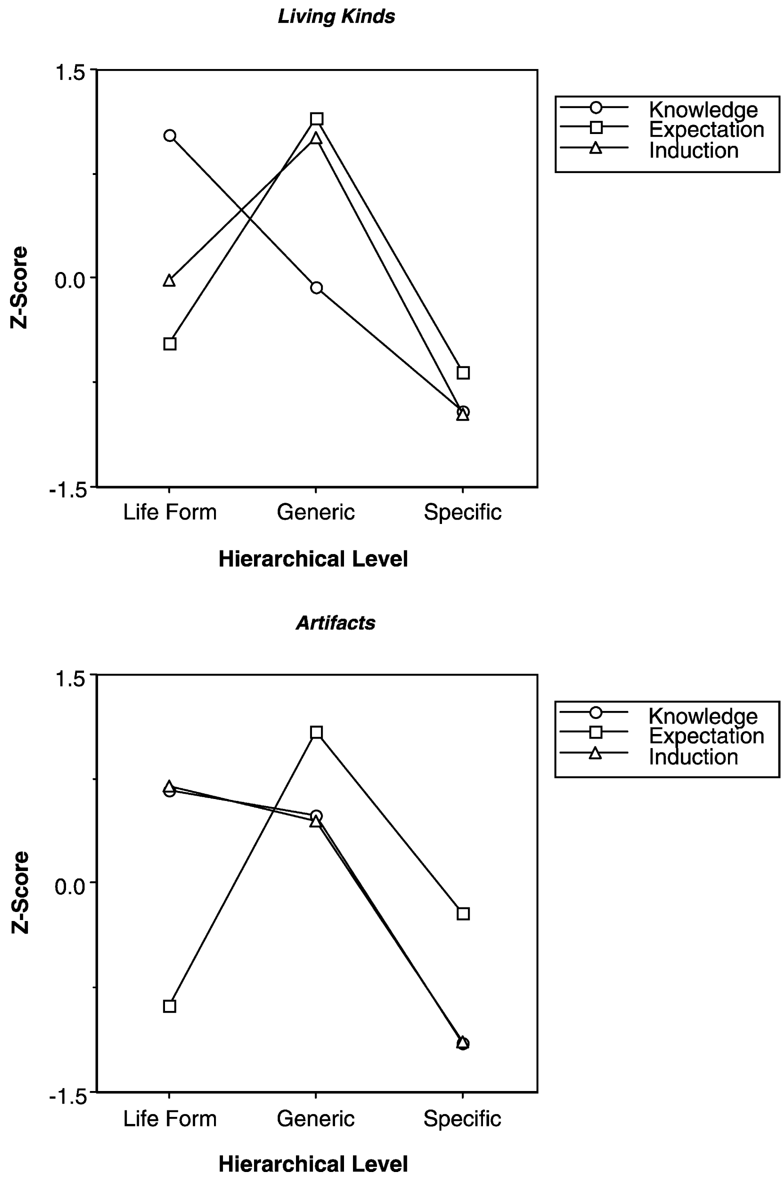

Fig. 7. Standardized mean increase relative to the immediately superordinate level as a function of conceptual measure and hierarchical level from Experiments 1–3.

of actual knowledge of the categories involved. This can be seen by comparing relative changes in each index from general to specific hierarchical levels (see Fig. 7). For living kinds the largest gain in knowledge occurs at the life-form level; gains in knowledge are much smaller for concepts at the folk-generic and folk-specific levels. In contrast, the gains in expected informativeness and in inductive strength are relatively low for concepts at the life-form and folk-specific levels, and much higher for folk-generic concepts. Thus, for living kinds, changes in inductive strength correspond to changes in expected informativeness, not knowledge.

This pattern is also evident upon examination of the levels that showed relative advantage across the three experiments. As is evident in Table 1, the location of the privileged level for knowledge and for induction corresponded in only 25% of living kind life-forms tested. In contrast, the privileged level for expected informativeness and for induction corresponded in 67% of living kind concepts. Moreover, when category knowledge, expected informativeness and inductive potential were measured continuously, expected informativeness alone predicted inductive potential for living kinds; category knowledge explained virtually no unique variance.

Finally, knowledge and inductive potential show different developmental trajectories for living kinds. Although 8-year-olds and adults show gains in knowledge for life-form, folk-generic and folk-specific concepts relative to 5-year-olds, the life-form level nevertheless retains its privileged status by showing the largest increase in informativeness across the ages tested in Experiment 1. In contrast, the level privileged for induction shows developmental change: 5-year-olds privileged *tree* at the folk-generic level and showed little inductive distinction between levels for animal concepts; 8-year-olds privileged *tree* and *bird* at the folk-generic level and *fish* at the life-form level, and adults privileged all three at the folk-generic level. Thus, the increasing relative advantage of folk-generic concepts for induction contrasts with the consistent relative advantage of life-form concepts for knowledge. This suggests that the primary development is not the acquisition of knowledge, but rather changes in beliefs about the underlying nature, and therefore inductive potential, of categories. In sum, these results show a clear dissociation between knowledge and induction for living kinds, and support the idea that expectations about underlying commonalities may be critical in guiding inductive inferences about living kinds.

For artifacts, relations between knowledge, expected informativeness and induction were very different from those observed for living kinds, although our conclusions must be qualified because we only examined *tool*, *clothing* and *furniture*. Inductive inferences about artifacts were much more closely related to actual category knowledge, although expected informativeness still played a role. As seen in Fig. 7, relative changes in expected informativeness for artifacts show a similar pattern to that seen for living kinds; gains are largest for concepts at the “folk-generic” level. But the similarity ends there. Gains in both knowledge and inductive potential are highest for artifact concepts at the “life-form” level. Gains in knowledge and inductive potential are modestly smaller but still relatively large for “folk-generic” concepts, and relatively low for “folk-specific” concepts. For artifacts, changes in inductive strength correspond to changes in knowledge, not expected informativeness.

This pattern is also evident upon examination of the levels that showed relative advantage across Experiments 2 and 3. As is evident in Table 1, the location of the privileged level for knowledge and for induction corresponded in 67% of artifact concepts tested, whereas the privileged level for expected informativeness and for induction corresponded in only 33% of artifact concepts. Moreover, when category knowledge, expected informativeness and inductive potential were measured continuously in the regression analysis presented in Experiment 3 both expected informativeness and category knowledge predicted inductive potential for artifact kinds.

Coley et al. (1997) found that the level privileged for induction did not correspond to Rosch et al.'s "basic level", and argued that this discrepancy might indicate the importance of expectations about underlying commonalities in guiding inductive inferences about living kinds. Results of the present experimental series support this conjecture by demonstrating a clear dissociation between knowledge and induction for living kinds, and by showing that expectations about categories outweigh category knowledge in guiding inductive inferences about living kinds. Moreover, the present results show an important difference between living kinds and artifact categories regarding interrelations among knowledge, expectations, and induction. For living kinds, expectations are the sole predictor of inductive potential, whereas for artifacts, category knowledge and expectations are both related to induction. In sum, these results suggest that relatively abstract expectations about categories are as important, if not more important than specific category knowledge in guiding inductive inferences.

5.2. Domain differences in conceptual structure

It is important to emphasize that our definition of "privileged level" is quantitative rather than qualitative. As such, it should be taken to indicate a relative advantage for concepts at a particular hierarchical level rather than an absolute qualitative distinction among different levels of conceptual hierarchy. Nevertheless, our results may have implications for domain differences in the nature of conceptual hierarchies. Across Experiments 2 and 3, we observed more consistency in the location of the relatively advantaged level for induction for living kinds, and less consistency coupled with a greater impact of specific knowledge for artifacts. One possible interpretation of these findings is that the notion of a hierarchical level may have more reality for living kind concepts. For living kinds each level of the conceptual hierarchy is associated with a rich cluster of features on multiple dimensions relevant to category membership (e.g. morphology, genetic makeup, habitat, typical behaviors). Moreover, concepts at each rank of a folk biological hierarchy (e.g. life-form, folk-generic) have been argued to show similar taxonomic, linguistic, biological, and psychological properties (e.g. Berlin, 1992). In contrast, the organization of artifact hierarchies may be dominated by feature values on a single dimension, namely an object's intended or current function (Bloom, 1996; Keil, 1989). As such, conceptual levels may be more differentiated and meaningful for living kind hierarchies, as reflected here in more consistent responses on our inductive measure. If levels of abstraction are less differentiated for artifacts, then there may be more room for the influence of individual knowledge and experience, as reflected in less consistent patterns of induction and a larger role for informativeness.

However, even if conceptual levels in living kind hierarchies are richer and better defined than in artifact hierarchies, we must still explain the differential importance of expected informativeness for induction as revealed in the item-wise analysis in Experiment 3. Coley et al. (1997) discuss regularities in nomenclature as one possible source of the relative advantage of folk-generic living kinds for induction. In all of the experiments reported above, life-form and folk-generic concepts all had unique names (e.g. *tree*, *oak*) whereas folk-specific concepts had names that transparently marked them as a subset (e.g. *red oak*). Given this nomenclatural regularity, an assumption that uniquely-named concepts share important albeit unknown properties could result in folk-generic privilege. In the present studies, regularities in naming could be relevant in identifying folk-generic concepts. However, several results suggest that this cannot be the entire story. Specifically, patterns of nomenclature were identical for living kind and artifact hierarchies, yet artifacts showed more variability in the relatively advantaged level for induction, and showed very different relations among knowledge, expectation, and induction. Thus, an assumption that unique labels signal important commonalities cannot explain our results.

Rather, our results indicate that participants expected uniquely-named (i.e. folk-generic) living kinds to support inductive generalizations despite the fact that those same folk-generic concepts were relatively uninformative. This is consistent with views that stress the importance of relatively abstract beliefs or explanatory theories in organizing conceptual structure (e.g. Murphy & Medin, 1985; Wellman & Gelman, 1992). Participants may believe that members of biological categories share many properties because of an underlying biological nature that gives rise to those properties (e.g. Ahn et al., 2001; Gelman & Coley, 1991). If so, expectations about conceptual similarities derived from this belief should be a stronger predictor of inductive potential than actual knowledge of the concepts. In contrast, for artifacts, no presumption of any underlying biological nature exists, and so inductive potential is much more closely tied to knowledge.

5.3. Implications

Our findings suggest that different metrics may apply to different conceptual functions. Specifically, the privileged level for organizing knowledge (i.e. the level showing the highest differentiation and the highest gain in informativeness) need not correspond to the privileged level for induction. In contrast, induction seems driven in large part by relatively abstract expectations about similarities rather than knowledge of shared features per se. These expectations play a much larger role in inductions about living things, and may therefore be informed by theory-driven beliefs about biological entities. Previous work (see Murphy & Lassaline, 1997) has identified a number of possible principles and metrics that can be used to predict the location of the psychologically privileged level within conceptual hierarchies. In general, the idea that category differentiation may predict psychological privilege for tasks tapping knowledge of category members is consistent with other proposals that basic-level categories are those that maximize within-category similarity and minimize between-category similarity (cf. Jones, 1983; Medin, 1993; Rosch et al., 1976). These metrics assume that similarity computations are based on knowledge of the shared and distinctive features of category members.

Metrics such as Corter and Gluck's (1992) "category utility", on the other hand, assume that the categories most likely to show psychological privilege will be those that improve our ability to predict unknown features given category membership. In this sense the category utility principle seems close to our notion that the expected informativeness of category labels plays a major role in determining the psychologically privileged level. Like Corter and Gluck (1992) we argue that one of the chief functions of category labels is to promote the expectation that similarly labeled instances will share many features in common, even when we have little specific knowledge of these instances. Seen in this light, the novel contributions of the current studies are that they show that this metric is particularly relevant to inductive inference, that the expectations involved are not merely a function of knowledge, and that such expectations are differentially important for living kind vs. artifact concepts. Our results do not dispute that other metrics that are based more directly on knowledge of the common and distinctive features of category members (e.g. Medin, 1993) may be accurate predictors of the location of the privileged level in knowledge-based tasks like feature listing or categorization; rather, they highlight the relevance of a different metric for inductive reasoning.

The finding that expected within-category similarity was closely related to inductive strength is also consistent with a growing body of evidence that the strategies that people rely on when making category-based inferences differ from those used in other categorical judgments such as classification. For example, Yamauchi and Markman (1998) have shown that making inductive inferences promotes sensitivity to exemplar information within a category and helps subjects to extract family resemblance information, whereas classification focuses attention on a small number of features that differentiate category members and non-members (see Lassaline & Murphy, 1996; Verbeemen, Vanoverberghe, Storms, & Ruts, 2001 for related findings). Moreover, our results also suggest that models of inductive inference should not be based solely on similarities computed over known features, but must incorporate relatively abstract beliefs and expectations about concepts as well (e.g. see Medin, Coley, Storms, & Hayes, in press).

Markman and Ross (2003) suggest that comparisons of performance across different categorical tasks need to be informed by a careful analysis of the processing steps involved in each task. We have argued that induction across hierarchies is driven by general expectations about category coherence and within-category similarity. In the biological hierarchy folk-generic categories showed the largest gain in expected informativeness and also showed the greatest gain in inductive potential. Feature listing, on the other hand, was assumed to reflect knowledge about category informativeness, tapping knowledge about the commonalities among category members at a given level of abstraction. This description of the way that people approach feature listing tasks is generally consistent with the assumptions made by previous researchers (e.g. Rosch et al., 1976 viewed feature listing as a measure of category differentiation).

We acknowledge that these task descriptions remain somewhat general and do not specify all of the steps involved in completing each task. Nevertheless, it is possible to construct a more elaborate process model of feature listing and show that this model would still predict privilege at the life-form level for biological hierarchies. For example, feature listing at a given hierarchical level may require a person to compare subordinate concepts that are members of that category and list the properties that emerge from these comparisons. According to this account listing common features for life-forms such as "bird" would involve comparing the commonalities and differences between folk-generic categories such as eagles, sparrows, and larks. Markman and Wisniewski (1997) have shown that because such categories have similar representational structures (i.e. they have large numbers of features such as "wings" that have similar relational roles within each category) subjects can readily identify their shared features. The increase in the number of shared features identified at more subordinate levels is negligible (see Markman & Wisniewski, 1997, Experiment 3).

Because feature listing for the life-form level involves comparing large numbers of folk-generic categories, it is likely to be the most privileged level for this task.

5.4. Conclusions

One conclusion supported by this research is that for adults, different hierarchical levels are privileged for different conceptual functions. Across three experiments we observed consistent differences between the level at which the greatest gain in informativeness occurred, and the level at which the greatest gain in inductive potential occurred. This suggests that there is no one basic level; which level of a conceptual hierarchy is psychologically privileged depends on which conceptual function is under consideration.

A second conclusion is that expectations about conceptual informativeness play a critical role in guiding inductive inference, in many cases more so than specific knowledge about category members. Thus, it appears that inductive inference is driven by expectations about conceptual structure that go beyond what is known about particular category members. Moreover, the relations between expected informativeness and inductive inference were much stronger for living kinds than for artifacts, indicating a larger role for expectations about conceptual structure in folk biological thought. Precisely what these expectations are, how they come about, and how they may interact with knowledge to influence induction remains to be seen. Nevertheless, our results suggest that the influence of relatively abstract beliefs about conceptual structure on basic conceptual functions such as inductive inference cannot be ignored.

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Appendix A. Concept names used in Experiment 1

Folk-kingdom	*Life-form*	*Folk-generic*	*Folk-specific*	*Folk-varietal*
Animal	Bird	Sparrow	House sparrow	Common house sparrow
		Cockatoo	Palm cockatoo	Australian palm cockatoo
		Crow	Torresian crow	Northern Torresian crow
	Fish	Shark	River shark	Common river shark
		Trout	Rainbow trout	Northern rainbow trout
		Bream	Bony bream	Common bony bream
Plant	Tree	Gum	Ghost gum	Eastern ghost gum
		Wattle	Hickory wattle	Eastern hickory wattle
		Oak	Desert oak	Western desert oak

Appendix B. Concept names used in Experiments 2 and 3

Folk-kingdom	*Life-form*	*Folk-generic*	*Folk-specific*	*Folk-varietal*
Animal	Bird*	Lark	Meadow lark	Northern meadow lark
		Eagle	Bald eagle	White-collared bald eagle
		Sparrow	House sparrow	Brown-backed house sparrow
	Fish*	Shark	Hammerhead shark	White-collared hammerhead shark
		Bass	Largemouth bass	Brown-backed largemouth bass
		Trout	Rainbow trout	Northern rainbow trout
	Mammal*	Tiger	Bengal tiger	White-collared Bengal tiger
		Squirrel	Grey squirrel	Brown-backed gray squirrel
		Deer	Whitetail deer	Northern whitetail deer
	Reptile	Snake	Garter snake	Common garter snake
		Turtle	Painted turtle	Eastern painted turtle
		Crocodile	Nile crocodile	Upper-Nile crocodile
Plant	Herb	Rosemary	Mediterranean rosemary	Curly Mediterranean rosemary
		Parsley	Common parsley	English common parsley
		Basil	Sweet basil	Common sweet basil

(*continued on next page*)

Appendix (*continued*)

Folk-kingdom	*Life-form*	*Folk-generic*	*Folk-specific*	*Folk-varietal*
	Bush*	Azalea	Torch azalea	Common torch azalea
		Juniper	Rocky mountain juniper	Eastern rocky mountain juniper
		Elderberry	American elderberry	Spotted American elderberry
	Flower*	Violet	Blue violet	Common blue violet
		Lily	Day lily	Eastern day lily
		Marigold	Marsh marigold	Spotted marsh marigold
	Grain	Wheat	Durum wheat	Golden durum wheat
		Rice	Basmati rice	Indian basmati rice
		Corn	Sweet corn	Northern sweet corn
	Tree*	Oak	Red oak	Northern red oak
		Maple	Sugar maple	Spotted sugar maple
		Pine	White pine	Eastern white pine
Object	Tool*	Saw	Hand saw	Cross-cutting hand saw
		Screwdriver	Flathead screwdriver	Heavy duty flathead screwdriver
		Hammer	Sledge hammer	12-lb sledgehammer
	Furniture*	Chair	Rocking chair	Wooden rocking chair
		Cabinet	Filing cabinet	Metal filing cabinet
		Bed	Canopy bed	King-sized canopy bed
	Clothes*	Shirt	Collared shirt	Short-sleeved collared shirt
		Skirt	Mini skirt	Leather mini skirt
		Pants	Khaki pants	Pleated khaki pants

All stimuli were used in Experiment 2. Life-forms marked with an asterisk (*) and their subordinates were also used in Experiment 3.

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