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Form or Function: A Comparison of Expert and Novice Judgments of Similarity Among Fish

Ethnobiologists debate whether folk biological classifiers are natural historians attending primarily to the morphology of organisms or are pragmatists concerned primarily with utility. We argue that this question is best understood as a problem in intracultural variation: the relative importance of form and function depends on who is asked to judge the similarity of organisms as well as how they are asked to judge it. We find that expert fishermen judge similarities among fish on both functional and morphological criteria, while novices judge on morphological criteria alone and thereby approach the scientific classification of fish more closely than experts. Experts also vary more than do novices, presumably because they control more different kinds of knowledge on which to base a similarity judgment.

> . . . the Mexican sierra has "XVII-15-IX" spines in the dorsal fin. These can easily be counted. But if the sierra strikes hard on the line so that our hands are burned, if the fish sounds and nearly escapes, and finally comes in over the rail, his colors pulsing and his tail beating into the air, a whole new relational externality has come into being—an entity which is more than the sum of the fish plus the fisherman. The only way to count the spines of the sierra unaffected by this second relational reality is to sit in a laboratory, open an evil-smelling jar, remove a stiff colorless fish from formalin solution, count the spines, and write the truth "D.XVII-15-IX." There you have recorded a reality which cannot be assailed—probably the least important reality concerning either the fish or yourself.
>
> —John Steinbeck, *The Log from the Sea of Cortez*

DO WE SEE THE WORLD WITH OUR GUTS OR WITH OUR MINDS? To what extent is our perception of the world shaped by our wants, needs, and goals? Steinbeck is not alone in seeking an answer to these questions; it has been an important concern for anthropologists in general and ethnobiologists in particular. Writers on this issue divide into two camps. On one side are those who argue for an intellectual basis of folk biological classification: the folk are seen as natural historians interested in understanding organic diversity for its own sake (e.g., Lévi-Strauss 1966; Berlin, Breedlove, and Raven 1973). On the other side are those who argue for the utilitarian basis of human attention in the environment, picturing folk biologists as pragmatists interested in the natural world primarily as a means of satisfying human needs (e.g., Malinowski 1954; Hunn 1982).

The earlier authors take the more extreme positions in this debate. In an often quoted passage, Malinowski states: "The road from the wilderness to the savage's belly and consequently to his mind is very short, and for him the world is an indiscriminate background

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against which there stand out the useful, primarily the edible, species of animals or plants" (1954:44). For Lévi-Strauss, Malinowski is simply mistaken. He argues that "animals and plants are not known as a result of their usefulness; they are deemed to be useful because they are known" and that the purpose of folk biological knowledge is that it "meets intellectual requirements rather than or instead of satisfying needs" (Lévi-Strauss 1966:9).

The major modern proponents of these points of view have been closer to a common ground. Hunn argues that folk biological classifications are composed of a "general purpose biologically natural taxonomic core and special purpose biologically artificial peripheral taxa" (Hunn 1982:830).[1] He asserts that this natural core model is superior in explanatory power and is more explicit about the purposes of classification than taxonomic hierarchy models. While Hunn argues that ethnobiologists should pay closer attention to the adaptive significance of folk biological knowledge, he nevertheless acknowledges that some adaptionist explanations are oversimplifications (Hunn 1982:831), following Hays (1982).

Berlin has dedicated much of his career to articulating the general principles of folk biological classification systems and to documenting the close correspondence of folk and scientific systematics (Berlin 1972, 1973, 1976; Berlin, Breedlove, and Raven 1973, 1974). He has often emphasized that morphology is more important than function in determining the structure of folk genera. While Berlin agrees with Lévi-Strauss that "the satisfaction of [the basic needs of sustenance] is surely not the primary mover in the recognition and classification of [potentially edible] species" (Berlin and Berlin 1983:324), he criticizes the ad hoc character of Lévi-Strauss's claim that primitive classifiers have an inherent intellectual need for order (Berlin and Berlin 1983:322). According to Berlin, one needs neither utilitarian nor intellectual motivations for folk biological classification systems; in general, the natural order is so clear that it would be difficult *not* to recognize local species (Berlin and Berlin 1983:324).

Both Berlin and Hunn might accept the following compromise position: Humans are purposive beings; their activities and works, including classification systems, have to be understood as outcomes of their intentions. But human purposes are complex and cannot be reduced to a blind search for sex and calories. A playful curiosity about the world is surely one of the motives that people have in attending to biological diversity. Moreover, even crude pragmatists totally devoid of intellectual curiosity would pay considerable attention to morphological characters: the most useful general classification would cut nature at its joints and recognize the most important "objective natural discontinuities."

However, rather than working to eliminate the debate, here we address the empirical issue that underlies it. The first two steps in framing this issue have already been taken by Berlin and Hunn. The first step is to transform the question from one of *kind* to one of *degree*. Human concern with the environment should be seen as neither purely intellectual nor simply utilitarian but arising from a combination of motives; the problem is one of measuring the relative importance of these factors in shaping folk biological classifications. The second step is to shift the problem from one of assessing the motives for classification to one of evaluating the outcomes. We accept the equivalences already used by participants in the debate: Berlin stresses that "intellectual" classifications are based on morphology; Hunn (1982) argues that utilitarian classifications are based on "activity signatures" or patterns of use of the organisms. Here, we use people's beliefs about the appropriate use of organisms as a proxy for their actual behavior.

The third step is to avoid the issue of whether folk biological classifications should be treated as taxonomic hierarchies. Berlin's theory of folk taxonomic rank has been criticized from a variety of quarters (Bulmer 1974; Ellen 1979a; Healey 1978–79; Hunn 1976, 1982; Randall 1976). Although we share Hays's (1983) assessment that Berlin's theory represents a seminal contribution to the documentation of general patterns in folk biological classification, we also do not want the "wrangling over rank" to divert our attention from the main issue here: the relative importance of form or function to folk biological classification. Thus, our methods and analysis make no commitment as to whether folk biological classifications are inherently hierarchic or not. We do this by shifting the focus from the class-inclusion relationships between categories to the pattern of similarity among comparable categories, as was done in Boster, Berlin, and O'Neill (1986).[2]

The fourth step is to try to solve the measurement problem. On one hand, methods should be explicit, systematic, and replicable. On the other, they should not constrain the informants' responses in a way that biases the outcome. For example, Randall (1976) points out that even though the elicitation procedures used by ethnobiologists generate responses that can be represented as taxonomic trees, one cannot infer that informants have taxonomic trees "in their heads." He asserts that taxonomic trees model an artifact of the methods rather than the cognition of the informants. Ellen (1986) in considering this problem argues that systematic data collection procedures should be largely abandoned in favor of nondirective, unobtrusive observation: "simply listening to people talking about animals, using prompts which are less inclined to force the data into formal taxonomies" (1986:89). While we recognize the seriousness of the problem that Ellen is wrestling with, we believe he has thrown out the baby and kept the bathwater. Ellen's methods of data collection also constrain informant responses in a way that biases the outcome. By depriving his informants of an opportunity to express themselves in a systematic fashion, he has committed himself to a representation of folk biological classification as anecdotal and devoid of general pattern. Ellen's particularism does not stop with his methods of data collection. He concludes that we should seek generalizations that encompass "all conceivable appearances, including the most obscure and atypical" (1986:94).

We believe Ellen's quest to explain everything would result in explaining nothing. Rather than retreating to radical particularism, it would be more profitable for ethnobiologists to carefully criticize their research methods and recognize that some methods are not an appropriate means to answer some questions. For example, the research methods used in some recent ethno-ornithological experiments (Boster, Berlin, and O'Neill 1986; Boster 1987) either implicitly or explicitly constrained the informant to make judgments of similarity of bird specimens on the basis of form. Thus, the authors could not (and did not) draw an inference about the relative importance of morphological and utilitarian considerations in informants' responses. But similar methods which allow informants greater freedom in choosing the basis of their similarity judgments would be appropriate to address this issue (e.g., the free pile sort described below). These methods still constrain the informants' responses, but not in ways that are relevant to the question under study.

Our final and most important step in approaching this issue is to directly examine variation in people's knowledge of the domain. Intracultural variation in folk biological knowledge has been well-documented (Boster 1985, 1986; Boster, Berlin, and O'Neill 1986; Ellen 1979b; Gardner 1976; Gal 1973; Hays 1976); individuals generally vary in their abilities, motivations, and opportunities to learn about organisms. An examination of this variation seems particularly relevant to the problem addressed here: there are good reasons to expect that the relative importance of form and function in organismal similarity judgments depends on who is asked to make the judgment. While morphological information is available to anyone who looks at organisms, cultural knowledge of the utility of the organisms usually requires extensive experience and direct communication with those who know. These differences in the ease of acquisition of different types of information have consequences for the pattern of intracultural variation: experts and novices should differ not only in the *amount* but in the *kind* of information they control. Information available through immediate direct observation (e.g., morphological) will be available to novice and expert alike, while information available only through cultural transmission or long experience (e.g., utilitarian) will be more or less restricted to experts. If this difference in knowledge leads to a difference in judgment, then experts would be more likely than novices to evaluate organismal similarities on the basis of utility.

Thus, an appropriate empirical test of the form-function question is to evaluate the degree to which people's unconstrained judgments of the similarities among organisms is determined by their beliefs about the organisms' utility or by their perceptions of the organisms' morphological similarities. Furthermore, groups of informants with and without expert knowledge of the organisms should be compared in order to determine whether there are significant differences in the way they judge the similarities of the organisms. The intellectual model predicts that informants would primarily base the sorting on the morphological similarities of the organisms. The utilitarian model predicts that informants would primarily base the sorting on their knowledge of the uses of the organisms. We suggest that there may be patterned intracultural variation in the bases of organismal similarity judgments, with experts closer to the utilitarian model and novices closer to the intellectual model.

Fish are an especially suitable domain to investigate since, as aquatic creatures, they are hidden from view to a much greater degree than are terrestrial birds and mammals. Domain novices do not have opportunities to try out strategies of discriminating kinds of fish to the same extent that they are able to practice distinguishing terrestrial vertebrates. We would expect that the gulf separating experts and novices in this domain would be greater than for those domains in which information is more freely available.

Methods

Data Collection and Transformation

We compare similarity matrices based on four types of data: (1) unconstrained similarity judgments of fish from domain novices, (2) unconstrained similarity judgments of fish from domain experts, (3) beliefs about the use and functional characteristics of the fish, and (4) a measure of the morphological similarities of the fish.

Unconstrained similarity judgments of fish (data types 1 and 2 above) were elicited in pile-sorting tasks. Subjects were asked to place line drawings of fish into piles according to which they believed were similar to one another. Subjects could form as many piles as they wished and could base their judgments of similarity on whatever characteristic they pleased. Each of the 43 line drawings was labeled with the fish's common name or names. A list of the species used as stimuli is shown in Table 1. After the informants had sorted the fish, they were asked to describe their reasons for their placement of fish in the piles.

Both novices and experts performed the pile-sort task. The novice sample consisted of 15 undergraduate students enrolled in lower-division anthropology courses at East Carolina University in Greenville, North Carolina. Subjects who had the least experience in salt water recreational fishing were selected: most of these had never been fishing; a few were individuals who had been fishing in the past but who described themselves as uninterested in fishing and had not gone fishing in the last year.

The expert sample consisted of recreational fishermen from four areas in the southeast United States: east Florida, west Florida, Texas, and North Carolina. These fishermen were contacted by first obtaining the membership lists of sport fishing clubs in the four areas. Approximately 30 informants from each area were randomly selected and were interviewed either in their homes or at their places of business. In this study, only the responses of the first 15 fishermen interviewed from each area were analyzed.

The responses of the group of novices and the four groups of experts to the fish pile-sort task were aggregated to form five fish-by-fish similarity matrices. Each cell of these pile-sort similarity matrices contains the number of informants who placed the pair of fish corresponding to the row and column of the matrix in the same pile.

Beliefs about the use of the fish were elicited through sentence substitution frames (D'Andrade et al. 1972; D'Andrade 1976). The sentences fishermen used while spontaneously describing fish were recorded during the course of pilot interviews in Florida, Texas, and North Carolina. For example, if a fisherman volunteered that "the meat from amberjack is oily tasting," the sentence substitution frame "the meat from ______ is oily

Table 1
Identification of the 43 fish used as stimuli in the pile sorting and the belief frame tasks.[a]

ID	Taxonomic code	Latin name	English name
1	11122112111	*Carcharhinus limbatus*	Blacktip shark
2	11211111111	*Dasyatis sabina*	Atlantic stingray
3	21111111111	*Elops saurus*	Ladyfish
4	21111121111	*Megalops atlanticus*	Tarpon
5	22111111111	*Arius felis*	Sea catfish
6	22111111121	*Bagre marinus*	Sail fin catfish
7	22211111112	*Prionotus tribulus*	Bighead sea robin
8	22221111111	*Centropomus undecimalis*	Snook
9	22221131111	*Centropristis striata*	Black sea bass
10	22221131121	*Epinephelus morio*	Red grouper
11	22221131123	*Epinephelus itajara*	Jewfish
12	22221131132	*Mycteroperca phenax*	Scamp
13	22221141111	*Pomatomus saltatrix*	Bluefish
14	22221151111	*Rachycentron canadum*	Cobia
15	22221161111	*Caranx crysos*	Blue runner
16	22221161112	*Caranx hippos*	Crevalle jack
17	22221161121	*Seriola dumerili*	Amberjack
18	22221161131	*Trachinotus carolinus*	Pompano
19	22221171111	*Coryphaena hippurus*	Dolphin
20	22221181111	*Lutjanus griseus*	Gray snapper
21	22221181113	*Lutjanus analis*	Mutton snapper
22	22221181115	*Lutjanus campechanus*	Red snapper
23	22221191111	*Lobotes surinamensis*	Tripletail
24	222211A1111	*Eucinostomus gula*	Silver jenny
25	222211B1111	*Orthopristis chrysoptera*	Pigfish
26	222211C1111	*Archosargus probatocephalus*	Sheepshead
27	222211C1121	*Lagodon rhomboides*	Pinfish
28	222211D1111	*Leiostomus xanthurus*	Spot
29	222211D1121	*Bairdiella chrysoura*	Silver perch
30	222211D1132	*Cynoscion nebulosus*	Spotted sea trout
31	222211D1142	*Menticirrhus americanus*	Southern kingfish
32	222211D1151	*Micropogonias undulatus*	Atlantic croaker
33	222211D1161	*Sciaenops ocellatus*	Red drum
34	222211E1111	*Chaetodipterus faber*	Atlantic spadefish
35	22222111111	*Mugil cephalus*	Striped mullet
36	22223111111	*Sphyraena barracuda*	Great barracuda
37	22224111111	*Acanthocybium solanderi*	Wahoo
38	22224111121	*Scomberomorus maculatus*	Spanish mackerel
39	22224111122	*Scomberomorus cavalla*	King mackerel
40	22231111112	*Paralichthys lethostigma*	Southern flounder
41	22241111111	*Balistes capriscus*	Gray triggerfish
42	22242111111	*Lagocephalus laevigatus*	Smooth puffer
43	22242111121	*Sphoeroides nephelus*	Southern puffer

[a]The taxonomic code contains the information necessary to compute the taxonomic distance among species used in the sorting tasks. The 11 code fields provide unique identifiers for class, infradivision, superorder, order, suborder, superfamily, family, subfamily, tribe, genus, and species, following Nelson (1984). Other ranks used by Nelson (e.g., subclass, infraclass, division, subdivision) were not relevant for distinguishing pairs of species and so were not included in the code.

tasting" would be derived. Approximately 230 individual sentences variously referring to the attributes and uses of fish were compared for overlap. Sentences that were redundant were eliminated, leaving a final list of 62 unique belief frames. This list of belief frames is presented in the Appendix. The same four groups of expert fishermen who participated in the pile-sort task were also asked to compare a list of fish with each of the belief frames and identify individual fish that were subjectively seen to "fit the sentence." Data were aggregated across informants into species-by-attribute matrices, in which each cell represents the number of informants in each group who describe the species corresponding to the row as having the attribute corresponding to the column. Four fish-by-fish similarity matrices, one for each group of expert fishermen, were formed by calculating the Pearson correlation between the rows of these species-by-attribute belief frame matrices.

The morphological similarities of the fish were measured through the use of the *taxonomic distance* (Boster, Berlin, and O'Neill 1986) between pairs of fish species. This measure is calculated by counting the nodes one has to ascend in the scientific taxonomic tree (Nelson 1984) to arrive at a node that includes both fish species.[3] Because systematists base their reconstructions of phylogeny primarily on the sharing of morphological characters, taxonomic distance is an easily computed proxy measure of the similarities in form among species.

Aggregate Analysis: Is It Form or Function?

The first step in the analysis is to evaluate whether experts' and novices' aggregate similarity judgments are closer to the morphological resemblances among the fish (the taxonomic structure) or to the similarities in use or behavior of the fish (the belief frames). This is done by correlating the off-diagonal elements of the four sets of similarity matrices. The results of this comparison are shown in Table 2. In general, the aggregate similarity judgment of all five informant groups shows a fair degree of fit to the taxonomic structure, ranging between .36 and .47. However, the groups are not equally close to the taxonomic structure: the novices' judgments appear to be closer (r = .47) than the experts' judgments (.36 < r < .40). In contrast, the experts' judgments are much closer to the belief frame similarities (.24 < r < .60) while the novices' judgments are correlated with the

Table 2
Correlations of the aggregated similarity matrices.[a]

TAX		9.0**	7.5**	6.4**	7.2**	7.4**	4.9**	4.1**	1.4	2.2*
NOP	.47**		14.4**	12.1**	13.8**	14.2**	5.6**	6.1**	4.2**	3.9**
EFP	.40**	.52**		21.5**	18.7**	20.0**	14.8**	14.8**	6.8**	9.2**
WFP	.38**	.45**	.81**		16.7**	17.3**	15.0**	16.7**	6.7**	9.3**
TXP	.37**	.50**	.68**	.62**		17.8**	11.5**	11.2**	10.6**	6.8**
NCP	.36**	.50**	.71**	.63**	.63**		10.5**	10.0**	7.3**	11.0**
EFB	.31**	.22**	.57**	.60**	.44**	.39**		22.4**	10.6**	16.4**
WFB	.19**	.21**	.52**	.60**	.40**	.35**	.82**		14.6**	15.7**
TXB	.12	.18**	.30**	.31**	.45**	.30**	.52**	.59**		12.5**
NCB	.11*	.14**	.33**	.34**	.24**	.39**	.62**	.55**	.53**	
	TAX	NOP	EFP	WFP	TXP	NCP	EFB	WFB	TXB	NCB

[a]This table compares ten similarity matrices based on the aggregated responses of the different informant groups to the 43 fish (N = 903 pairs). The ten matrices are taxonomic distance (TAX), novice pile sort (NOP), East Florida pile sort (EFP), West Florida pile sort (WFP), Texas pile sort (TXP), North Carolina pile sort (NCP), East Florida belief frame (EFB), West Florida belief frame (WFB), Texas belief frame (TXB), and North Carolina belief frame (NCB). Pearson r is presented below and QAP z (Hubert and Schultz 1976) above the diagonal. Monte Carlo simulation (Hubert and Schultz 1976) was used to gauge the extent to which the pairs of matrices are more similar than would be expected by chance. Matrices that are more similar than randomly permuted pairs in 950 or more of 1,000 trials are marked with one asterisk; those more similar in 990 or more of 1,000 trials are marked with two asterisks. These correspond to one-tailed probabilities of .05 and .01.

belief frame similarities ($.14 < r < .22$) only about as much as the belief frame similarities are correlated with the taxonomic structure ($.11 < r < .31$).

In sum, informants could have based their pile sorting of the fish on the morphological characteristics of the fish as represented in the line drawings or on the characteristics learned from experience with the fish. It appears that novices and experts respond to the task differently. Figure 1 graphically illustrates this point with a multidimensional scaling of the correlations among the aggregate similarity matrices (Table 2). Novices are closest to the scientific classification of the fish, apparently judging the similarities among the fish on the basis of form. Experts are intermediate between the scientific classification and the belief frame similarities, apparently judging the similarities among the fish about equally on the basis of form and function. Given the low correlations between the taxonomic structure and the belief frame similarities, it is fair to infer that these are independent pieces of knowledge.

There are three additional pieces of evidence that help confirm our interpretation of the differences between novices' and experts' similarity judgments: (1) a comparison of multidimensional scalings of novices' and experts' similarity judgments, (2) a comparison of novices' and experts' explanations of their decisions in the pile-sort task, and (3) an examination of experts' beliefs about the interrelationships among attributes of fish. The North Carolina novice data are compared only with the North Carolina expert data, thereby controlling for possible regional variation.

Multidimensional Scalings of Novices' and Experts' Similarity Judgments

The contrast of the experts and novices is evident in a comparison of multidimensional scalings of their aggregated similarity judgments, shown in Figures 2 and 3. The expert scaling (Figure 2) seems to be organized on the basis of functional characteristics. On the

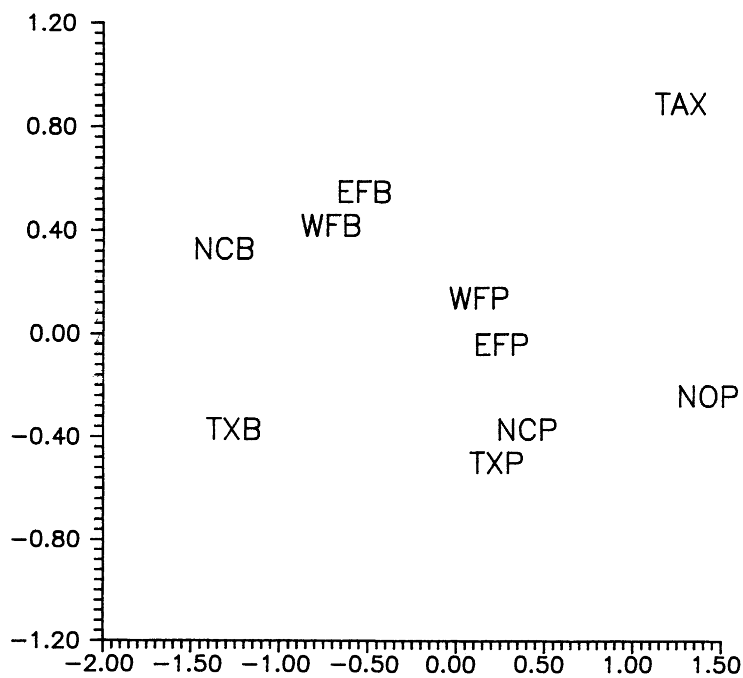

Figure 1
A multidimensional scaling of the similarities among the aggregate matrices (Kruskal stress = .07). (See note to Table 2 for explanation of symbols.)

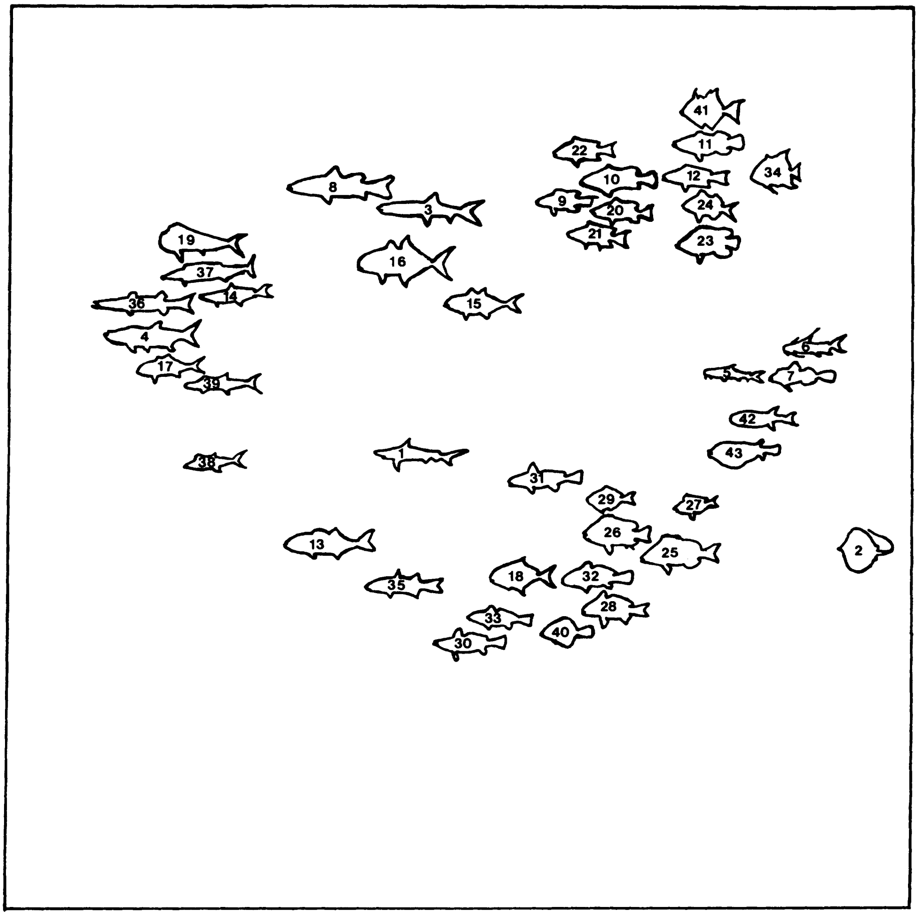

Figure 2
A multidimensional scaling of the similarities among the fish according to the North Carolina experts (Kruskal stress = .18).

left of the expert scaling is a group of superb sport fish (e.g., wahoo-37) while "trash fish" (e.g., sea robin-7) are on the right. Similarly, a group of "offshore" meat fish (e.g., snappers-20,21,22) are at the top of the expert scaling while "inshore" meat fish (e.g., trout-30) are at the bottom. This division of meat fish on the basis of habitat separates species that are morphologically similar (e.g., spot-28 and gray snapper-20).

The novice scaling (Figure 3) seems to be organized much more strongly on the basis of morphological characteristics. Anomalous species appear below and on the periphery of the main cluster of fish: At the lower left are sharks and rays (1 and 2) and two ocean species of catfish (5 and 6). Flounder (40), placed among the prized meat fish by the experts, is separated from the other species at the lower center by the novices due to its flat shape and unusual eye placement. Two flat and round disc-shaped species, triggerfish (41) and spadefish (34), are paired in the lower right. The more typical[4] fish form an arc across the top of the scaling, from the long and slender species at the left (e.g., barracuda-36) to the oblong, perch-like species on the right (e.g., grouper-10). Most of the fish in the middle of the arc (e.g., 15,16,17,18) are spindle-shaped with V-shaped tails.

Experts and novices differ most when morphological and functional criteria for sorting are at odds with one another. Table 3 identifies the eight pairs of species that were sorted

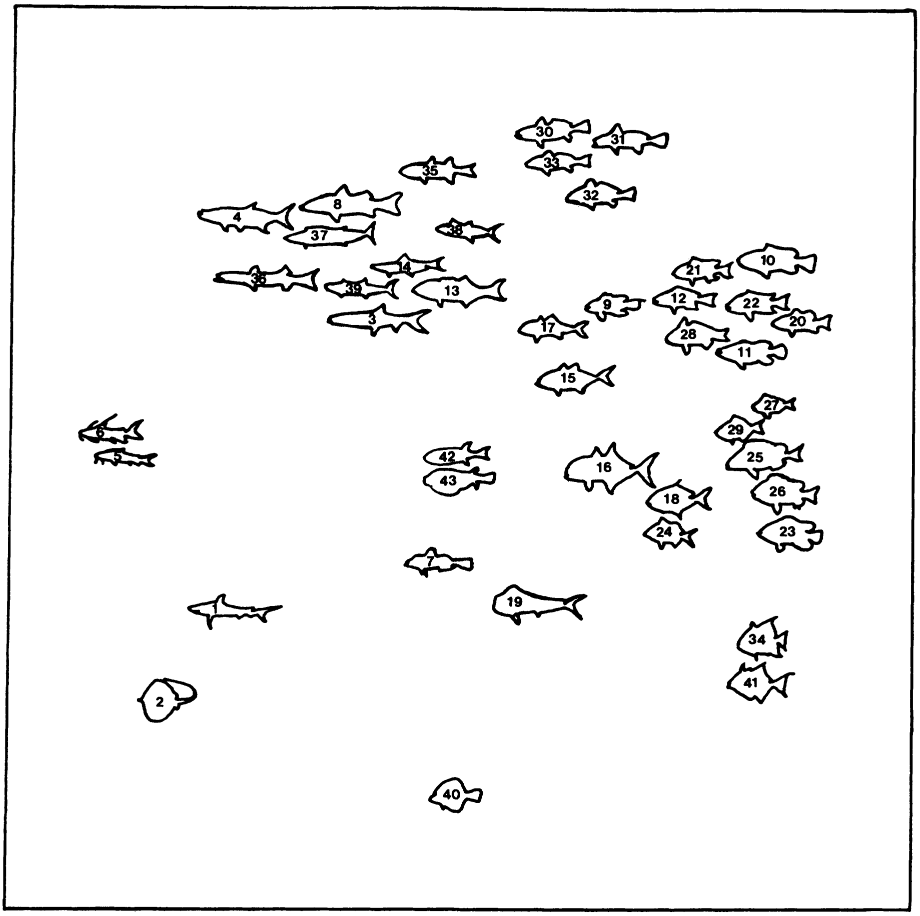

Figure 3
A multidimensional scaling of the similarities among the fish according to the North Carolina novices (Kruskal stress = .10).

most differently by experts and novices. Species regarded as similar by the experts but not the novices tend to be similar in behavior but dissimilar in appearance. For example, although the wahoo (37) is long and slender and the pompano (18) is spindle-shaped, experts apparently group these species because of their value as sport fish and the high quality of their meat. Conversely, species regarded as similar by the novices but not the experts tend to be similar in appearance but dissimilar in behavior. For example, sheepshead (26) and tripletail (23) were placed together by the novices apparently on the basis of their similar oblong body shapes and long comb-like dorsal fins. However, experts view sheepshead as distinct from tripletail because differences in the food preferences of this pair lead to differences in methods of catching them. Sheepshead use their distinctive sheep-like teeth to eat barnacles on piers and rocks, while tripletail prefer shrimp. The remaining pairs of species shown in Table 3 involve similar differences in reasoning between the two groups.

Even when expert and novice sort the fish similarly, their reasons for doing so may not be the same. For example, both experts and novices recognize one large group of fish that includes tarpon (4), wahoo (37), king mackerel (39), spanish mackerel (38), cobia (14), and barracuda (36). These are all elongate torpedo-shaped fish that are strong fighters.

Table 3
Differences between novices and experts in sorting of fish species.[a]

Species pair		Percent difference	Reason for grouping
Species grouped much more frequently by experts than by novices			
Pompano (18)	Wahoo (37)	.70	High sport and meat value
Amberjack (17)	Barracuda (36)	.61	High sport and meat value
Amberjack (17)	Wahoo (37)	.61	High sport value
Species grouped much more frequently by novices than by experts			
Red Snapper (22)	Spot (28)	.65	Oblong shape
Tripletail (23)	Sheepshead (26)	.65	Oblong shape
Snook (8)	Barracuda (36)	.58	Elongate shape
Snook (8)	Wahoo (37)	.58	Elongate shape
Spadefish (34)	Triggerfish (41)	.57	Disc shape

[a]These differences were determined by subtracting the novice aggregate matrix from the expert aggregate matrix, where cell values in each matrix are the percent agreement that the pair of species belong in the same group.

In this case (as in many others), there is a strong biological relationship between form and function: the elongate shape reflects an adaptation for swift, sudden attacks by these predators (Webb 1984). Thus, torpedo-shaped fishes are much more likely to make good sport fish than are disc-shaped fish adapted for maneuvering (e.g., spadefish-34, triggerfish-41). It seems likely that the experts have placed these predators together on the basis of their fighting ability while the novices have placed them together on the basis of their shape. This interpretation is supported by the fact that experts group the spindle-shaped amberjack (17) and dolphin fish (19) together with the six elongate species above. Although this pair have a different shape from the rest of the cluster, both are valued as sport fish for their hard fighting behavior.

Subjects' Explanations of Pile Sorts

The inference that the experts sort the fish on the basis of both functional and morphological features while the novices sort on the basis of morphology alone is also supported by the reasons offered by informants for their sorting decisions: novices tend to justify their pile sorts on the basis of the form of the fish, while the experts tend to justify their sorts in terms of the use or behavior as well as form. Approximately 98% of the novices' reasons for their sorts were morphological. The morphological features noted by novices included characteristics of the fins (e.g., "both had continuous fin across the top, two fins on the bottom and on the side"), body shape (e.g., "all long and skinny fish"), and esthetic characteristics (e.g., "ugly—the ugliest thing I've ever seen"). In other cases, the novices made inferences about the behavior of the fish on the basis of its form (e.g., "all fast swimmers because their tail fins and back tail look similar and make them look like fast swimmers"). About 2% of novices' explanations were concerned with the behavior of the fish (e.g., "predatory") or habitat (e.g., "they live on the bottom"). Novices virtually never justified their sorts on the basis of utilitarian considerations (e.g., "good to eat").

In contrast, the North Carolina expert fishermen were more evenly divided between morphological and functional explanations of their sorting decisions. Approximately 30% of the experts' explanations of their groupings were in terms of visual similarity or family membership. In some of these cases (5%), morphological criteria were combined with behavioral or other characteristics (e.g., "most small, caught out in the surf in the summertime especially"). There were more explanations (41%) in terms of functional characteristics such as edibility, sport or fighting characteristics, or range or habitat. Of these, edibility was a particularly important basis for sorting the fish. For example, one fisherman explained a pile as follows: "[These are] fish I will eat on occasion. I have eaten them. They're not my favorite, but I will eat them. It depends on how full the cooler is." Sporting characteristics were also used, such as type of gear needed to catch a certain class of fish or their fighting characteristics (e.g., "striking fish . . . caught with lures or live bait"). Fish were also sorted by experts on the basis of the range or habitat, since this consideration is important in planning where, when, and how to catch a particular species. For example, one fisherman described a pair of fish as "caught in warm, shallow, salty water in the late summer or early fall." Fishermen also combined these criteria (e.g., "bigger-class sporting fish that you probably find in the same area while fishing for mackerel"). The remaining explanations of sorting decisions (29%) included lack of familiarity and descriptions of the uniqueness of a fish.

Relationships Among the Attributes of Fish

A third source of insight into experts' fish similarity judgments is through an examination of experts' beliefs about the attributes of fish. Figures 4 and 5 show two alternative ways of representing the relationships among these beliefs. Figure 4 presents an optimal scaling (Nishisato 1980) of the North Carolina expert belief frame matrix.[5] It illustrates

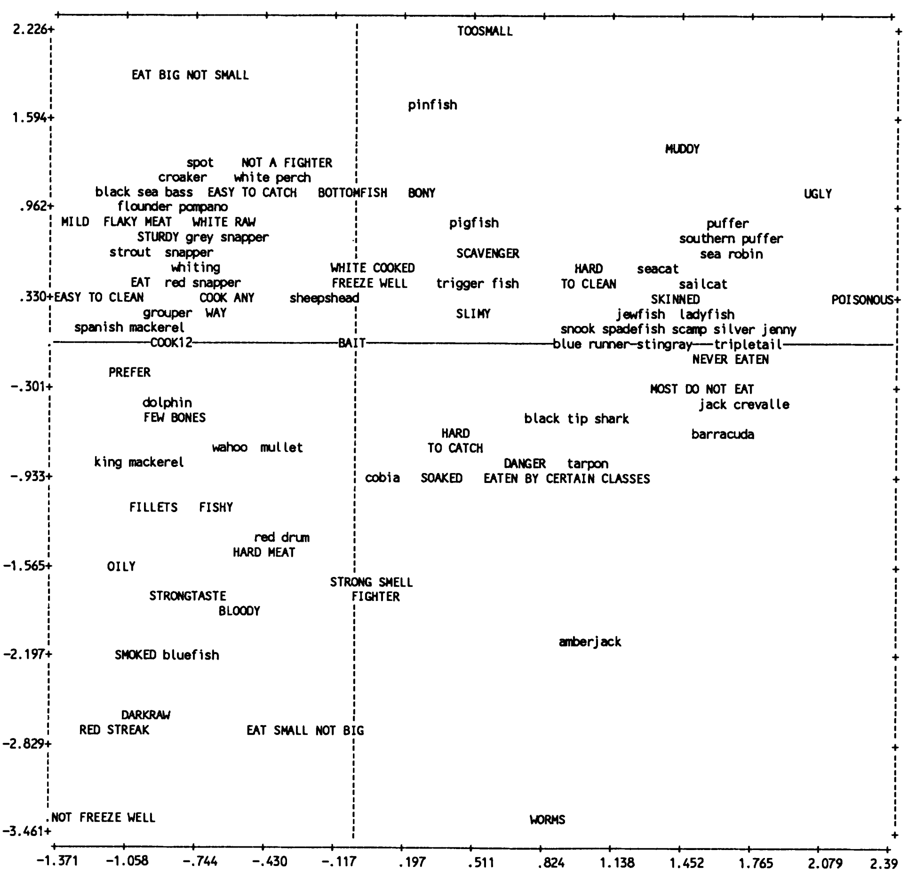

Figure 4
Dual optimal scaling of North Carolina expert belief frames.

which fish have similar attributes and which attributes are found in similar sets of fish. Abbreviated attributes are in capital letters and species are in small letters. There are three major clusters of species and attributes in this configuration. To the far right are trash fish, the less desirable species. These fish are believed to be "ugly," potentially "poisonous," and needing to be "skinned" before cooking and eating. This last step is rarely necessary because most informants have "never tried" these species and regard them as fish that "most people do not eat."

Moving left across the scaling one finds a cluster of "meat fish." These species have desirable characteristics such as "flaky meat" that is "mild" and "white when raw." They are "easy to clean," "freeze well," and can be cooked in a multitude of ways ("cook any way"). This cluster includes fish commonly served in restaurants, such as snapper, grouper, and flounder. However, although these fish are very good to eat, they are not considered good sport fish ("not hard fighters").

A loose cluster of "game fish" is found directly below the meat fish. These sport fish, including dolphin, king mackerel, cobia, wahoo, and bluefish, are "hard fighters" that yield "thick fillets." On the other hand, the dark-colored meat of some of these species (e.g., king mackerel, bluefish, and amberjack) is viewed as "bloody," "oily," "strong tasting," and does not keep well in the freezer ("do not freeze well"). Fish with this type of dark oily meat are thought to be best "smoked." Some of these species (e.g., amberjack) should be "eaten when small" in order to avoid the "worms" found in larger catch.

Figure 5 illustrates a portion of a propositional analysis of the North Carolina expert belief frames. This technique allows the investigator to trace what attributes of items follow from what other attributes (D'Andrade 1976; White, Burton, and Brudner 1977). Reading across the top of Figure 5, having "nice flaky meat" implies the fish is "not a hard fighter," which implies that its "meat is white when raw." Having "nice flaky meat" also implies that the fish has "few bones," which further implies that it is something most people "prefer" to eat. The attributes "prefer" and "poisonous" are in contrast: if a fish is believed to be "poisonous," it is not a fish people "prefer." These implicational relations exemplify the types of rules or heuristics that experts use (and novices do not use) in sorting the fish. These rules correspond to clusters of attributes (and fish) in the optimal scaling shown in Figure 4.

In sum, various means of comparing expert and novice similarity judgments of fish lead to the same conclusions: apparently, a major reason for the difference between the responses of experts and novices to the fish-sorting task is that experts know (and novices do not know) the interrelations of the functional attributes of fish and that these interrelations of attributes (or rules) are used by the experts in forming their groupings of fish.

Individual Analysis: Does Knowledge Result in Consensus, or Does the Truth Set You Free?

Our next question concerns whether the experts or the novices show greater variation in their responses to the pile-sort task. Recent analyses of intracultural variation suggest that experts are generally more consistent in their responses than novices: greater knowledge or skill generally leads to greater agreement with others. This has been demonstrated for Aguaruna identification of manioc varieties (Boster 1985), U.S. college students' responses to a general information task (Romney, Weller, and Batchelder 1986), American adolescents' beliefs about appropriate discipline (Weller, Romney, and Orr 1986), Tarascan folk medical knowledge (Garro 1986), and American responses to a word association task (D'Andrade 1987). However, a consideration of the kinds of knowledge controlled by novice and expert in this case leads to a contrary expectation. The aggregate analysis presented above suggests that experts base their similarity judgments on both morphological and functional characteristics of the fish, while the novices base theirs on morphological information alone. Because experts control more different kinds of knowledge and offer more varied justifications for their responses than do novices, they might be expected to be more variable in their responses than the novices.

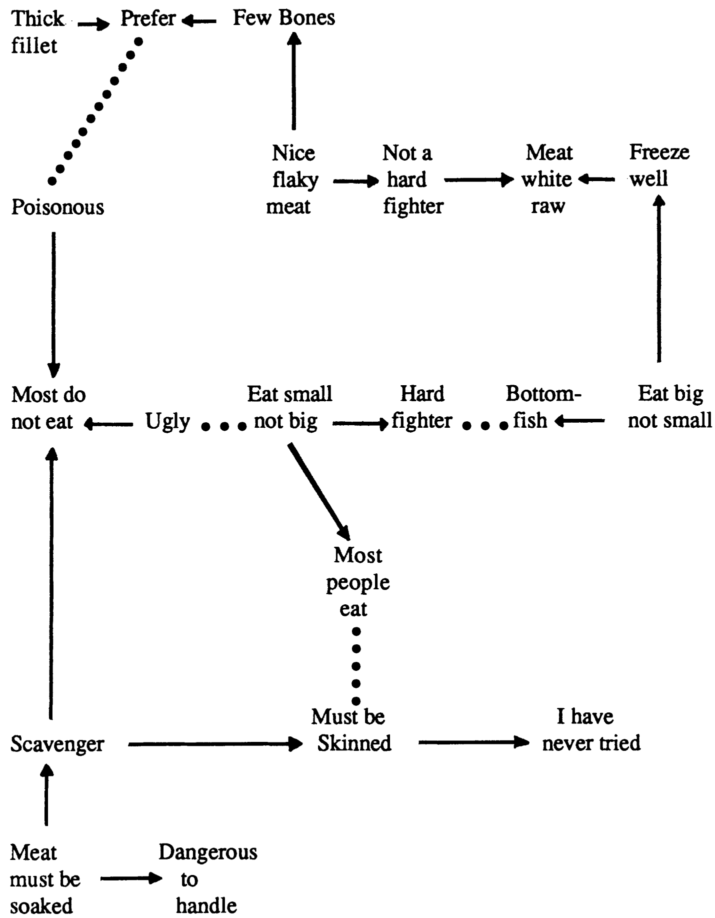

Figure 5
Propositional analysis of North Carolina expert belief frames. Arrows link attributes that imply each other: the attribute at the head of the arrow is implied by the attribute at the tail. Dots link attributes that negate one another.

To address this question, we first created an informant-response matrix representing informants' responses to the pile-sort task. The columns of the matrix correspond to informants, while the rows correspond to every possible pair of items in the stimulus set. The cells of this matrix have a value of one if the informant corresponding to the column placed the pair of items corresponding to the row in the same pile. We then computed an informant-by-informant correlation matrix by correlating the columns of the informant-response matrix. This informant-by-informant correlation matrix reflects the similarity of responses to the sorting task among the informants: informants whose responses are highly correlated group the fish similarly, while informants whose responses are weakly correlated group the fish dissimilarly.

Our next step in the comparison of experts and novices was to operationalize agreement or knowledge in three ways: First, we used the cultural consensus model (Romney, Weller, and Batchelder 1986) to derive estimates of the "cultural competence" of all informants. The cultural consensus model formalizes the insight that agreement often reflects shared knowledge and allows the estimation of individual knowledge levels from interinformant agreement.[6] The responses to the pile sort did fit the cultural consensus model, indicating that there is an overall consensus sorting of the fish shared by all groups of informants, expert and novice alike.[7] Cultural competence was estimated by the informant's score on the first factor of a minimum residual factor analysis of the correlation matrix. The competencies of experts and novices were then compared.

Second, we computed all the within-group correlations for the novices and the four groups of experts, and compared the magnitude of these within-group correlations. Third, we calculated the proportion of times that each informant agreed with the majority in placing (or not placing) a pair of items in the same pile. We then compared the proportion of modal responses offered by novices with that offered by experts.

As shown in Table 4, these three different ways of comparing the amount of agreement among experts and novices give mixed results. There is no significant difference between the novices and the experts in the first factor score, their cultural competence according to the Romney, Weller, and Batchelder (1986) model. However, there is a significant difference between experts and novices in their scores on the second factor. This result is illustrated in a scatterplot of informants on the first and second factors, shown in Figure 6. It demonstrates that there is no segregation of groups on the first factor, but a strong segregation of novices from experts on the second factor.

On the other hand, the other, more direct, measures of agreement indicate that there are differences between experts and novices, as shown in Table 4. Novices are significantly more highly correlated with other novices than experts are with each other. Moreover, novices offer modal responses significantly more often than do experts. On balance, novices appear to agree more with each other on this fish similarity judgment task than do the experts, even though there is no significant difference between the experts and novices in competence, as measured by the cultural consensus model (Romney, Weller, and Batchelder 1986).

Table 4 also indicates that there are other important differences between the novices and experts: novices' responses are more highly correlated with the scientific taxonomy of fishes, while the experts' responses are more highly correlated with the functional similarity of the fish as determined by the belief frames. This reinforces the conclusion made above that novices sort primarily on the basis of the form of the fish (as represented on the cards) while the experts make use of both morphological and functional information in making their similarity judgments.

These results are illustrated in Figure 7. It presents a multidimensional scaling of this informant-by-informant correlation matrix. The novice responses (indicated by "no") form a fairly tight cluster in one wedge of the space, while the expert responses (indicated by "ef," "wf," "tx," and "nc") are much more widely scattered through the rest of the similarity space, reflecting the different degrees of agreement in these two groups of in-

Table 4
Comparisons of novices with experts on measures of competence, agreement, and approach to folk and scientific models.

	Novices		All experts		NC experts		Novices vs. all experts		Novices vs. NC experts	
	mean	*sd*	mean	*sd*	mean	*sd*	*t*	*p*	*t*	*p*
First factor	.36	.11	.39	.13	.39	.12	.7	.48	.6	.53
Second factor	.25	.06	−.06	.16	−.11	.13	7.3	.00	9.4	.00
Correlations	.21	.09	.17	.10	.18	.11	4.1	.00	2.0	.04
Modal response	.89	.06	.82	.11	.81	.12	2.3	.02	2.2	.04
Taxonomic *r*	.24	.09	.16	.08	.17	.08	3.1	.00	2.3	.03
NC beliefs	.08	.04	.15	.09	.20	.12	3.1	.00	3.7	.00

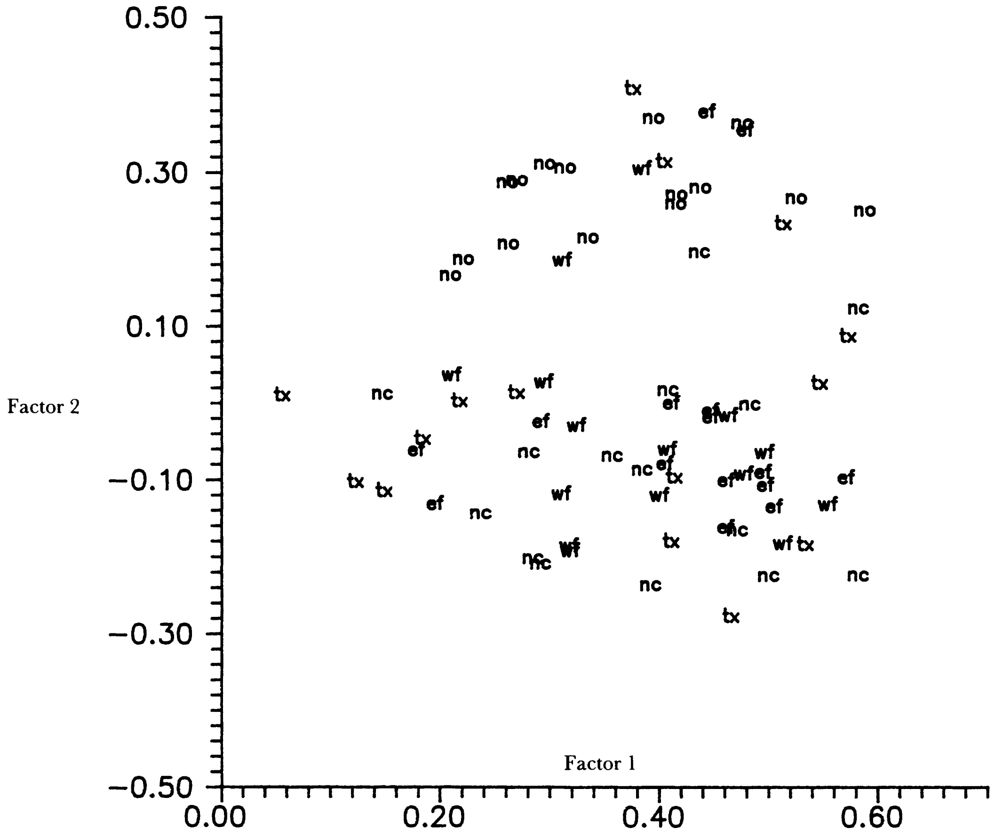

Figure 6
First and second factor of a minimum residual factor analysis of the informant-by-informant correlation matrix.

formants. (While novices and experts are fairly clearly distinguished from each other, the experts from different parts of the country seem to be thoroughly intermixed.) Furthermore, the scientific taxonomy of the fish (indicated by "TAX") is closer to the cluster of novice responses than it is to the cloud of expert responses, while the functional similarities of the fish derived from the expert belief frames (indicated by "EFB," "WFB," "TXB," and "NCB") are closer to the expert than to the novice responses.

Discussion

To review, there are two salient results of our research. First, in the aggregate analysis, we find that experts judge the similarity of fish on both functional and morphological criteria while novices judge on morphological criteria alone. This is evident both in the content of the groups formed and in informants' justifications for their groups. Second, in the individual analysis, we find that experts vary more in their responses to this sorting task than do novices. Novices offer modal responses more frequently, and their responses are more highly correlated than are the experts' responses.

We interpret both results as an outcome of the difference in the kind and amount of information controlled by experts and novices. The difference between experts' and novices' aggregated similarity judgments apparently stems from the experts' use of their knowledge of the functional attributes of fish in forming their groupings. Novices do not have this option because they are ignorant of these functional attributes.

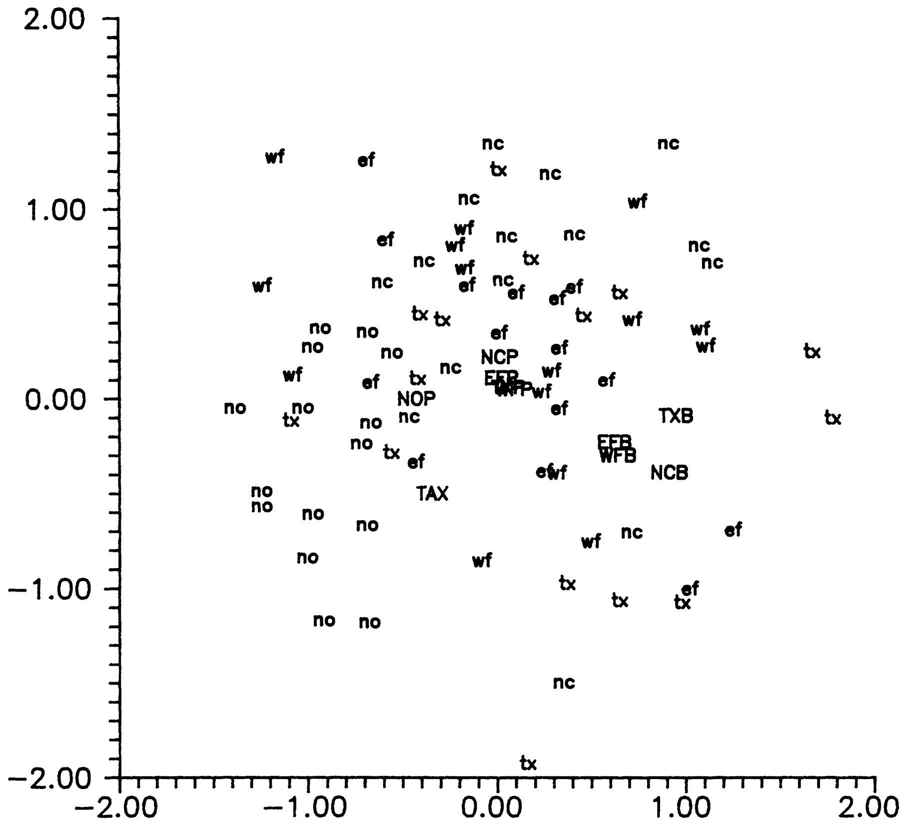

Figure 7
A multidimensional scaling of fish similarities (Kruskal stress = .24). Each point in this space corresponds to a different similarity matrix: lower case letters indicate similarity judgments by individuals, upper case letters indicate aggregated response data. Individual novice responses are indicated by "no" while individual East Florida, West Florida, Texas, and North Carolina expert responses are indicated by "ef," "wf," "tx," and "nc," respectively. The aggregated novice response to the pile sort is indicated by "NOP" while the aggregated expert pile-sort responses are indicated by "EFP," "WFP," "TXP," and "NCP." The functional similarities of the fish, as inferred from expert responses to the belief frame task, are indicated by "EFB," "WFB," "TXB," and "NCB." The scientific taxonomy of the fish is indicated by "TAX."

The greater variation among experts has a similar explanation. Different experts appear to use functional and morphological information to different degrees in making their sorting decisions; they not only show more variation in their sorts of the fish, they also offer more varied justifications for their sorts. A small number of experts base classification almost entirely on morphological characteristics, some almost entirely on the basis of functional attributes, while most use both types of information in varying degrees. In contrast, the novices know virtually nothing about the fish except the form of the fish as represented on the cards. Without functional or behavioral knowledge of the fish, the novices' limited knowledge constrains their responses so that novices sort more consistently than do the experts. Ironically, because novices are constrained to use the same type of information that scientific systematists rely on (i.e., morphology), they approach the scientific taxonomy more closely than do the experts.

These results have implications for three areas of research: the study of the nature of expertise, the study of intracultural variation, and the study of ethnobiology.

Expertise

Cognitive psychologists have long been interested in the nature of the differences between experts and novices in the content and organization of domain-specific knowledge.[8] One consistent finding is that novices tend to classify items or problems on the basis of superficial criteria while experts rely on more abstract, often functional considerations (see review by Chi, Glaser, and Rees, 1982). For example, physics experts (advanced Ph.D. students) classify physics problems on the basis of general similarities in solution, whereas novices (undergraduates) base their solutions on more literal characteristics of the problem. Experts were thus able to see underlying similarities among problems that appeared very different to the novices (Chi, Feltovich, and Glaser 1981). Novice electronics technicians reconstruct circuit diagrams by attempting to recall spatially proximate elements, while expert technicians recall the functional interrelations of elements (Egan and Schwartz 1979). While novice chess players can remember only small numbers of spatially contiguous pieces in memorizing a chess board, experts are able to remember in a "chunk" the positions of much larger numbers of pieces interrelated by attack and defense (Simon and Barenfeld 1969). Child dinosaur novices tend to sort dinosaurs by morphological criteria (e.g., size of hands, heads, presence of horns), while child experts group on the basis of functional or behavioral considerations (e.g., aggressiveness, plant or meat eating) (Chi 1983, 1984).

Our finding that expert fishermen make much greater use of functional information in sorting fish, while novices rely on morphology, falls in line with the pattern established by the cognitive psychological work and suggests an explanation of it. Morphological information in most domains is much more readily available to novices than is functional information, which often can be learned only when the morphological distinctions are mastered.

Intracultural Variation

These results also bear on recent developments in our understanding of intracultural variation. As discussed above, one of the most consistent and important findings of recent work on this topic has been that consensus means knowledge: that individuals who agree more often with each other can be said to know more than individuals who do not (Boster 1985; Romney and Weller 1984). This insight forms the starting assumption of the cultural consensus model developed by Romney, Weller, and Batchelder (1986).

The results presented here suggest that the relationship between consensus and knowledge implicit in the cultural consensus model is dependent on a particular mode of learning of cultural information. In fact, part of the power of the cultural consensus model as an empirical research tool is that it formalizes a particular model of the way cultural knowledge is learned. The cultural consensus model assumes that people learn by moving from ignorance (random responses) to knowledge (coherent, consistent responses), from the absence of a model to the acquisition of one. The results of these experiments suggest that people learn in this way when they have no alternative: when there is no structure in experience to guide the responses of novices. In that case, novices would show more variation around the cultural consensus than domain experts because they have no model to constrain their responses. However, when there is a source of information readily available to domain novices, as in the present study, they will make use of it. In this case, rather than simply acquiring an expert model when they had none before, novices become experts by starting with readily available models (e.g., morphologically based) and gradually acquiring alternative ones (e.g., functionally based). Experts do not necessarily abandon early models for later ones, but may simply accumulate alternative models. When the development of expertise results in the learning of many alternate devices or bases for structuring a domain, the experts will be more variable in their responses than novices and so appear to deviate more often from the consensus.

There is another interesting result that puzzles us: the cultural consensus model detected no significant difference in the competence of experts and novices, even though these informant groups were significantly different on other more direct measures of agreement. Perhaps this null result is a reflection of the anomaly of a case in which experts varied more than domain novices. Perhaps it reflects a problem in extending the application of the consensus analysis beyond the data types for which it was designed. (See Note 6 for a discussion.) Whatever the explanation, our results suggest that while we explore the use of this powerful new method, we apply it in conjunction with other simpler procedures for measuring agreement and knowledge.

Ethnobiology

We began this article with the long-standing problem of whether utility or morphology dictates the structure of folk biological classifications. We argued that this is really a problem in intracultural variation: informants' judgments of organismal similarity depend on what knowledge they can bring to bear on the task and on what knowledge the task calls for. Once demonstrated, the point seems a self-evident implication of the fact that cultural knowledge has a social distribution: if novices do not know anything about the use or behavior of the fish, they cannot very well use that information when they perform a sorting task; if experts face a task that allows them to make use of the various kinds of information they know, they likely will.

We believe there is a good reason why this (seemingly obvious) point has been largely overlooked: The problem is masked because it is so often resolved in natural contexts. Usually, the demands of the tasks informants perform strongly constrain the kinds of information that are appropriate to consider. If asked to identify a fish, informants will probably pay careful attention to the morphological characteristics of the specimen. If asked how to prepare it for dinner, the texture and flavor of the meat become the most important considerations in picking a cooking technique that will either hide or accentuate the flavor. Perhaps it is only in the context of an experiment that informants are faced with a task in which form and function are potentially equally relevant. Similarly, the intellectual division of labor in society usually dictates who should be consulted on particular topics. We talk to fishermen if we want to discover how and where to fish for red snapper. We consult physicians if we want to find out about the diagnosis of disease. It is only common sense to learn from the individuals who know the most on a topic. However, this strategy will lead us to interview relatively homogeneous subgroups of informants and thus underestimate the amount of intracultural variation in the community as a whole.

Finally, these results bear on the interpretation of the universals in folk biological classification. One might attribute the strong correspondence between folk and scientific systems of biological classification to "savage" wisdom: the folk distinguish themselves in their skill at discriminating natural kinds. These results suggest another interpretation of these universals, one in line with Berlin's recent claim that the natural order is so clear that it would be difficult to mistake it (Berlin and Berlin 1983). Here it is the novices, not the experts, who are closest to the scientific classification because the morphological information is readily available to a casual observer, while information on the utility and behavior of the organisms requires long experience and cultural transmission. It may be that the reason folk biological taxonomies are primarily morphologically based is that only morphological information is freely and universally available to observers.

Conclusions

This research has assessed the relative contributions of utility and morphology in determining informants' unconstrained judgments of the similarity among fish. It has done so using methods that avoid hierarchical representations of categorization, that minimize the possibility of response bias, and that explore the relationship between aggregate structure and individual cognition. The results show that the form-function question is best understood as a problem in intracultural variation: some informants (all of the novices and a handful of the experts) based their judgments of similarity almost entirely on the morphology of the organisms, some others (a small portion of the experts) based their judgments almost entirely on the utility of the organisms, while others (most of the experts) based their judgments on a combination of morphology and utility. These results shed light on three areas of research.

First, the results suggest something about the nature of cultural expertise. In some cases, experts may have more alternative structures on which to base similarity judgments and hence show less agreement with each other and with naive informants about the structure of the domain. In other words, it is an empirical question whether greater knowledge will lead to greater constraints or greater freedom of response to an experimental task.

Second, the results suggest a qualification of the conclusion of many recent studies of intracultural variation: consensus means knowledge in many, but not all, cases. The more different and independent kinds of domain knowledge individuals have, the greater the variety of ways they can sort the objects in the domain. Morphological information is often more available than other sorts and will probably serve as a universal basis of similarity judgments, when available. However, if an experimental task allows informants to use other sorts of knowledge, many probably will use it.

Finally, the results complement some recent work in ethnobiology. Boster and D'Andrade (1989) show that when informants are constrained to base their judgments on morphological characters, culturally diverse groups choose the same morphological characters in judging the similarity of bird species. However, the results presented here suggest that when constraints on the form of response are removed, there is much greater variation of response even within relatively homogeneous cultural groups. In short, the original question of whether form or function is more important to folk biologists does not have a simple answer, it depends both on who we ask and how we ask them.

Notes

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[1]Hunn's recent emphasis on the utilitarian character of human interest in the environment represents a change in focus from earlier work that developed a perceptual model of folk biological classification (e.g., Hunn 1976).

[2]In Boster, Berlin, and O'Neill (1986), we explain this shift as follows: "Following Hunn (1976), we treat biological classification as a description of the pattern of similarity between organisms rather than of the boundaries of categories of organisms. Two systems of classification can be said to correspond when they recognize the same pattern of similarity between organisms." Given the shallowness of folk biological taxonomies, most of the pattern of similarity among organisms is not linguistically recognized in any event. Ethnobiologists have long recognized that some categories of organisms are "covert" or not labeled (Berlin, Breedlove, and Raven 1968; Berlin 1974; Hays 1976).

[3]Hunn (1975b) uses a similar insight to derive a measure of the correspondence of folk and scientific systems of classification.

[4]Although there are 50 orders of fish, more than a third of all fish species (7791/21723) are members of the Perch order, Perciformes (Nelson 1984). This helps explain why perch are regarded as "typical" fish: more species resemble perch than resemble members of other orders. Boster (1988)

makes an analogous argument for why members of the largest order of birds, the Passeriforms (e.g., robin, wren, sparrow, finch), should be regarded as the most typical birds.

[5]Optimal scaling belongs to a family of techniques that include correspondence analysis (Greenacre 1984), dual scaling (Nishisato 1980), and canonical analyses (Gittins 1985). These techniques allow for an investigation of the relationship between two sets of variables (e.g., the rows and columns of a contingency table). Particularly important is the use of such techniques for simultaneously projecting the rows (items) and columns (attributes) of the belief frame matrix as points in a low-dimensional vector space (e.g., two-dimensional graphical display). Thus, the relationships between row and column variables, as well as the relationships among variables within rows and columns, can be explored.

[6]Minimum residual factor analysis was used to check whether the informant-by-informant correlation matrix fits the consensus model. If a matrix fits the model, there should be a single-factor solution such that there are no negative scores on the first factor and the first latent root (the largest eigenvalue) should be large in comparison to all other latent roots. In this case, all scores on the first factor were greater than .05, and the first latent root (12.15) is 4.6 times larger than the next largest latent root (2.63). The application of the cultural consensus model to pile-sort data represents an extension of the method beyond the scope of the *formal process model* developed by Batchelder and Romney (1986) and by Romney, Weller, and Batchelder (1986), since the original model applies only to dichotomous data. When Romney, Batchelder, and Weller (1987) and Weller (1987) generalized the consensus model to accommodate rank order and interval scale data, respectively, they referred to these extensions as *data models* to distinguish them from the more fully developed formal process model. Our use of the consensus model to analyze pile-sort data would also be termed a data model and was suggested to us by Romney. Both in this case and in a study of social networks in a university administration office (Boster, Johnson, and Weller 1987), the consensus model seems to fit pile-sort data quite well. However, despite this apparent success, we would advise some caution in applying the model to pile-sort data. Boorman and Arabie (1972; Arabie and Boorman 1973) have shown that often the pattern of individual variation on the pile sort is swamped by differences between lumpers and splitters: they conclude that pile sort is essentially useless for making inferences about individual differences. Our result suggests a qualification of their finding: for those domains that offer a variety of different possible levels of making splits among stimuli, individual differences in pile sorting will probably only reflect differences in esthetic preferences for number of groups. However, for those domains that have a salient cutpoint, analogous to Berlin's notion of the generic or Rosch's notion of the basic level object, then the differences among individuals' responses are more likely to be independent of the lumper-splitter contrast. That appears to be the case here: there did not appear to be any significant differences between the experts and the novices in the number of groups formed ($F = 0.8, p = .37$). However, there is a significant difference among experts: the West Florida fishermen formed significantly fewer categories than did the expert fishermen from other areas ($F = 8.9, p = .003$).

[7]The fact that there is an overall consensus on fish sorting does not mean that there are not systematic differences among the groups as well. To test this possibility, the Quadratic Assignment Procedure (QAP) (Hubert and Schultz 1976) was used to compare the correlation matrix with a structure matrix composed of blocks of ones (corresponding to within-group correlations) and zeros (corresponding to between-group correlations). When all groups were compared, the QAP z was 9.0, while when informants are simply split into novices versus experts, the QAP z was 3.0. The results are similar if this is treated as a simple t test comparing the magnitude of within-group correlations (mean = .18, sd = .10) with the between-group correlations (mean = .14, sd = .10): $t = 7.5, p < .001$. These results indicate that in addition to an overall consensus, there are subgroup consensuses as well: higher degrees of agreement within groups than between groups.

[8]There is also a substantial cognitive anthropological literature concerning differences between experts' and novices' categorizations. For example, Hunn (1975a) notes that expert bird-watchers have a different strategy for distinguishing gulls than do beginners. Dougherty (1978) argues that the salient or basic level in folk classification is relative to the classifier's overall knowledge of the domain. Kempton (1981) shows that expert potters' ceramic categories have a different internal structure than those of non-potters. Chick and Roberts (1987) present evidence that machinists share a different esthetic appreciation of lathe parts than non-machinists, due to their better understanding of how the parts are made.

Appendix: Belief Frames

(The 46 belief frames used in the optimal scaling and the propositional analysis are indicated by an asterisk.)

* 1. Most people eat ________ .
* 2. Most people do not eat ________ .
* 3. I prefer to catch ________ .
* 4. I have never tried eating ________ .
* 5. ________ are hard fish to catch.
* 6. ________ are easy fish to catch.
* 7. Usually, fishermen don't eat big ________ but will eat the smaller ones.
* 8. Usually, fishermen don't eat smaller ________ but will eat the bigger ones.
* 9. ________ are dangerous fish to handle.
*10. It is hard to clean ________ .
*11. It is easy to clean ________ .
*12. In order to eat ________ it has to be skinned.
*13. ________ are sturdy or durable fish; you don't have to worry about them spoiling very quickly.
14. ________ are not sturdy or durable fish: they spoil easily.
*15. ________ do not freeze very well.
*16. ________ freeze very well.
*17. The meat of ________ has to be soaked before cooking.
*18. ________ has a real mild taste to the meat.
*19. The meat from ________ tastes fishy.
*20. ________ are usually not eaten because they can be poisonous.
*21. The meat from ________ is oily tasting.
*22. ________ is strong tasting.
23. The meat from ________ often has an iodiney taste (tastes like iodine).
*24. When cut open, ________ has real white meat.
*25. When cut open, ________ has dark meat.
*26. When cooked, the meat from ________ is white.
*27. The meat from ________ has a strong smell.
*28. There is a muddy taste to the meat of ________ .
*29. ________ have bloody meat.
*30. ________ are bony.
31. ________ have a lot of big bones in them.
32. ________ have a lot of small bones in them.
*33. ________ have very few bones.
34. ________ are good pan fish (body fried whole in pan).
*35. You can get big, thick fillets or steaks from ________ .
36. You can never get big, thick fillets or steaks from ________ .
*37. ________ can be cooked just about any way you like.
*38. ________ can only be cooked one or two ways.
*39. ________ are best if they are smoked.
40. ________ can be eaten only if they are smoked.
41. ________ is very easy to prepare.
*42. When cooked, the meat from ________ is on the hard side.
43. When cooked, the texture of the meat from ________ is firm.
44. When cooked, the texture of the meat from ________ is tender.
45. When cooked, the meat from ________ is on the hard side.
46. When cooked, the meat from ________ is on the soft side.
47. When cooked, the meat from ________ is stringy or tough.
*48. ________ has nice flaky meat.
*49. The red streak of meat should be cut out of ________ before eating.
50. ________ don't even taste like fish.
*51. ________ are usually too small to bother with.
*52. ________ are very hard fighting fish.
*53. ________ are not hard fighting fish.
*54. ________ is used mostly for bait.
*55. ________ are slimy fish.

*56. Big ________ often have worms or parasites and are thrown away.
*57. ________ are thrown back because they look different from other fish (they look ugly or awful).
*58. ________ are scavenger fish.
*59. ________ are eaten by certain classes or types of people.
60. ________ are scavenger fish, but are picky about what they will eat.
*61. ________ are bottom feeders.
62. Though edible, people usually don't keep ________ because there are so many other better fish to keep and eat.

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