6 / Difficulties in mathematics class

NOW THAT WE HAVE CONSIDERED the general outlines of Kpelle society, it is appropriate to turn to the problems which served as the immediate impetus for this research.

In roughly sixty elementary schools within Kpelle land there are Kpelle boys and girls struggling to learn enough English, mathematics, and science to make their way into the modern world. These children go to school for a variety of reasons. A minority are there because their parents are of the literate middle-class and wish their children to follow them. A somewhat larger group are in school because their parents, although illiterate, feel it is advantageous to have some education. In many cases, however, the parents actively oppose education for their children. It is true that some chiefs and elders want schools, but probably more oppose them. To these people education for the child means nothing but trouble and sorrow. The child does not help on the farm. He only attends Bush school for a few weeks during the school vacation, and generally loses interest in tribal life. He is likely to shun early marriage since it will interfere with his schooling. Perhaps worst of all, he is likely to move away from the village altogether, returning only occasionally from the city with a gift—which cannot substitute for his presence.

Many children are therefore in school despite their family and their whole culture. These children support themselves by finding odd jobs, patronage, a scholarship, or sometimes by stealing. They have status neither in the new world nor in tribal society.

Two cases are perhaps relevant. One young man's mother died when he was young. He has made his own way in the world from the age of eight. He has lived with relatives or friends wherever he could find a room and one meal a day. He has worked for missionaries throughout this period and has reached the sixth grade in a local Baptist school. He now lives in a basement room underneath the house of a Peace Corps volunteer, and is strictly on his own, even though he is only about fifteen years old.

Another case is that of a boy who has worked for educated Liberians for years, and has acquired prestige and money by well-concealed stealing. He is in the sixth grade, at about the age of eighteen, and will probably go far. He has almost no tie with his family, not even the tie of a last name, since he has changed his to a "civilized" name.

These Kpelle boys are caught between two cultures. The context of life for both remains the Kpelle culture, but it is extensively modified by foreign institutions. There are many such boys. Although fewer in number, there are even girls who work as domestics or are supported by a patron (sometimes in return for favors).

When the child first enters school he is still part of village life. He speaks almost no English when he comes to his first class, and still has fairly close ties with his family. His parents are perhaps suspicious, but willing to let him start. He customarily spends a year or two in "primer" class, learning to speak English, and memorizing a few isolated facts. He then is ready for first grade, which he enters between six and twelve years of age. The point of decision for him is in the second or third grade, when he must decide whether he is to continue school and cast his lot with the "civilized" world, or return to his tribe. His parents may have been willing for him to remain a few years in school, since in the old days three or four years in Bush school was not uncommon. But they assume that by second grade he has had enough, and that it is time he returned to take up his responsibilities in the village. If he does not choose to return, they let him go his own way, and expect him to support himself. Only when he has finished school do they reestablish ties, in order that he assist them in their old age, and to aid his younger brothers and sisters through school.

THE SCHOOLS

What sort of education do these children receive? Little appears to be accomplished at the primer level, except that at the end of a year or two the child has acquired a minimal command of English and some comprehension of how schools are run.

His education in subsequent years is modeled after that of an American school. He uses American texts, with American illlustrations (of snowballs, circuses, and so forth). The textbooks are often several years out of date; in many cases the only textbook in the school is the teacher's. The curriculum consists of materials drawn largely from a culture the child only faintly comprehends. The teacher usually deals with it as with the religion of which Hobbes spoke: "As with wholesome pills for the sick, which swallowed whole, have the virtue to cure; but chewed, are for the most part cast up again." (*Leviathan,* Part 3, Chap. 32). There are increasingly many exceptions at present, but the general pattern remains.

We have had the opportunity to observe at length some of the difficulties the Kpelle child experiences in many elementary schools in Kpelle country. In what follows, we will report our observations. Our generalizations relate to schools in Kpelle land, but they can be extended to schools in coastal cities as well as in other tribal areas. In short, these difficulties are not simply confined to the Kpelle, although the Kpelle are our focus of interest in this book.

LINGUISTIC DIFFICULTIES

First, we made a number of observations of linguistic phenomena. The children knew almost no English when they began school, and what English they did know was the local Liberian pidgin, a language with elements drawn from English as well as the tribal languages, and with features of its own. Its phonology is sharply divergent from that of standard English. For example, a word cannot end in a consonant, but only in a vowel or a nasal. Its structure has elements peculiar to itself (a system of two future tenses, for instance, one immediate and one remote). Its vocabulary has many items which radically distort the usual English meanings. For example, the term "kitchen" in Liberian-English refers to a room not where food is prepared, but to a small hut or shed where rice is stored or where discussions are held.

Before they begin to learn English, the children hear substandard Liberian-English spoken in the villages and identify it with the standard English they are expected to use in school. The teacher does one of two things in this circumstance: He himself will identify this variety of Liberian-English with standard English, because he speaks only a similar type of Liberian-English. Or he will berate the children for their bad English, not realizing they are speaking a different language. In neither case is effective learning advanced.

One principal effect of this in mathematics is that the child is not able to use words or structures precisely. He finds that terms and structures are used one way in textbooks and another way by his fellow substandard Liberian-English speakers. Take, for example, the question of pluralization. In English, the regular indication of plurals is a final "s". This ending does not exist in the local Liberian pidgin which does not use final consonants. Pluralization can, if desired, be indicated in a different way. But normally pluralization is omitted in favor of a generic usage, which is neither singular nor plural. Thus, "Bring the pencil" stands equally well for "pencil" or "pencils." The result is that the child either ignores pluralization in English or misuses it. Needless to say, this can do considerable damage when he attempts to solve word problems.

Another example is the English phrase "as many as." A first grade class we observed, taught by a good teacher, using a good textbook, a copy of which was in the hands of each pupil, failed completely to understand the concept "as many as." But there was a reason. In uneducated Liberian-English, to say that there are more boys than girls, one may say that the boys are "many than" the girls. "Many than" is the closest phrase in Liberian-English to "as many as," therefore the child identifies the two. Naturally, he is totally confused when the teacher tells him that a set of five boys is "as many as" a set of five girls. On the contrary, he would say that a set of six boys is "many than" a set of five girls. The teacher who failed to grasp the situation, was baffled and impotent.

For the Kpelle child the use of large words per se is of value, for it lends status. It is extremely common for children to acquire large words, like a chief acquires wives, and use them at every opportunity, appropriate or inappropriate. This tendency is most marked at the upper level, when the child begins to make long, flamboyant speeches in the classroom. Large words, he believes, attest to the fact that he is an educated man.

It is of little significance that a word may have a simple meaning. The phrase "as such" is customarily used in an English sentence to refer to some previously mentioned attribute of the person or thing in question. However, the Kpelle schoolchild uses this phrase without antecedent, simply for effect. He has seen and heard it used, and he likes it. It adds color to a sentence, but not meaning.

A more mathematical example is the word "half." This term means one of two things to the Kpelle schoolchild: some indeterminate part of a whole, or else a meaningless symbol used in school arithmetic. We have heard children refer to a fractional part, which must have been less than $1/10$, as a "half," and also refer to a part which must have been more than $9/10$, as a "half." We have observed these children perform complex fraction problems without the slightest comprehension.

TECHNIQUES FOR LEARNING

A second area of difficulty for students is in the techniques for learning. Rote learning seems to be common procedure. The words themselves are basic, not their meanings or applications in an extra-verbal context. In one case a teacher in a nearby school told a child that insects have eight legs. This child (who worked in the Gay household) one day happened to bring an insect to Mrs. Gay. They discussed the fact that it had six legs, contrary to the teacher's remark. The child, with Mrs. Gay's encouragement, took the insect to school to show the teacher. The child was beaten for his efforts—and insects continued to have "eight legs." From the teacher's point of view, the important thing to learn was a set of words and respect for authority.

Another example of this reliance on rote learning involves the multiplication tables. In many primer classes, children who cannot yet understand a word of English and who have made no systematic study of simpler arithmetic parrot the multiplication tables. A story was brought to our attention, not from the Kpelle, but it might well have happened there. A child was asked to recite the multiplication tables for his teacher. He began, "la–de–dah–de–dah, la–de–da–de–dah," at which point the teacher interrupted to ask what he was saying. His response was that he knew the song, but did not yet know the words. The same phenomenon is seen in Koranic schools throughout West Africa, where children are set to the task of memorizing long passages from the Koran, without knowing Arabic.

This means, of course, that the child makes no further use of such things as multiplication facts beyond satisfying his teacher. He is not taught a relation between the mathematical fact and any real-life situation. In mathematics as we conceive it in the West, the multiplication fact is a mediating link, joining one practical, concrete fact with another. The child who knows that 2 sets of 6 stones are 12 stones altogether, soon learns to use the multiplication table as a device to lead him from sets of stones to sets of persons, or other objects. Not so the Kpelle child who has learned the multiplication table by rote. One child could not tell without counting how many eggs could be put in a carton with 2 rows of 6 eggs each. He was asked, "What is 2 times 6?" He knew the answer immediately. He was then questioned about the egg carton, but the situation had not improved. He could not apply the multiplication fact in a new context.

Another case we observed was a child who had learned that the number 27 is composed of 2 tens and 7 ones. Yet he could not explain the number 43 in a similar manner. The first fact was not related to the second problem by an abstract, intermediate understanding of the structure of numerals. Similarly, a child who learned geographical facts about a particular area in one class, could see no reason to use these facts in another class dealing with the same geographical area but in a different subject.

LOGIC AND REASONING

No occasion arises for a child to use his talent for discovery, or his curiosity, in relation to the subject matter of a course. He is forced to repeat aloud collections of words that, from his point of view, make no sense. He knows that he must please the teacher in order to survive, but he finds what is taught incomprehensible. Therefore he tries to find other ways to survive; he uses his wit to anticipate the teacher. If the material being taught has no apparent pattern, at least he can figure out the teacher. Often the teacher has come from the same Kpelle background as the student, and so his words and actions are more or less predictable. The teacher's words and actions do not seem haphazard, disorganized, and irrelevant. This leads the child to guess at the best way to please the teacher, using nonacademic, social clues. Even when the teacher is not of Kpelle origin, he behaves in a way that makes sense to the Kpelle child, because many of the patterns of Westernized Liberian life duplicate the authority structures of Kpelle life.

It is common for children to shout out answers to the teacher before he has finished stating a problem. They try to outguess each other to show the teacher how smart they are. For example, a teacher gave the problem, "Six is two times what number?" When the children had heard the words "six," "two," and "times," they shouted "twelve." Their experience with the teacher showed that he was always asking the times table, and they guessed he was asking it again. They were wrong —and probably were never quite sure why. They were told the answer was "three," which probably confirmed their idea that school made no sense whatever. They had not discovered the pattern, but considered only the isolated words out of context.

The main techniques in their repertoire of "scientific method" are rote memory and clever guessing based on familiar clues. Clever anticipation is more important than literal understanding, and logical development is ignored in favor of one-shot guesses.

The child makes little use of logical organization and structure, or argumentation in school. For instance, it seems rare for the child to make use of visual regularities. In one class a series of textbook problems were written in a haphazard fashion on the board. Neither teacher nor student thought of arranging the problems in a neat fashion on the blackboard, even though they were written in a definite sequence in the textbook and part of the lesson depended on seeing the pattern formed by the answers. The groupings we perceive immediately were neither perceived nor used in these classes.

Another example of the same kind concerns sets of stones used to illustrate multiplication problems. For many children an organized group of 3 sets of 4 stones has no more significance than a randomly scattered set of 12 stones. To find the number in each set the child counts them; the visual pattern in the structured case seems to provide no help.

The child is rarely challenged to follow a train of reasoning to its conclusion. Geometry proofs at the high school level are given as exercises to be memorized, not occasions for reasoning. The child knows a proof if he can repeat it, but he is never expected to discover a new proof in a similar problem, based on his understanding of the first problem.

Nor is evidence used to reach general conclusions. The child who cannot tell the answer to the problem, "One-half of what is eight?" is not encouraged to experiment until he finds an answer. He is supposed to have learned the answer to this particular question. The unwillingness in this case to do practical experiments may be caused in part by his using the word "one-half" as a vague term for any part of a whole. The word has two usages, one as an arbitrary symbol in arithmetic, and the other as a vague term in village life; the two have little or nothing in common.

Since logical argument is not stressed in the classroom, it is understandable that inconsistencies do not upset the students. A striking case concerns the nature of living things. A Kpelle college student accepted *all* the following statements: (1) the Bible is literally true, thus all living things were created in the six days described in Genesis; (2) the Bible is a book like other books, written by relatively primitive peoples over a long period of time, and contains contradiction and error; (3) all living things have gradually evolved over millions of years from primitive matter; (4) a "spirit" tree in a nearby village had been cut down, had put itself back together, and had grown to full size again in one day. He had learned these statements from his Fundamentalist pastor, his college Bible course, his college zoology course, and the still-pervasive animist culture. He accepted all, because all were sanctioned by authorities to which he feels he must pay respect.

The net result of this pattern of difficulties in school is that mathematics, indeed almost the entire curriculum, is not useful outside the classroom. The child has no occasion in village life to use mathematics skills learned by rote in school, and has no knowledge of how to use these skills, other than to please the teacher. The subject is isolated and irrelevant, a curious exercise in memory and sly guessing.

It comes as no surprise, then, when numerical statements are not related to physical reality. The students are unable to estimate and approximate in a word problem. If the problem posed was how much the payroll was for a business that employed 97 men for 21 days at 50 cents a day, the student knew how to perform the necessary multiplications. But he had no idea how to figure out approximately what the answer might be. He could make no sense of the answer which concluded that it was almost the same as 100 men for 20 days at 50 cents a day. In short, he could not relate the classroom method to the real world. Only in the most elementary cases does he use arithmetic in the village, cases which are provided for by traditional techniques.

In summary, Kpelle students who encounter mathematics in Western-oriented schools misuse the English language, learn by rote memory and guessing, do not use logical patterns, and have no use for what they learn. School mathematics has largely failed, and the child produced by the system needs radical help to overcome this failure, no matter what the grade level. He rarely gets the help he needs. His teachers know something is wrong, but they do not understand enough to propose a coherent course of action. In this study we attempt to do both—to understand what lies behind the failure, and to recommend proper and effective relief. We turn now to the mathematical behavior of the Kpelle in their tribal setting, in order to find the materials on which understanding and action depend.

7 / Arithmetic

ARITHMETICAL BEHAVIOR among the Kpelle can be discussed under four major headings which correspond closely to those now current in discussions of mathematics in Western culture. The first is the organization and classification of objects into sets, which is basic to our Western understanding of the foundations of arithmetic. The second is the use of counting systems to describe sets of objects. The third concerns the relations of equality, inequality, and comparison between sets, as well as between numbers. And finally, we consider the operations performed on numbers, corresponding to our addition, subtraction, multiplication, and division.

SETS

We must consider the ways in which the Kpelle form and describe sets of objects. This investigation is particularly important, since the modern approach to teaching elementary arithmetic, from the earliest school years, builds upon the use and description of sets of objects. The mathematics curriculum developed by Educational Services Incorporated for use in African schools is no exception to this pattern. For this reason in particular we must know how Africans themselves classify into sets the objects they encounter in their daily lives.

The Kpelle use the terms *kpulu,* "group," and *seêi,* "set," to speak of sets of objects. The word *seêi* has the same root meaning as our English term "set." It refers to the result of placing things together. The term *seêi* applies to any collection of distinct, countable objects. One can say, for instance, *koni seêi náan ká tí,* "Those are four sets of stones," where the stones may be in four random piles or in four straight rows. The term *seêi* is more general than, for instance, the term *pere,* "row." The sentence *koni pere náan ká tí* must be translated "Those are four rows of stones." In this case the term *pere* and the term *seéi* would have the same reference. But if the set were expanded to include objects of more than one kind, the word *seéi* would be applicable while the word *pere* would not, because *pere* refers only to things that are put in rows.

Other terms for set are also more specific than the term *seêi.* The term *kãya* refers to things within one family or type, such as fruits or vegetables. The *kuu* is a set of people gathered together for some particular purpose, whether a feast, a funeral, or a work group. The suffix *-bela* refers to a collection of persons. Therefore *tii-ke-bela*

are workmen and *taa-bela* are townspeople. In English, the term "regiment" is more specific than the term "group," to give only one example.

CLASSIFICATION

Members of such sets can be individual objects, or they can be general and indefinite. Two general terms used are *nuu,* "person," and *sen,* "thing." The world of objects seems to be divided roughly into the class of persons and the class of things. Within these classes there are subclasses of objects, such as, *wuru,* "tree" and *sua,* "animal," both within the class *sen,* and thus in the class of things. A full description of all possible classes of objects and subclasses within those classes, is a worthwhile project, but is beyond the scope of this case study.

Thus far all the terms for sets of objects have referred to countable objects. We do not normally speak of such material as *molon,* "rice," or *yá,* "water," in this way. The hypothetical sentence *molon seêi náan ká tí,* patterned after the sentences given above for stones, means nothing. Rice is not spoken of in sets. One of two modifications in that hypothetical sentence is necessary. Either we must refer to grains of rice by adding the suffix *-kau,* "seed," in which case we can say *molon-kau seêi náan ká tí,* "Those are four sets of grains of rice," or we must speak of *molon* by using one of an entirely different class of structure-describing words.

The latter class includes such terms as *sane,* "bottle," *boro,* "bag," *legi,* "pot," and *kôpi,* "cup." Words in this class organize a noncountable mass into countable units, yet not in the same way as the suffix *-kau* isolates bits of the material.

The distinction in Kpelle between countable and noncountable nouns is less fundamental than in English. In English we must state a countable noun as singular or plural, and the noncountable noun in singular form. For example, we can speak of "a horse" or "horses," but only of "air" in normal usage. In Kpelle, however, the fundamental use of any noun is generic, showing neither singularity nor plurality. The statement *séle káa à sua kéte* can be translated with equal ease as "An elephant is a big animal," "Elephants are big animals," or "(The) elephant is a big animal." The term *séle,* "elephant," is in its root form generic, and the singularity or plurality must be supplied by the context. It can be counted, but it need not be counted. The structural distinction between a word such as elephant and a word such as water may, but need not be, expressed.

There is a suffix used with countable free nouns which resembles our English plural, but which is actually an individualizing form. To add the suffix *-ná* is to think of the items as discrete, counted one by one. A countable set of objects would be individualized only to show that the objects were scattered and not in a uniform, homogeneous collection. Thus we can distinguish *nátée saabai,* "my three chickens," and *nátée-nà saabai,* "my three (particular, isolated) chickens." The second expression focuses the attention one by one on the three chickens—perhaps one near the man's house, one in the cassava patch, and one near the blacksmith's shop. The first expression does not call attention to their physical relation to each other, but refers to their presence as a group.

It appears that the Kpelle language has an adequate vocabulary for dealing with sets of objects. The classification system this vocabulary supports is built into the language and the daily life. The Kpelle know and use sets of stones, bottles of water, bags of rice, and work groups of people, although this type of classification is not conscious and explicit.

These general observations led us to set up a simple problem mentioned in the introductory chapter, in forming sets of objects according to different attributes. Before beginning this experiment we feared it might prove too simple, but we hoped to at least determine if there was any difference in the order that the sets were formed. The task was so constructed that the objects could be sorted according to three principles (or attributes): color, number, and form.

In the first problem each subject was given 8 cards (5 inches by 4 inches) on which were pictured triangles and squares, either red or green; there were 2 or 5 on a card. These 8 cards were put before the subject in a haphazard arrangement and he was asked to sort them into two groups.

The initial results were astonishing. The task was almost impossibly difficult for all three groups—illiterate children, schoolchildren, and adults. Most often the subject would shuffle the cards around for a while and then look up expectantly. When asked what sort of group had been formed, the answer was a shrug of the shoulders or no answer at all. We asked ourselves if the instructions were inadequate or the material on the cards too difficult to grasp.

In order to find out more about these questions, two modifications were made in the experiment. First of all, we tried to make sure that the subjects understood the instructions by preparing a set of sample cards on which figures were drawn in ink. The figures were large or small dots, some were filled, some open, and located in the center or near the edge of the card. The experimenter began by saying that this pack of cards could be sorted into two groups in different ways and then proceeded to form the groups in each of the three possible ways. The subject was then shown the pack of experimental cards and asked to perform the same kind of task.

Another possible factor we sought to evaluate in this revised experiment was the cultural relevance of the figures on the cards. For this purpose we prepared 8 cards identical to those described earlier, but using instead pictures of a woman beating rice, with a baby on her back, and a man carrying a bucket of water on his head, followed by a dog. These pictures were readily understood and accepted as culturally appropriate. There were either 2 or 5 pictures on a card. The cards themselves were either red or green. Thus, the cards could be sorted according to the picture (man-woman), color, and number. As before, the subjects were requested to sort the cards in three different ways.

The overall effect of the demonstration sorting procedure was to increase the number of sorts that the people made. But severe problems remained. There were no significant differences between the ability to sort the triangle-square and the ability to sort the man-woman cards.

The results of these experiments are summarized in Tables 1 and 2, where the experiment using triangles and squares and that using men and women are grouped together.

The most striking aspects of these data are the relatively small proportion of

TABLE 1

PROPORTION OF KPELLE SUBJECTS WHO SUCCESSFULLY SORTED CARDS

	1st Sort	2d Sort	3d Sort
Illiterate Children (42)*	0.95	0.48	0.10
Schoolchildren (50)	1.00	0.72	0.36
Illiterate Adults (63)	0.95	0.65	0.16

TABLE 2

MEAN TIMES IN SECONDS REQUIRED BY KPELLE SUBJECTS TO SORT CARDS SUCCESSFULLY

	1st Sort	2d Sort	3d Sort
Illiterate Children (42)	56	151	82
Schoolchildren (50)	29	88	131
Illiterate Adults (63)	58	115	103

* In all tables and graphs the numbers of subjects are given in parentheses after the title of the group.

subjects who managed even a second sort of the cards and the great amount of time each sort required. The average American twelve-year-old takes one look at these cards and instantly proceeds to sort them into the three possible sets. The average Kpelle adult could not complete this task and only two-thirds of the Kpelle adults could make a second grouping. Moreover, the amount of time for the sorts, from one or two minutes, is extraordinarily great.

It is also interesting that there was no special preference for any one attribute. In the test using triangles and squares, 14 persons chose form dimension first, 26 chose color, and 27 chose number. In the test using pictures of women and men, 24 chose form, 32 chose color, and 26 chose number. There is a slight preference for either number or color over form, but the differences are not reliable. Some American authors have tried to show that the attribute chosen first depends on the developmental level of the subjects. No such clear relation is shown by our data. This may be due to cultural differences or to the stimuli we used. The question deserves further study.

What is the relevance of this discussion of sets and classification for arithmetic? Arithmetical procedures among the Kpelle, and very likely among any group of people, are built upon manipulations of sets of objects. The sets of objects normally used in this way are those categorized and classified by the language and culture. We have seen that the Kpelle language is capable of such classification, but the results of this card sorting experiment indicate that the typical Kpelle person finds such classification very difficult in strange situations or when using unfamiliar material. Apparently the linguistic potential for classification does not guarantee that the process will occur. We are certain that had we asked a person to sort cotton goods into country cloth or store cloth, sewed into clothes or not, and whether dirty or clean, no such difficulties would have arisen. Because there was great difficulty when "nonsense" materials were used, we consider this an important fact to be considered when discussing the Kpelle child's activities in school. Clearly, familiar materials are essential in building a proper foundation for the study of arithmetic.

COUNTING SYSTEMS

The natural progression in arithmetic (natural in our Western eyes, and, as we shall see, also probably natural to the Kpelle) is from sets to numbers. One reaction to a set of things is to count them. This the Kpelle do in much the same way we do in English. Their numeral system is basically a decimal system, although buried within the decimal system is a subordinate base-five system. There are cultures whose methods of numeration differ greatly from our own, but the Kpelle is not one of them.

Numerals are used in two forms, one preceded by the noun it counts and the other with a pronoun prefix replacing the noun as shown below. The numerals from 1 to 5 are basic, and are added to 5 to form the numerals from 6 to 9. There are independent numerals for 10 and 100 which are the basis for other numerals as shown below. The Kpelle occasionally use a word for 1,000 which is borrowed from the Mandingo language. Some of the more Westernized among them use English terms for higher numerals. Some typical numbers are:

*táa*n—"one of it"
*veer*e—"two of it"
nóolu—"five of it"
nóolu mei da—"six of it"
*nóolu mei feer*e—"seven of it"
puu—"ten of it"
buu káu t*ò*no—"eleven of it"
*buu káu feer*e—"twelve of it"
*buu feer*e—"twenty of it"
*buu feer*e *káu lóolu mei da*—"twenty-six of it"
n*u*n *tòno pôlu puu lóolu mei feer*e *káu tòno*—"one hundred seventy-one of it"
*wala feer*e—"two thousand"

A typical use of a numeral with a noun is the expression *taa lóolu*, "five towns," which can be compared with *ǹóolu*, "five of it." There is no term for zero as such in the Kpelle language. But it is possible to refer to an empty set in several ways. For instance, in a game played by successively removing stones from piles, a pile with no stone is referred to by the phrase "fall in the hole." In a similar game, the player says of the pile without rocks "Let's enter old-town site," implying that no one lives there any more. It is also possible to speak of *seei-folo*, "empty set." Many different things can be called empty, but all are described by containers or sets of words. For example, a bottle, house, box, hole, mortar, chicken coop, bag, farm, pan, or purse, can all be called empty.

There is a rudimentary fraction system where the word *gbôra*, "middle," and the word *-kpua*, "part," are used to indicate portions of wholes. The term *gbôra* is used in the same way as *sama*, "middle," referring to the middle of a road, or the middle of a hill, or the water in a river which is not full. In no case does the word have a precise meaning. Often the hamlet where persons rest when they are on their way from one village to another is said to be at the middle of the trip. Once we were told that we had reached the "halfway" town on a long, hot walk. Our expectations proved to be sadly mistaken when we found that the term was not used in a precise, mathematical sense!

That part of a banana which one person receives when two people share a banana is called *gwei-kpua*, "part of a banana." Where four are required to share a banana each part may be called *gwei-kpua-kpua*, "part of a part of a banana." *Kpua* does not denote exactly half, however, since *gwei-kpua* can also refer to that part of a banana which each of three people receives. One pragmatic informant who was asked to consider this situation said he would mash up the banana and give it out in spoonfuls! In this way he avoided having to describe the exact division into equal portions.

The word *hâvu* has been borrowed from English, and is used in such expressions as *molon tooi feere da hâvu*, "two and a half stacks of rice." This term has become part of the Kpelle language, and few recognize its English origin. It has the same indefiniteness of references as *kpua*.

Perhaps the most common counting system among the Kpelle is the sequence of terms *da*, "some," *támaa*, "many," and *kélee*, "all." They are common answers to the question *geelu* bé, "How many?" or "How much?" A person might say he has some rice, much rice, or all the rice; or he might speak of some people making a farm, many people making a farm, or all the people making a farm. These expressions are vague and imprecise, but they have sufficient precision for the Kpelle who knows approximately what constitutes "many" when applied to familiar objects.

There are special terms for things which come in pairs. They are referred to as *nyowãa*, "twins." Human beings, cassava, plantains, and bananas come in such pairs. Triplets are also called *saa*ban, a term derived from *saa*ba, "three."

There is an ordinal number system, which is related in a regular way to the cardinal numbers described. Only the term for "first," *mà*a-n*ú*n, is irregular. Otherwise the ordinals are formed as in *ǹuui veere-gélei*, "the secondman." The numeral, preceded by the noun which it modifies, is given the suffix *-gélei*, which is derived indirectly from *géle*, "sky," or "day."

NUMBERS AND KPELLE CULTURE

We must now determine just what the people do and do not count in daily life. Our observations indicate that it is possible to count many things but that some things are not counted. For instance, it is not proper to count chickens or other domestic animals aloud, for it is believed that some harm will befall them. This has also been the case in many other non-Western cultures, including that of the Old Testament, where it was not considered proper to count people aloud, lest some die. The Liberian government requires the Kpelle to count people from time to time, both for the census, and for taxes, but it is not a traditional practice. People count houses, poles for building houses, bags or other measures of rice, kola nuts, and other commonly used items. Counting is not so common an activity as it is in more highly commerical or technological cultures.

There are few occasions for counting beyond approximately 30 or 40. A young man, who spoke Kpelle as his native language, had been through three years of school, and was of at least normal intelligence, could not remember the Kpelle terms for such numbers as 73 or 238. He was able to reconstruct them, but his use of them was far from automatic. Many people cannot solve problems involving numbers higher than 30 or 40. Commonly, round numbers such as 100, are used to indicate any large amount.

The word "number" is not found in the vocabulary of Kpelle adults. It is possible to construct an artificial word *támaa-laa*, "many-ness," but this is more the invention of the linguist (using, to be sure, authentic Kpelle word-construction) than a term in actual use.

Number-magic and numerology appear in the culture. Man is considered to have one more degree of power than woman. The number representing man is four and the number representing woman is three. A boy-child is presented to the world on the fourth day, and a girl-child on the third. The boys' Bush school is in session for four years, and the girls' Bush school for three. The burial rites for a man are completed on the fourth day, and those for a woman on the third.

There are proverbs and parables which use numbers. For example, *ífeere ká ní*, "this is your second," is a warning that a person should not commit a particular offense for the second time. Or a man can say "they can say one and then two," which means that someone has done something to him, but that he will wait until the second time before reacting. "The ten years did not kill me, is it the eleventh that will kill me?" means that a man has merely done the work he plans to do, and will finish soon. In a court case, this same proverb was interpreted to mean that a creditor could afford to wait a little longer for his money. Numbers are also at times used for a person's name, which happens most often when a man is employed by someone knowing no Kpelle. To refer to a man as *náa*n, "four," is to curse him.

Divination may involve numbers. The *zoo*, or medicine man, takes two kola nuts and splits them in half. He puts medicine or a "spirit" stone in a particular kind of leaf. He then throws the kola halves to the ground to determine the outcome of a given matter. If all the kola halves face upwards, it is certain the spirits are concerned about the affair at hand. If two face upward and two face downward, the spirits are divided. If all face down, the spirits are unfavorable and not inclined to help the situation. It is the number of halves in each position which determines the outcome. The *zoo* asks a series of questions of the kola nuts. He will suggest various possibilities, until all the halves face upwards for one of his suggestions. This is taken to be the correct answer. He may identify a guilty person in this way, or find the particular crime someone has committed. The guilty party must then confess the ill feeling or the bad action. The kola nuts are thrown once again to determine if the spirits are satisfied with the confession. When they are finally satisfied, a chicken is killed as a sacrifice, and the blood is sprinkled on the "spirit" stone or the medicine. This procedure is used to predict the success of any activity of concern to the people.

One cannot help notice the rigged nature of this use of numbers. There is apparently no reliance on the laws of chance, as an analogy between throwing kola nuts and tossing coins might suggest. The *zoo* makes the seemingly chance nature of the process work to his own ends. He manipulates the force to verify his solution of the problem, which he determines on the basis of his knowledge of the situation.

The Kpelle do not, of course, use numbers only in this semi-magical way. They count things, and they use stones to help them in the process. Sets of objects are often noted and matched by sets of stones. For instance, once we counted the number of people in a small village. One of the elders of the town went with us, putting one stone in the pocket of his gown for every person we counted. Similarly, for tax purposes, dollars and persons are matched with stones in the hope that enough dollars can be obtained from enough persons to satisfy the government.

NUMBER RECOGNITION

On the assumption that the widespread use of stones as markers would result in relatively accurate estimation of the number of stones in a pile, we conducted a simple experiment. For comparative purposes, two groups of American subjects were given the same task—a group of poorly educated adults and a group of college students. The procedure followed was quite simple. The subject was shown 10 piles of small stones, 1 pile at a time, and given about 10 seconds to estimate the number of stones in the pile. The answer was recorded, but no information was given the subject until he had made all his estimates. The actual numbers of stones varied from 10 to 100 in steps of 10, with the piles of various sizes always presented in the same haphazard order.

The results of this experiment are summarized in Figure 1.

The graph shows clearly that the Kpelle adults perform much more accurately than either of the American groups, which do not differ from each other. One point remains to be made: The second set of data points for Yale undergraduates represents data from an extra stage in the experiment. The college students, once they had completed the usual series of estimates, were told the number of stones in the pile containing 60 (thus the "perfect" performance for that data point). Immediately their performance improved until it was on a par with the Kpelle adults. It appears that we can instill instantly in the American college students a skill which the Kpelle attain through years of experience. (Unfortunately, this manipulation was thought of after the Kpelle data had been gathered, so we cannot compare the relative skills of the two groups after instructions are introduced.)

Another experiment involved the application of numbers to familiar objects, but objects which were not usually counted. We asked 20 people from a village containing 97 people and 41 huts to tell how many houses and how many people they thought lived in their town. The average guesses were quite low—29 houses and 64 people. More striking, however, was the extreme variability and the frequent inappropriateness of the guesses. Some made estimates as low as 11 houses and 30 people, while others guessed as many as 60 houses and 200 people.

The last in this set of experiments concerned with counting requires a more lengthy explanation. We reasoned that if the people are genuinely unfamiliar with applying numbers to objects, a deficit should appear if they are asked to make very rapid estimates of the number of objects present in a group. On the other hand, if their normal experience with objects is such that they can readily apply numbers to sets of modest size, such estimates ought to be possible even at a glance. To study this question, a special device called a tachistoscope was constructed. This device could present visual displays for time intervals as short as $\frac{1}{100}$ second by shining a light on the stimulus display for this interval while the subject observed the proceedings. The stimulus was housed in a metal box and the time interval controlled by a camera shutter.

Our procedure was as follows: The subject was seated near the apparatus in a dimly lighted room. He was told that he would be shown spots on a card, but that the spots would be shown for a very short time. He was then shown 6 cards, each a representative of one of the cards used in the actual test. These cards contained either 3,4,5,6,8, or 10 dots, each $\frac{1}{4}$ inch in diameter, arranged in a haphazard way on the cards. In the actual test each of the dot frequencies occurred 3 times, totalling 18 stimulus cards in all.

The subject was then asked to look into the tachistoscope and tell us what he saw. A card containing 5 dots was displayed for a few seconds. This stimulus card was shown 3 times, each time at a more rapid speed. After this pre-training, the

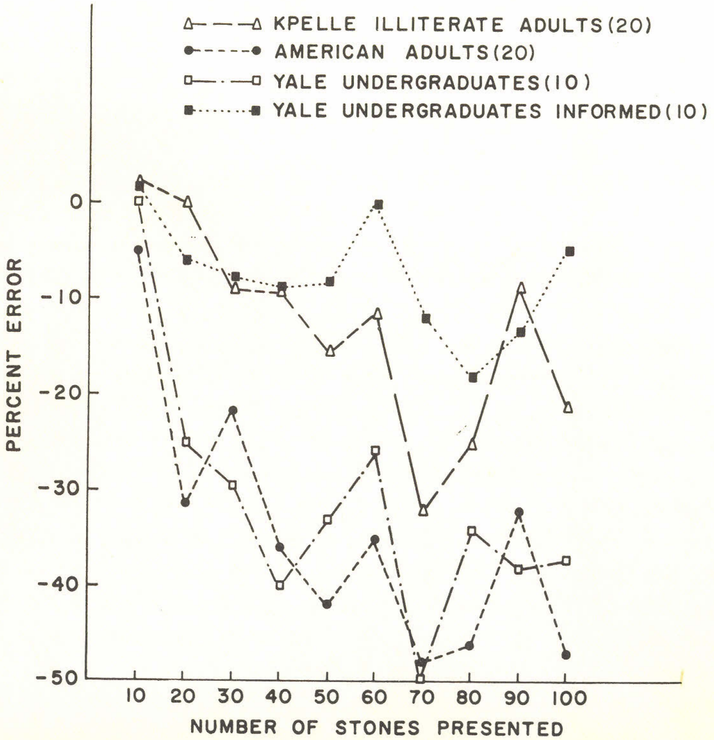

Fig. 1. Mean percent errors of Kpelle and American subjects in estimation of numbers of stones in piles.

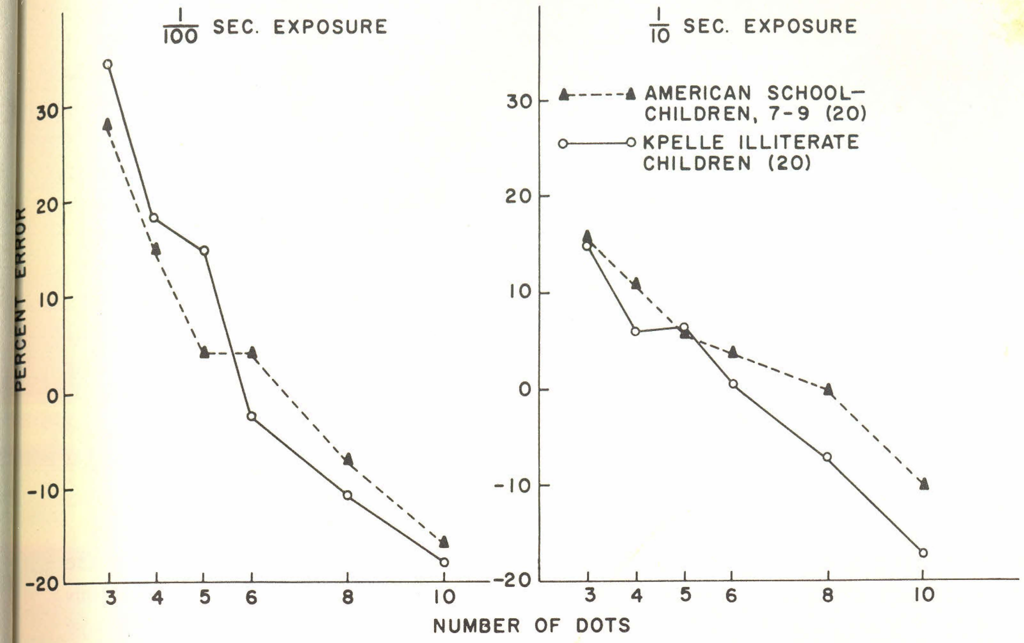

Fig. 2. Mean percent errors of Kpelle and American children in estimation of numbers of dots in random visual displays.

experiment began. The main purpose of these preliminary procedures was to ensure that the subject could count the number of dots, given sufficient time, and that his eyesight was normal, so he could see the dots when looking into the tachistoscope.

Each subject viewed all 18 of the stimulus cards at three different exposure intervals, first at $\frac{1}{100}$ second, then at $\frac{1}{25}$ second, and finally at $\frac{1}{10}$ second, so that we could obtain some information on the relation between accuracy and speed. The results were then plotted in terms of the relative amount of error for the various groups on each of the 6 stimulus frequencies. For instance if the average estimate when 3 dots are presented is 4, the average error is 1 dot and the relative error is $\frac{1}{3} = 0.333$ dots. Several different groups of subjects were run, but for our purposes it is sufficient to consider the results obtained from 4 of the groups: Kpelle adults, Kpelle children, American college students, and American schoolchildren seven to nine years (See Figures 2 and 3).

Looking first at Figure 2, two features of the graphs warrant mention. First, as expected, there is less error at the slower speed than the faster. Second, and more important, there is little or no difference between the Kpelle and American children's groups, although the Americans have attended school for three or four years and the Kpelle are completely illiterate.

The results in Figure 3 show a different pattern. Here it is clear that at the shorter exposure time ($\frac{1}{100}$ second) the college students are more accurate at estimating numbers. When the time interval is extended to $\frac{1}{10}$ second, however, the superiority of the American subjects is greatly diminished, primarily because both groups are very accurate. Only for the stimulus display containing 10 dots does a really substantial difference appear.

Taken together these results seem to indicate that familiarity with numbers may be of assistance in making rapid estimates. In the present context, the most interesting fact is that the differences between Kpelle and American subjects attain significant magnitude only when the Americans are sophisticated in the use of numbers. It is difficult to see how differences such as these bear import on everyday operations with numbers, but it does indicate that subtle differences do exist.

EQUALITY AND INEQUALITY

Having considered the way in which sets are counted, we move to an examination of how the equality and inequality of sets are expressed.

The Kpelle language has a graded series of terms comparing things and sets of things. These terms can be translated as "equal to," "the same as," "similar to," and "appears to be like." They range from strict equality to vague similarity. Other equivalent terms can be used, but these are representative.

The expression for "equal" is the term *-póoriee*, literally translated, "to be of the same strength as." We can say *ǹurii ní dà ǹúril tí kôon á kè dí póoriêe*, "Measure this stick and that stick if they are equal." Another example is *sumo dà kékula dí fé pôori ní too-lâa sù*, "Sumo and Kekula are not equal in wealth." In both cases what matters is the ability of the one to perform, or to act, in the same way as the other.

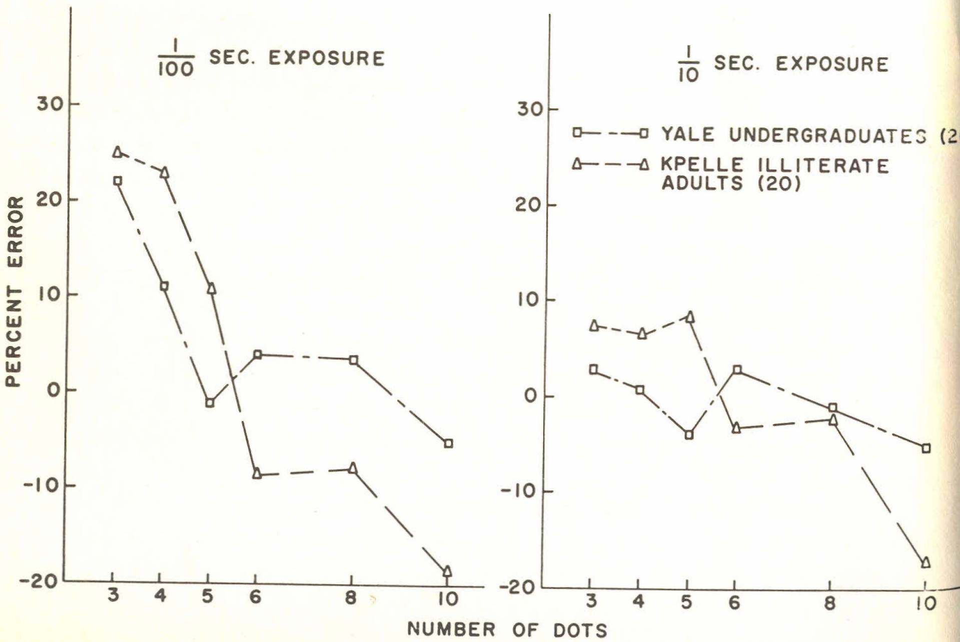

Fig. 3. Mean percent errors of Kpelle and American adults in estimation of numbers of dots in random visual displays.

The expression for "the same as" is *gáa à síi tòno*, "It is one type." Objects with the same shape would often be described by using this expression. It does not mean that the two things are the same in every way, but that they are the same in the particular way being considered.

To say that one object is "similar to" another, the Kpelle use the term *ǹélenôi*, "active" or "smart." For instance they say, "The tallness of Tokpa is active on Flumo," or more freely, "Tokpa is of similar height to Flumo." This term also refers to activity. And finally, to say that one object "appears to be like" another, one can say *è ké pâi kêi ye*. This expression shows resemblance and similarity, not equality.

We wished to find how these terms are used in practice, since the bare English translation is not enough to distinguish them clearly. We held interviews with 10 Kpelle adults in which they were asked what in their experience is "equal to," "the same as," "similar to," and "appears to be like" the following familiar objects: "that house," "yourself," "that tree," "that stone," "your farm," "myself," "this pot," "the St. Paul River," "that goat," and "God." In this way we hoped to confirm our understanding of the proper meanings of the different types of equality and similarity.

To summarize the findings of this inquiry, the responses were sorted into three categories. The first, which was not very common, consisted of responses identifying the object with some activity or portion of itself ("That tree is equal to the trunk it rests on"). This seems to be the category most intimately related to the object. The second category consisted of objects of the same species ("That tree is equal to another fruit-bearing tree"). The third category consisted of objects related to the reference object by analogy or by a superficial physical resemblance ("That tree appears to be like sugar cane").

In order to obtain a summary score indicating the relative frequency of each kind of response for each type of equality statement, the three categories were assigned scores of 1, 2, and 3, respectively. With 10 items and 10 informants, the total number of points could range from 100 (if all responses fell within the first category), to 300 (if all responses fell within the third category). Each of the four equality statements was scored in this manner with the following results (in terms of total points): "equal to" –194, "same as" –223, "similar to" –235, and "appears to be like" –241.

Although we have not tested the significance of this trend, there appears to be a tendency to use these terms in differing ways. The term "equal to" is restricted to the thing itself or things very closely related to it; at the other end of the spectrum, "appears to be like" seems to extend to objects only vaguely similar to the object in question.

To obtain information on the way the term "same as" is applied by the Kpelle, a modified version of a word pair similarities sub-test from a standard American I.Q. test (the Wechsler Adult Intelligence Scale) was given to 10 adult Kpelle informants. The task in this case was to tell how the first member of each word-pair is related to the second. The pairs we used were orange–banana, chief's gown–lappa (woman's dress), axe–hoe, dog–leopard, north–west, ear–eye, air–water, table–chair, egg–seed, song–mask (which they all interpreted as a masked dancer), praise–punishment, and fly–tree. The order of the pairs is that used with American subjects and for them shows a progression from concrete to abstract. It is obvious that the application of general categories to these pairs becomes more difficult for Americans as they proceed through the list. The ability to give general categories for increasingly difficult items constitutes the rationale for the I.Q. test. We were not concerned with trying to obtain I.Q. scores for the Kpelle, whose meaning would be very obscure in view of the changed items and the lack of standardization outside American culture. We were interested in the way these different items would be seen as the "same."

The most common type of answer related the activity of the two objects. There were 79 such answers concerning an action, purpose, report, or use of the pair of objects. For instance, a song and a mask are alike because a song is sung for the masked dancer. There were 37 static answers, those which refer to the species, quality, or origin of the objects. For example, an orange and a banana are alike because both are sweet. In 13 cases the person could not state how the objects were the same or else stated that they were different.

TABLE 3
RESPONSES TO WORD COMPARISONS BY 10 KPELLE ILLITERATE ADULTS

	Don't Know	Static	Active
Orange—Banana	1	8	4*
Chief's gown—Lappa	1	6	4
Axe—Hoe	0	4	6
Dog—Leopard	0	4	8
North—West	6	0	4
Ear—Eye	1	0	9
Air—Water	1	1	8
Table—Chair	0	9	3
Egg—Seed	1	2	8
Song—Mask	1	0	9
Praise—Punishment	0	2	8
Fly—Tree	1	1	8
	—	—	—
	13	37	79

* The totals in each row may be greater than 10 because some of the 10 persons interviewed gave more than one response to a pair of words.

When we look at the way these classifications are distributed among the various pairs, a clear-cut trend appears. As shown in Table 3, the static and active items are more or less equally distributed for the first few items, but for the later, more difficult pairs, there is a noticeable preponderance of activity responses. Clearly, the meaning of "same as" depends on what is being compared. It should be noted that for the Kpelle, "table and chair" should be nearer the beginning of the list than for Americans.

ORDER PROPERTIES

Another set of terms must be used when the objects being compared are not the same; therefore the terms we have considered in the preceding paragraphs are not applicable. If two things are unequal or dissimilar, there are ways of expressing which one is higher or lower on the scale. The word *seri,* "reach," enables us to compare things, as does the phrase *tée . . . mà:* "pass by," "surpass," "excel." For example, we can say *bérei ní kétêi é tée nyíti má,* "This house is larger than that one."

Normally, comparisons in Kpelle put the member with the higher value first in the comparison, as in the previous example. It is possible to do the contrary, as in this example: *bérei ní kurotêi é tée nyíti mà,* "This house in smallness it passes over that one." However, in normal conversation, Kpelle speakers will tend to transform such a sentence so the higher in value is first in the statement.

Curious though this linguistic asymmetry may be, it is not clear what implications this has for the actual use of "greater than" and "less than." To find out if this linguistic asymmetry has a role in determining which objects are initially attended to, and the rate at which different quantities are learned, the following experiment was run:

For a series of trials, the subject was shown two groups of stones. The number of stones in a group varied from 1 to 5, and one group always contained more stones. The task was for the subject to guess which group the experimenter had in mind. For half the 80 subjects, the larger group of stones was always correct; for the other half, the smaller group was always correct. After each guess the experimenter told the subject if he was correct. After the subject had identified the correct group for 8 consecutive trials, the experimenter reversed the "correct" response—those who had learned that the larger group was correct now had to choose the smaller. A record was kept of each response and each subject was assigned scores equal to the trials on which he made his last errors. The average trial of the last error is one measure of the speed at which the concepts, "larger than," and "smaller than" are learned. In addition, after the experiment each subject was asked which concept was correct. The proportion of subjects describing the task in terms of each of the concepts was calculated.

The results seemed to confirm the linguistic tendency to prefer the concept "greater than" to the concept "less than." Those who had to choose the larger pile on the first run and the smaller on the second took to an average of 5.9 trials to identify "greater than," and 11.5 trials to identify "less than." Those who first had to identify the smaller pile took an average of 8.0 trials to identify "less than" and 9.1 trials to reverse and identify "greater than." This difference is not statistically significant, but the trend of the results is supported by the fact that 53 of the subjects were able to verbalize their correct identification of "greater than," but only 27 were able to verbalize "less than."

OPERATIONS

Finally, we observed Kpelle use of arithmetical operations similar to addition, subtraction, multiplication, and division in Western arithmetic. The first important fact is that the Kpelle recognize no abstract arithmetic operations as such. They put objects together, take objects away, put like sets of objects together, or share objects among sets of people; they have no occasion to work with pure numerals, nor can they speak of pure numerals. All arithmetical activity is tied to concrete situations.

One informant working with two piles of three stones each said, *zeêi ní ká saaba, zeêi ní ké bó saaba—mei da,* "this set is three, this set is three-six." Another informant said, *tée feere pelée tée saaba mà káa à tée lóolu,* "two chickens added onto three chickens is five chickens." This can be said *veere pelée zaaba mà káa à ǹóolu,* "two of them added onto three of them is five of them." However, the abstract statement, *feere pelée saaba mà káa à lóolu,* "two and three is five," is not permissible in the language.

Two expressions for subtraction are *kuláa . . . mà,* "taken off from," and *segée . . . mà,* "taken away from." These expressions parallel the English "taken from" rather than the English "taken away," in that they put first the number being subtracted. An example is: *veerei kuláa zaabai mà káa à táan,* "two of them taken from three of them are one of them." The English phrase "take away" reverses the order of the numerals, as in the statement "three take away two is one."

At mentioned before, we found that people could solve problems involving numbers up to about 30 or 40. Beyond that, accuracy rapidly diminished. The informants guessed a large number as the answer, rather than trying to work out the exact result. The normal procedure for obtaining an answer in such problems is to use stones, or fingers, but this proves tedious for large numbers.

We interpret as multiplication the operation expressed by the following statement: *tée feere-feere seêi saaba káa à tée lóolu mei da,* "three sets of two chickens are six chickens." This is, in fact, a repeated union of sets, where the numerical result is obtained by counting the objects. Since there is no such operation as multiplication, there are no multiplication facts for the child to memorize. No coherent answer was given when informants were asked to explain how they solved such problems. Apparently they simply counted the number of objects in the resulting union of sets. One person was asked a complex problem, which reduced in our terms to multiplying 6 by 7. He was evidently trying to count, in his head, all the objects, but he got lost on the way.

Division also deals with unions of sets, only in this case the procedure is reversed. Thus we can say gwêi puu *nákolee à zeêi lóolu; zeêi tɔ̀nɔ̀ káa à veere,* "divide ten bananas into five sets; one set of them is two of them." The procedure is clearly to share the objects into sets and find the number which can be put into each set so that all sets are equal and no objects remain. This is the procedure commonly used when taxes are paid. The government requires that the people in each hut pay 10 dollars as an annual tax. The people determine individual payments by taking a pile of stones representing the sum and sharing the stones among the occupants of the hut.

Such operations are more often performed by specialists within the society than by ordinary villagers. A blacksmith or a trader has more occasion than a farmer to add and subtract because he must buy and sell materials and products. The same is true of the chief, because he deals with taxes. Market women often use simple repeated addition, although they have trouble with complicated problems. When one blacksmith was asked how he was able to solve certain arithmetical problems, he

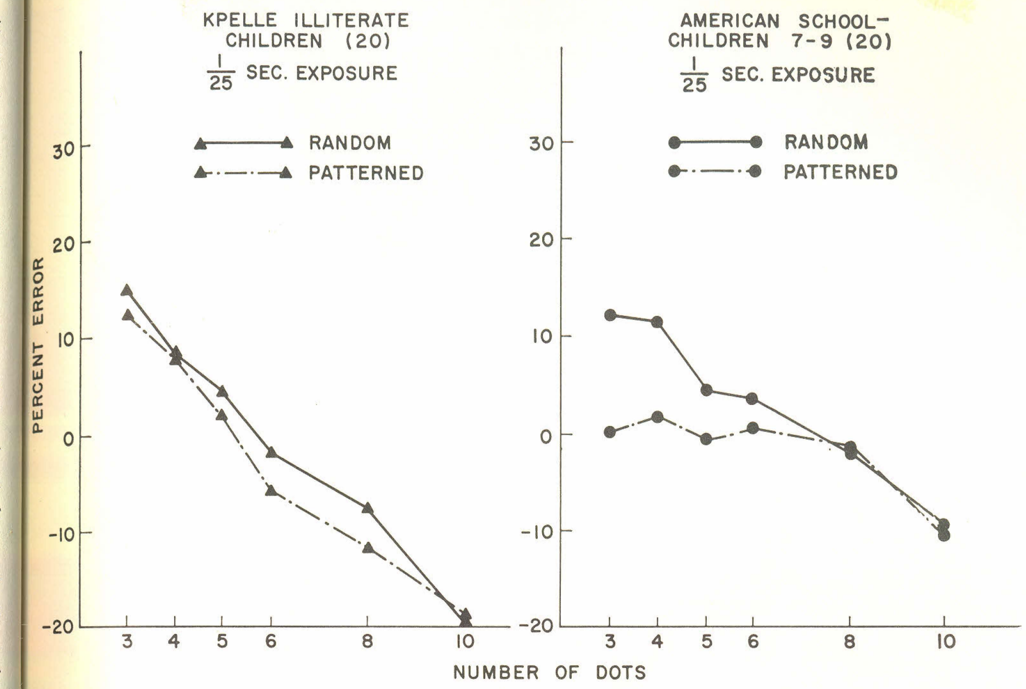

Fig. 4. Mean percent errors of Kpelle and American children in estimation of numbers of dots in random and patterned visual displays.

was quite insulted, and almost walked out of the interview. We apologized and he responded by saying proudly that his knowledge was part of his trade. He then asked us how we knew what we knew. He was not prepared to reveal the secrets of his business and one of those secrets was apparently his ability at mental arithmetic.

Further tachistoscopic experiments confirmed the fact that the Kpelle do not recognize multiplication and division in visual situations. Patterned sets of dots were not estimated more accurately than sets of random dots, indicating that no use is made of the pattern which makes up a multiplication fact. For instance, we think of 3 × 4 in terms of a rectangle 3 on one side and 4 on the other. Apparently the Kpelle man does not; he sees 12 dots in a pattern and 12 dots at random in very much the same way. American subjects in this situation rapidly improved in their ability to estimate. This ability of the Americans is a result of the amount of schooling, probably because they are trained to think of numbers in terms of their factors which can be displayed in a geometric way. This result is shown in one case in Figure 4. The curves for random and patterned dots are essentially the same for the Kpelle subjects, as this graph shows, but radically different for American children. The same results were obtained for several different experimental situations.

We investigated this apparent nonuse of patterned regularity involving multiplication operations in a different way with several informants. We had stones arranged in a circular pattern on the table before the subjects. We asked each informant to describe what he saw on the table. The typical response was that the stones were arranged *kere-kere*, "in a circular way." But when we moved the stones to form a rectangle, the subjects would usually say that the stones were now scattered. They did not respond to the new pattern, perhaps because the pattern has no special significance within the culture.

This concludes the discussion of arithmetic-like behavior among the Kpelle. We have seen that there is a well-developed system of terminology for putting objects into sets and materials into containers. The classification system implied by this is not commonly used, however, and is certainly not part of a Kpelle's normal response to the world. Objects are counted, but there are no independent abstract numerals. Numerals must modify a noun or a pronoun. Numerical identification of random patterns is about as good as that of Americans. There is a rudimentary fraction system, but the basic fraction term means a part rather than a precise half. Number-magic is occasionally used. Equality and inequality can be expressed, preferably in a dynamic rather than a static way. Comparison normally focuses on the larger of a pair. Addition and subtraction are performed in concrete fashion only. Multiplication and division exist only as repeated addition and subtraction. Operations are not usually performed, and when performed normally involve only numbers as high as about 30 or 40.

summary

8 / Geometry

GEOMETRICAL TERMS

THE NEXT MAJOR AREA of mathematical behavior among the Kpelle concerns geometric figures. We will not include in this chapter the measurement of such figures, but will reserve that for the following chapter. Here we will consider nonnumerical responses to the figures.

The most striking fact is the relative paucity of terms naming abstract geometric shapes. We have an abundance of such terms in English, that are used relatively often; there is apparently little need for them in Kpelle, and they are rarely used. Moreover, those terms which are used are quite imprecise. It is tempting to say that they represent topological concepts rather than Euclidean concepts. That is, it is not so much the precise figure that matters, but the way in which space is divided. Thus the term *pere*, "path," can refer to a straight line. However, it can be applied equally well to a curved or a jagged line. These distinctions, which we require in English, are unimportant to the Kpelle. The important thing about that which they term *pere* is that it extend from one place to another place without crossing itself. It is therefore much closer to our topological concept of a path dividing a surface into two parts than it is to our Euclidean straight line.

We made several observations to support this conjecture. Interviews with informants showed that the term *pere* could be applied equally well to a straight row of stones and a meandering row of stones. Another fact, remarkable to a person brought up in a technological culture, is that a path worn by hundreds of villagers crossing a field (which had been surveyed and carefully leveled by a bulldozer), followed a route which at one point deviated by more than twenty feet from the straight path between its end points. The people who had worn that path had felt no compulsion to walk in a straight line!

A number of other informal observations turned up similar phenomena. For instance, when some informants were asked to organize a set of stones into patterns, the results were invariably irregular and unsymmetrical. Kpelle towns have no regular plan or order, except the social groupings formed by kinship. Houses are clustered in irregular and uncoordinated ways. There are no rows of more than three houses even in a large town, and the few rows of three seem fortuitous. When crops such as rice and cassava are planted, the rows are crooked. Only rubber farms planted by wealthy, Westernized people use the straight row pattern so familiar to Western culture.

The figure called *kere-kere,* "circle," does not have the precision of our word circle. It is the shape of a pot, a pan, a frog, a sledge hammer, a tortoise, a water turtle, and a rice fanner. Some of these are noncircular ellipses, and others may be irregularly closed shapes. The informants were aware of the difference and called the elliptical figure *koya,* "long," but the term *kere-kere* was still applicable. It is, therefore, close to our topological concept of a simple closed path, although some slight measure of circularity is required for the term to be used.

There is a term for triangle, *kpẽilaa.* Some things to which this word is applied are a tortoise shell, an arrow head, a monkey's elbow, a drum (shaped something like an hourglass), a bird's nest, and a bow. The term is not restricted to figures formed of three line segments, but includes other similar shapes.

By contrast, the term for quadrilateral refers directly to the fact that the figure has four sides. It is called b*ela-náa*n, "four parts." Informants told us that a rectangular house, a plank, a doorway, a chair, and a table are all of this shape. All of these items have assumed a rectangular form only in modern times and it is possible that the term b*ela-náa*n has recently been coined by the Kpelle people.

There are four solid figures which are commonly found among the Kpelle. The cone is called *soo,* and appears as the roof of a round house, *ton pére.* It is the shape of a spear head, the inside of a mortar, and one type of drum. The cylinder is called *t*oron*t*oron, and is the shape of many common objects. Informants applied it to a tree trunk, a bottle, a mortar, a bucket, the pestle for a mortar, a round house, and a tin can. The sphere is called *kpuma,* the shape of an orange, a tomato, and a papaya (which is far from spherical, from our point of view). Also, the objects which can be called *kpuma* include things we would identify as cubes. So, there are *kpuma* which are called *kere-kere*, "round," and *kpuma,* which are called *l*ebe-*l*ebe, implying that they have sides. The bouillon cube (an essential item in any store) is called *kpuma,* and so is the kola nut, which has curved sides. It is this sort of observation which leads us to think it is the topological and not the Euclidean shape that this term defines. The Euclidean rectangular solid also has a name, *kála*n, which is probably a somewhat later addition to the language, because such solids are not older than the encroachment of Western civilization. The rectangular house is called *kpiyâ*n *pére*, in contrast to the round house, *ton pére*.

GEOMETRICAL CONCEPT IDENTIFICATION

Having established a rough idea of the range and usage of geometrical terms, we were interested to see how rapidly the Kpelle could learn problems which involve the identification of these terms as represented in concrete instances.

Our general strategy was to incorporate a concept into a concept-identification experiment which was conducted as follows: On each trial the experimenter would draw two pictures on the blackboard. One of these pictures represented the concept which constituted the "correct answer" for that experiment. For instance, the two stimulus pictures might be a triangle and a circle (let us suppose for illustrative purposes that the circle has been selected as correct for this subject). The subject must point to the stimulus picture he thinks is correct. He is then told if he is correct. The pictures are erased and two new pictures, one a member of the class triangle and one a member of the class circle are drawn and the subject must guess again. (The side on which the positive stimulus appears is chosen randomly so the subject cannot respond correctly by consistently choosing a particular side.)

The experiment is continued until the subject has identified the correct stimulus 8 times in a row or until 32 trials have been administered. In order to compare the difficulty of the various concepts we used the average number of the trial on which subjects made their last error. The data in terms of the average trial of the last error are presented in Table 4 for each of the groups used in this experiment: Kpelle adults, Kpelle schoolchildren, Kpelle illiterate children, American kindergarteners, and American first-graders.

TABLE 4

MEAN TRIAL OF LAST ERROR OF KPELLE AND AMERICAN SUBJECTS IN EXPERIMENTS IDENTIFYING GEOMETRICAL SHAPES

	Kpelle Illiterate Children (30)	Kpelle Illiterate Adults (30)	Kpelle School-children (30)	New Haven First-Graders (10)	Palo Alto Kinder-garteners (15)
TRIANGLE–CIRCLE	8.4	5.2	3.5	6.0	5.0
CIRCLE–ELLIPSE	12.5	5.5	3.7	0.1	1.9
TRIANGLE–SQUARE	13.0	6.5	2.7	1.0	4.9
LARGE AREA–SMALL AREA	12.9	7.9	9.6	7.7	7.7
LARGE ANGLE–SMALL ANGLE	13.9	7.0	4.6	6.0	
WIDE–NARROW	16.3	6.9	6.2	19.4	
OPEN–CLOSED	15.3	12.5	11.1	8.7	
RIGHT ANGLE–NONRIGHT ANGLE	14.0	14.7	8.0	14.0	10.9
STRAIGHT–CURVED	17.2	13.6	7.7	2.6	9.0
QUADRILATERAL–NONQUADRILATERAL	24.7	19.5	14.4	13.0	

Several points regarding the outcome of this experiment seem pertinent. First of all, the Kpelle adults and illiterate children find the entire task more difficult than do the other groups. Secondly, the Kpelle schoolchildren behave very much like the two American groups, which are almost indistinguishable. As listed in the table, the various concepts seem to be ordered in difficulty, especially for the Kpelle subjects. The first three pairs, which represent the comparison of two closed classes, are learned most easily, the next four pairs which represent more "open," less definite classes, are somewhat more difficult, and the last three pairs, which involve the comparison of an open and a closed class, are most difficult.

Although many factors go into making up these results, it is probably significant that the easiest concepts are those for which the subjects have readily available verbal labels. This finding fits in with American data on concept-learning in children, and helps to explain why the Kpelle schoolchildren do so well on this task; their time in school has partly been taken up learning to label and manipulate such geometric figures. In fact, it was not unusual for the American children, prior to beginning the experiment, to ask a question such as, "Which are you thinking of, the triangle or the circle?", and it seems plausible that school is giving Kpelle children the same facility.

PUZZLE-ASSEMBLY

Another way we sought to assess the Kpelle's facility with geometric figures was to observe the way they tried to put together a simple six-piece jigsaw puzzle. It is common for many American teachers in Liberia to say that the Kpelle "have no aptitude for doing puzzles," a remark that seems to imply that they have difficulty in using the shape and color cues at their disposal for rapidly completing the puzzle.

In order to investigate this question we used two 9 inch by 8½ inch puzzles made by the Playskool Mfg. Co. One puzzle was painted plain black and the other had a simple three-color pattern on it, as shown in Figure 5. We did not use the picture, which is ordinarily a part of the puzzle, because of its complexity and extreme irrelevance to Kpelle culture.

We proceeded as follows: Each person was shown the puzzle in assembled form before being set to work with the disassembled pieces. Eight people were asked to do the plain black puzzle first, and the colored puzzle second. Seven worked in the reverse order. The time required to complete the puzzle was recorded by stop-watch

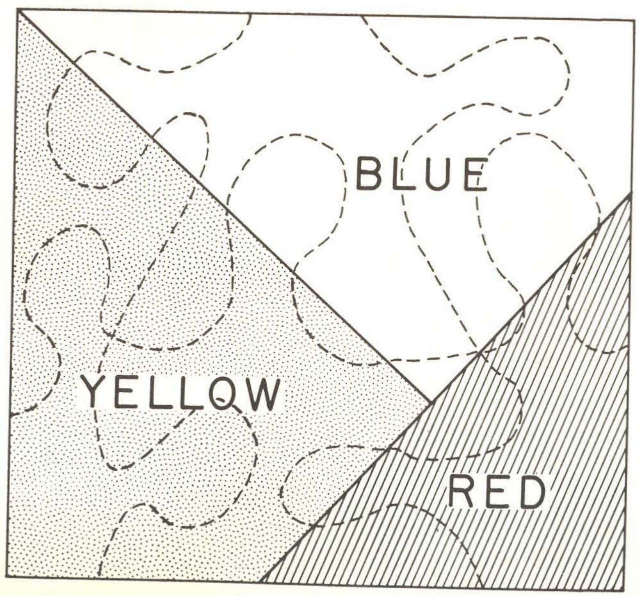

Fig. 5. Six-piece jigsaw puzzle assembled by Kpelle illiterate adults.

in every case, and the average times computed. These average times are reported in Table 5.

There was a wide fluctuation in times required to complete the puzzle. The minimum was 55 seconds, the maximum 15 minutes and 7 seconds. Nevertheless, the data indicate two things. In the first place, the task is very difficult for the Kpelle to perform. These subjects were illiterate adults, who had, of course, never seen such a game before. This might explain some of the difficulty, but the high average time also indicates a fundamental difficulty in using information about the relations between the shapes of the pieces. Puzzle-solving of this kind is clearly radically unfamiliar to the Kpelle, and thus is in a fundamental sense a culturally learned activity.

TABLE 5

MEAN TIMES IN MINUTES AND SECONDS REQUIRED FOR ASSEMBLY OF SIX-PIECE JIGSAW PUZZLES BY KPELLE ILLITERATE SUBJECTS

	First Try	Second Try	
PLAIN BLACK	7:13	2:09	(8)
COLOR	3:20	2:42	(7)

In the second place, we note that the addition of color clues materially helped the subjects. Those who began with a plain puzzle were much slower than those who began with color. This result was not observed on the second puzzle assembly for each subject.

Some difficulties experienced by the subjects can be better appreciated by looking at the photograph on the next page. Almost every subject behaved as shown there, attempting to fit pieces into holes, regardless of the difference in shape or the shape of the whole piece.

Granted that there may be poor use of color and form cues when a Kpelle person first encounters a foreign object like a jigsaw puzzle; can he learn to use these cues if given repeated practice? The answer, based on a small experiment run with 7 Kpelle children, seems to be "yes." These boys were given a series of 3 puzzles and asked to put each one together 5 times. The time it took to complete the puzzle on each trial was recorded. The puzzles were more difficult than those used with the adults; they contained complex pictures and 14 to 15 pieces. The results of this experiment are shown in Figure 6. Quite clearly, the subjects improved each time they practiced a given problem, and, what is more significant, they improved on the first try at each new puzzle. So it appears that the Kpelle learn very rapidly to use shape and color cues, given some practice.

LOCATION TERMS

Related to the perception of shapes is the perception of location, for which the Kpelle have a complex set of terms. In English we normally indicate location through use of prepositions—in the box, under the table, behind the screen. In Kpelle, the

Gbansu resident assembling a six-piece jigsaw puzzle.

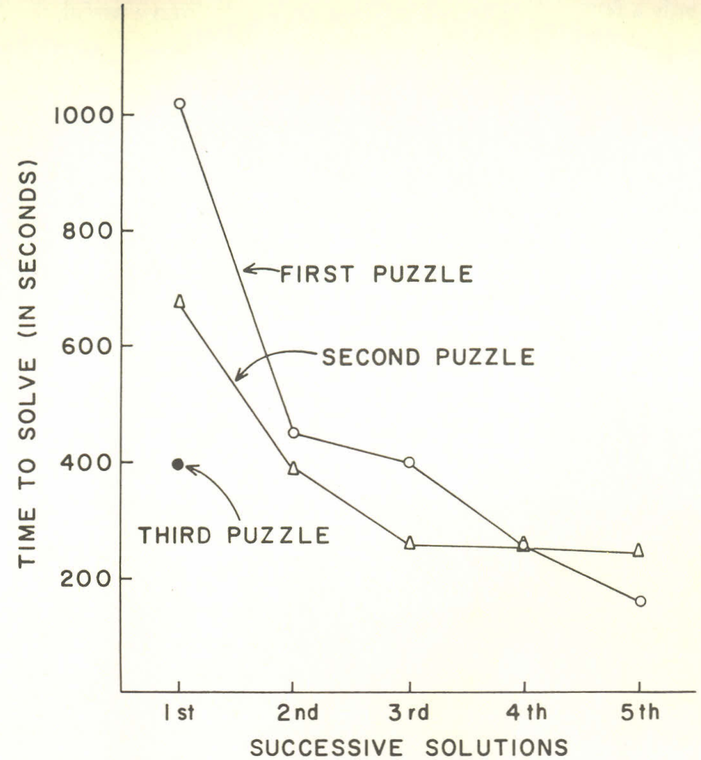

Fig. 6. Mean time (in seconds) taken by Kpelle children to assemble the 14- and 15-piece jigsaw puzzles.

same purpose is achieved with a special class of dependent nouns. We translate these terms by prepositions, as in *bérei mù,* "in the house." A more accurate translation, however, would be "the underneath part of the house." The reference of *mù* is to that which is under the roof. That which we do not translate by a preposition (although structurally it is the same) is *ǹyâi sáama,* "the middle of the river." The term *sáama* indicates location just as does the term *mù.* We translated one as a preposition in English, and the other as a location noun, because of the peculiarities of English. In Kpelle both are dependent location nouns.

These terms have specialized meanings in particular contexts, all more or less related to the root meaning of the term. Therefore *bérei ná* is "the ceiling of the house," *wuru ná* is "the point of the stick," and *menii ná* is "the truth of the matter." All these are related in some way to the "top" (as *ná* must be translated) of a thing. So, is *goloi ná,* "the bottom of the shoe," since it is farthest point reached in putting on the shoe.

There are idioms employing these terms, that are in some way related to the root meanings. Dee *pôlu,* "give it back," is related to *pôlu,* "back." The expression *see ńtue,* "wait for me," asks the person addressed to go "in front" and stand there. The command *lí twe* means "you go first." The term *mei,* "space over something" has been added to the numeral system: *ǹóolu mei feere* means "two over five" or "seven."

These are only a few examples showing that these terms form a useful, flexible body of function words of definite geometrical significance.

ASPECT NAMES

Another set of geometrically significant terms are those indicating particular qualities or aspects of familiar objects and materials. We might say *bérei ketei,* "the house is big." But there is no verb phrase in the sentence, so the word *kéte*, "big," functions as both a verb and an adjective. Words of this type have some structural features in common with verbs, but have other features which distinguish them from verbs. They have, however, no features in common with nouns.

It is possible, nevertheless, to create a nominal form for such terms, so that we can speak of *kéte-laa,* "bigness" or of *wiee-laa,* "heaviness." These are artificial words, and are rarely used by Kpelle speakers. They have the same construction as the artificial word *tamaa-laa,* "many-ness," mentioned previously. The suffix *-laa* seems to imply an excessive degree of the quality named by the adjective. The same distinction is made by these artificial words as exists between our words "heaviness" and "heavy." We think of "heaviness" as a somewhat artificial, unnatural term, and prefer to use "weight" as the noun referring to this quality. In the Kpelle language, there is no noun comparable to "weight," but the noun "heaviness" can be created.

The Kpelle, we see, do not usually isolate or discuss the aspects or qualities named by adjectives. They do not, therefore, think of length, weight, or size as independent realities. Since the Kpelle use these terms to describe things, not to name them, we would not expect them to attend to these qualities or aspects in the same way we do.

There are many such adjectival quality or aspect terms. They include terms for big, small, heavy, full, short, long, near, and light. As in the case of dependent location nouns, these adjectives have both literal and idiomatic uses. The informants we interviewed said, for instance, that the following are *foa*n, "light": a feather, cotton, a dry stick, a single cloth. They also used the term in the expression *nuu mù foa*nɔ̂*i,* "a man has no honor." Literally translated, this means "the inside of a man is light," implying that people do not respect him. The term for "short" can be used in referring to a distance, matter being discussed, or a person's temper. The term for "full" can be used to describe a container, or it can be used to indicate that a person is wealthy. Also, "heavy" can refer to the weight of an object, or to a man's importance. In the same way, a man who is referred to as "big" is an important man in the village. Such metaphorical use of adjectives is common in a wider circle of African languages.

There is no term for color as an abstract quality or aspect of an object, but there are terms for specific colors. It is natural to expect that persons would notice more quickly those aspects named than those which are not. In an experiment to be described in detail in a later chapter, children between the ages of five and seven were given a task which required attending to green, white, tall, and short blocks. The children responded more quickly to the length rather than to the color dimension, seeming to support the foregoing linguistic facts.

CONSTRUCTIONS

We must mention one last type of geometrical behavior. The Kpelle know constructions which in our society would be dignified by the name theorem. They can construct a circle by using a rope fixed at one end. A stick is tied to the other end, and rotated around the center with the rope as radius. A Kpelle man needs such a circle when he makes a round house or a "palaver" house.

The Kpelle also know how to construct right angles at the corners of a rectangular house and how to set the poles for the walls perpendicular to the ground. They know that if the opposite sides of a quadrilateral are of equal length and if the diagonals are also of equal length, the resulting figure will be a rectangle. They do not verbalize these rules, but they know the procedure.

They also know how to construct several solid shapes. They construct a cone and a cylinder, when making a house, by a combination of the techniques we described. They make rectangular boxes. Their technology is therefore not severely limited by the absence of abstract geometrical terminology and knowledge.

To summarize, the Kpelle name only those geometric shapes in common use in their culture. These names refer to topological as well as Euclidean properties of objects. Concept indentification experiments show that shapes named by nouns are more easily recognized than shapes not named, and that learning involving these shapes is usually difficult. There is a complete set of location names, which function as dependent nouns rather than as prepositions. Attributes are named by adjectives, not by nouns. Those attributes named are more quickly recognized than those not named. The Kpelle know certain constructions in their technology, although they have not verbalized these constructions nor incorporated them into the framework of an abstract system.

9 / Measurement

DEFINITION

WE WILL NOW CONSIDER areas where the Kpelle use measurement. First we must understand that our Western use of measurement is to impose an arbitrary system of units upon a material which may itself be continuous. In Western culture a unit such as a foot or an acre may be applied to geometric figures even though the foot and the acre are arbitrary units. We apply measures to nonspatial attributes such as time, weight, temperature, color, virtue, esthetic excellence, and so forth. We may not all agree on a particular application of a measure (the excellence of a painting, for instance) but our language is so constructed that a measure can be applied to any quality or attribute.

The Kpelle term for measure, *koôn*, has two distinct usages. First, it is used in the general sense of "test": it is applied to the ability of a messenger to remember a message entrusted to him, to evaluating a man's intelligence, to seeking the best location for a town or farm, or to a man's first sexual intercourse.

The term *koôn* also applies to measurement in the narrower sense, to imposition of a unit upon some unquantified material: the people measure length, volume, and money using culturally relevant units. For instance, cloth is measured in arm-spans, sticks are measured in hand-spans. For the actual counting of the number of units the Kpelle use the term *lóno,* which has both the transitive meaning "count," and the intransitive meaning, "speak."

Although the Kpelle's basic measurements involve length, time, volume, and money for which complex systems of units are available, they do not have measures for weight, area, speed, and temperature, or for other more subtle and complex attributes which we measure in Western culture.

MONEY

The most pervasive measurement system is that of money, where almost all the units now in use are derived from the English and American systems. There were, however, two types of money in existence before the Europeans came. One was the cowrie shell, a trade item used throughout much of the tropical world. It entered Kpelle society through the Mandingo traders, who gave cowrie shells in return for kola nuts and other forest products. Cowrie shells are no longer used as money, but appear as decorations on masks and wooden statues.

The more important type of money was one which has its roots firmly within the forest tribes of West Africa. This is *koli gîli,* made of twisted iron rods. The typical piece of "iron money" is about 10 inches long, has something resembling an arrow head at one end, and two fins at the other. It is about 1/8 inch in diameter, and is twisted so that there are about 15 or 20 turns in all. This was at one time the only currency in the tribal markets, and its value was set in some areas by the important elders in the Poro society. In the neighboring Loma tribe, before one could trade at the market, it was necessary to use goods to purchase a supply of iron money from the secret society at fixed rates.

This iron money is still used in some of the more remote parts of Liberia. Mrs. Gay was once stopped by a young man in the Gbande area who asked her to change some money. Knowing she had change in her purse, she agreed, and to her amazement the man brought out an armload of iron money. She kept her bargain, at the established rate of one piece of iron money for an American cent (American currency being legal tender in Liberia). Incidentally, traders made an excellent business out of these coins by selling them to tourists in Monrovia at 1 dollar apiece!

The first Western currency in common use in Liberia was British, which was legal tender until World War II. Consequently, some British terms have found their way into the Kpelle language—*pẫu* and *sêlen* being the local versions of pound and shilling, respectively. These terms have the same values in American currency now that they held before devaluation of the pound. In local usage, one *pãu* is worth 4 dollars and one *sêlen* is worth 20 cents.

Another British term has found its place in Kpelle in a very curious way. The term *ee-tî̃i* stands for 15 cents. On first hearing, it sounds like the English "eighteen," and that first hearing is correct. The etymology is a marvelous piece of linguistic development. The smallest British coin used in Liberia before World War II was the halfpenny, of which 24 made a shilling. A shilling was worth 20 cents, therefore 18 halfpennies were worth 15 cents. And so—*ee-tî̃i* is fifteen! In some Kpelle areas along the Guinea border, French currency has been used, providing an alternative set of borrowed terms.

Other terms for individual amounts of money include *fón* or 5 cents, *nei* or 10 cents, *dâla* or 1 dollar, and *kâpa* or 1 cent. The two terms *fón* and *nei* also have the slang meaning of worthlessness. The sentence *í fa pori fón kɛ̂ì à nyàa,* "you can't do 5 cents to me," means, loosely, "you can't give me any trouble." A very small person is described as *nei nei.*

The term *kâpa* is sometimes used as a general term for money. One informant described the things he can do with *kâpa.* He can buy, pay, "dash" (a West African term for a gift, tip, or bribe given to someone as part of a business transaction), redeem goods, claim illegitimate children, pay a girl for the privilege of her company, and sue persons in court.

Another general term for money is *sen-kau,* literally "seed of a thing" or "bone of a thing." It is the older, more traditional term for money, and is commonly replaced now by *kâpa.* The term sen-*kau* implies that, somehow, what is described is pure, good, and valuable. The suffix *-kau* is the same one that individualizes grains of rice, as in the expression *molon-kau.*

VOLUME

Measures of volume are used in situations where the amount of a given material is important. Rice, which is the staple food, is measured in a great variety of ways. We can follow rice from the farm to the meal in the terms which measure it. The term for a rice farm, *mo*lon *kpala*n, is a measure, since a family will normally plant only enough for its needs for the coming year. The size of a plot necessary to grow this amount of rice comes to represent a measure in much the same sense that acre originally meant simply a field. Other crops are also measured in farm units—cassava, peanuts, pepper, corn, potatoes, pineapples, bananas, greens, sugar cane, rubber, cocoa, and coffee. Naturally, the unit size differs in each case.

When the rice is harvested, it is cut into *mo*lon *fiy*en, "rice bundles." One of these is the size that a woman can conveniently hold in her left hand between her thumb and fingers, while she cuts the stalks with her right hand. Two or three rice bundles are then tied together to make a *mo*lon *k*ôon, "rice measure." These are stacked together into a pile called a *mo*lon *ko*lon. Such stacks of bundles of rice are then placed in the loft of a small hut called a *mo*lon-*kere,* "rice-kitchen." The term "kitchen" has nothing to do with cooking, as we mentioned before, but refers to a small, open-sided hut, used for "talking a palaver," storing rice, blacksmithing, shoe-making, preparing dead bodies for burial, or simply for resting.

When the people need the rice, which has been stored in the "kitchen" on the farm, the women thresh it and beat it. Fortunately they are not able to remove the entire shell from the grain of rice, since that is one of the few sources of vitamins in their diet. The rice so prepared is measured in several ways. The smallest measure is the *kôpi,* which is obviously derived from the English "cup." This measure may have one of two values, depending on whether the rice is being sold or bought. The local trade uses what is called a *sâmo-k*o, "salmon cup," for dealing in rice. It is the large size tin can (U.S. tall #1) in which salmon is normally packed. Since few of the Kpelle are wealthy enough to afford tinned salmon, it is not clear why they use this term.

The "salmon cup" contains almost exactly two English measuring cups, or one pint dry measure. The cup the trader uses to buy rice has the bottom rounded out by long and careful pounding, but the cup he uses to *sell* rice does not have the rounded bottom. This is the source of his profit. The usual price of dry rice is 10 cents a cup in "hungry time," and sometimes as little as 5 cents a cup after the new rice has been harvested and beaten. Since the cup almost equals an English pint, it is sometimes simply called *pâi.* Since it weighs about a pound, when filled with dry rice, the term *pâu,* "pound," is also used.

Other commodities measured by cups include palm oil, water, palm wine, peanuts, dry corn, palm kernels, soda, salt, millet, seeds, pepper, and kola.

The *bôke* and the *ti*n are even larger. Their names are clearly derived from the English "bucket" and "tin." The bucket contains, according to one informant, 24 cups of rice, and the tin, 44 cups of rice. His figures are remarkably close to correct arithmetic. The same informant also told us that there are two buckets in a tin, which is consistent with the previous figures. The most commonly used "tin" is a 35-pound flour tin. Others report the bucket as the same as a tin. Also measured by buckets and tins are many of the commodities mentioned above, as well as meat, cassava, bananas, plantains, yams, and greens. Singly, some of these are too large for a cup, and so a large measure is more appropriate for them.

The largest measure for rice is the bo*r*o, "bag." There are nearly 100 cups of rice in the typical bag in which rice is imported from the United States or sold from one part of Liberia to another. This fact is known to the Kpelle, who value a bag of rice at 100 times the going rate per cup. An informant told us that a bag contains two tins, which is quite consistent with the other information. Other commodities are also measured in bags.

There are measures of dry objects which do not apply to rice. One is the *kinja* or *kpiri,* "load." This measure is the amount that can be put into a back-pack frame. This is made by tying palm thatch around a frame of sticks which contains the goods to be transported. Such items as kola nuts, meat, cassava, bananas, plantains, palm nuts, peanuts, yams, and charcoal are transported in this way. It is not a standard amount, probably because it is not used for rice. Another such measure is the Coca-Cola cap, which is used for selling snuff.

The fact that rice is measured by so many interrelated terms is unique in Kpelle culture. They have no other system with such internal coherence and complexity. This makes eminently good sense, since rice is the staple of the diet. The centrality of rice to the diet, and to the culture itself, is underlined by this measurement system, as well as by the use of rice and rice utensils in ceremony and ritual. Therefore we might expect that if the Kpelle's ability to measure rice is compared with that of people for whom rice is of less importance, and the measures less familiar, the Kpelle should show a clear-cut superiority.

This supposition is supported by the results of a very simple experiment, mentioned in the first chapter, in which people were asked to estimate the number of *kôpi* of rice in each of four containers. This task was presented to 20 Kpelle illiterate adults, 20 Kpelle schoolchildren, and 80 poorly educated American adults. The results summarized in Figure 7 indicate that the Kpelle adult is extremely accurate in his use of the *kôpi* measure, with the Kpelle children running a close second. The Americans performed quite poorly, especially when a relatively large amount of rice was involved. Simple though this demonstration may be, it will put us on our guard when making generalizations about abilities to measure. Clearly, the Kpelle man who has been trained to enter a market, see a pan with rice in it, and make an offer for that rice from his meager supply of money will have a distinct advantage over his "naive" American counterpart. (Note that the American schoolchild is about as accurate as the Kpelle schoolchild.)

LENGTH

Measures of length are also closely tied to the objects of Kpelle material culture. One of the most common objects whose length is measured is cloth. Kpelle weavers weave cloth in long strips approximately 4 inches wide. These strips are sewn together to make shirts, chief's gowns, blankets, hats, and other items of clothing.

They are sold by the weaver by the sege-*wul*o, "bunch," whose length depends on the use to which it is put. It may consist of 9 to 11 *nuu*-n*wa*n, arm-spans, for a chief's gown or 21 to 24 arm-spans for a blanket. The arm-span is measured from the end of one outstretched arm to the end of the other. Other things besides cloth are commonly measured by arm-spans: rope, a long stick, a bed, a grave, or a bridge.

Half of *nuu*-n*wa*n is *nuu-kpasa* which is measured from the center of the chest to the tip of the finger of the out-stretched arm. Literally *kpasa* refers to a woman's head-tie, which is about one yard long. The arm-span is about two yards long, and is called by the term *lapa,* referring to a woman's wrap-around dress.

Two smaller units of measurement for length are *nuu-yée-laa,* "hand-span," and *nuu-k*oo-*laa,* "foot-length." These are only occasionally used in tribal life. Hand-spans may be applied to cloth, cutlasses, hoe handles, and other short objects. Short distances on the ground, whether for a grave, a mat, a floor, or a bridge may be measured by foot-lengths.

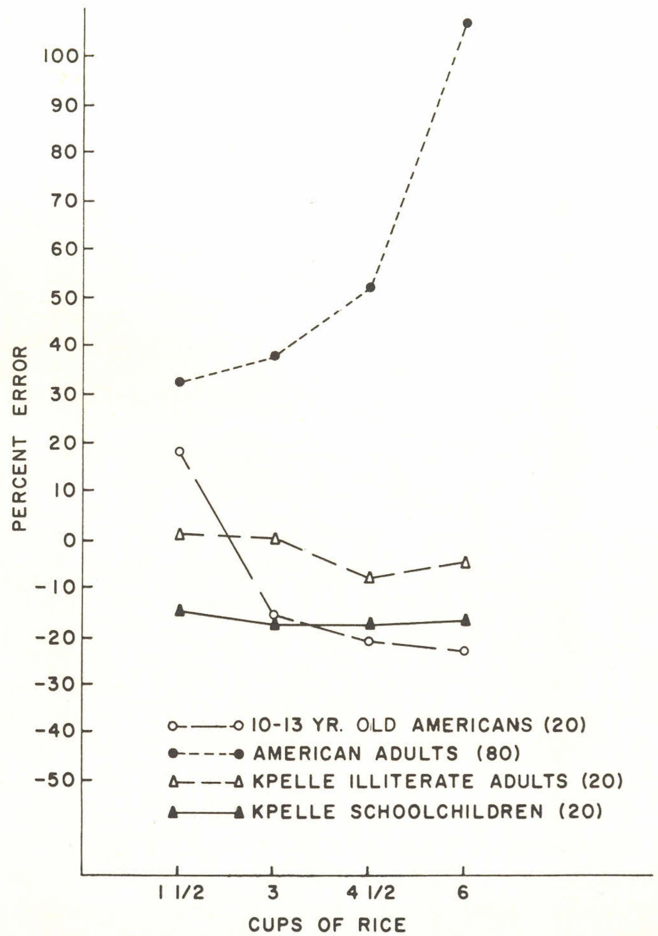

Fig. 7. Mean percent errors of Kpelle and American subjects in estimation of numbers of cups of rice.

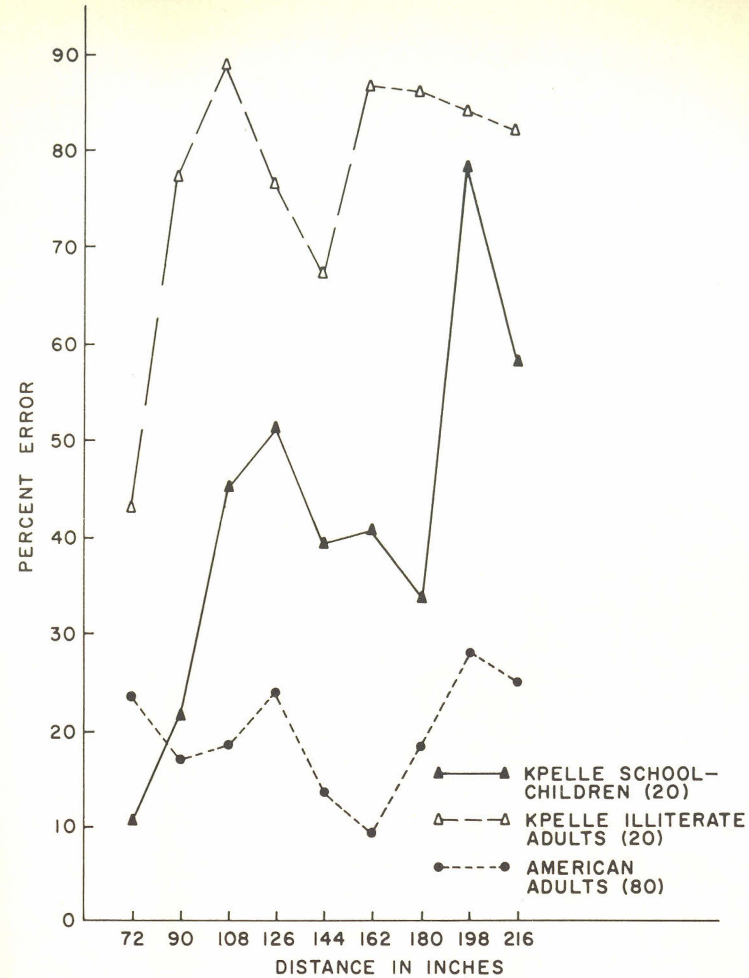

Fig. 8. Mean percent errors of Kpelle and American subjects in estimation of distances in hand-spans.

It is important, however, to distinguish between permissible and habitual measurement. We have found that in practice, foot-length is a seldom-used measure, supplanted in most cases by arm-span. We must remember this distinction, as well as the cultural relevance of the units of measurement, in interpreting the results of our experiments on length measurement.

We devised two experiments to evaluate the ability of our subjects to estimate length. The first required that distances of 2 to 6 yards be estimated using arm-spans, hand-spans, and foot-lengths. The distances were marked on the floor of a large room. The subject stood next to one wall and the experimenter at a particular mark on the floor, where he asked (for instance), "How many foot-lengths distance is there between us?" This question was asked of each of our subjects for each of 9 distances and for the 3 units of measurement. The same subjects who served in the rice estimation task participated in this study. The results summarized in Figures 8, 9, and 10 present a slightly more complicated picture than was true of the rice estimation data.

On the hand-span task (Figure 8), the performance of the American adults is clearly superior to that of the Kpelle. This task is culturally inappropriate for both groups, but the Kpelle are less able to cope with this strange way of measuring things than the Americans. The schoolchildren's performance is intermediate. We interpret this result as evidence that for the Kpelle, different units of length are not interchangeable, but that the American is able to translate hand-spans into some

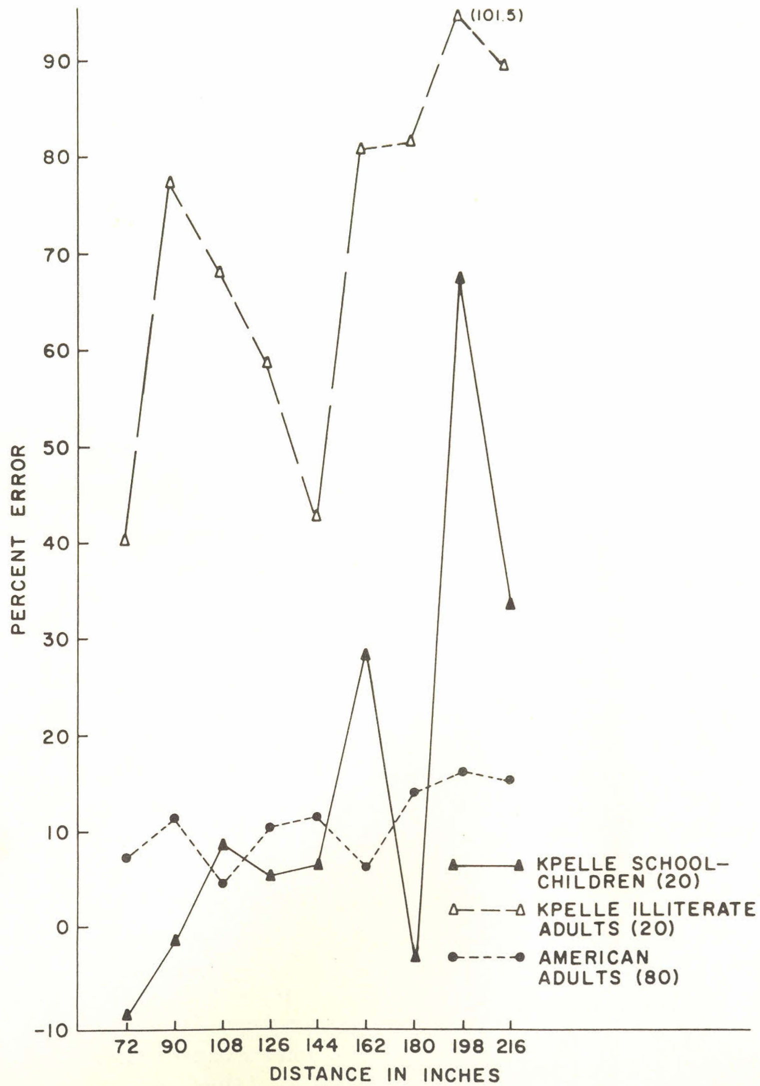

Fig. 9. Mean percent errors of Kpelle and American subjects in estimation of distances in foot-lengths.

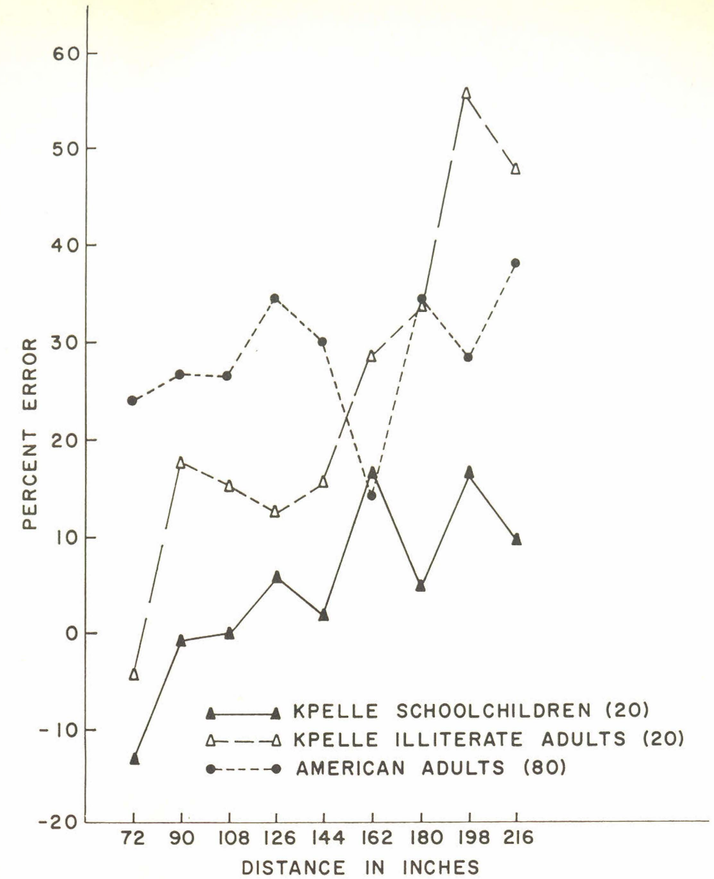

Fig. 10. Mean percent errors of Kpelle and American subjects in estimation of distances in arm-spans.

unit involving inches and feet, which he then uses to estimate the distance. Informal questioning of some of the subjects seems to support this conclusion.

We were quite puzzled that this same pattern appeared in the results shown in Figure 9, since our informants had told of the use of foot-lengths as a measurement of various types of distances ("How far from here to that house?", "How long is that house?") indicating that for such intermediate distances the Kpelle almost always used hand-spans or arm-lengths, and only rarely foot-lengths. We concluded that we had been misled by the possibility of using foot-lengths as a unit of length. This interpretation receives some support from the arm-span measurement data in Figure 10, where there is little difference in performance between the two adult populations and definite improvement by the Kpelle over their foot-length performance. We are not sure how to interpret the superiority of the Kpelle schoolchildren on this task; perhaps they are getting the best of both worlds.

The pattern of results is quite different on the second type of length-estimation experiment. Here the objects to be estimated and measured were sticks of wood