/kɔ̂pi/, as do peanuts, but the /kɔ̂pi/ is different in each case. However, for each particular case, the /kɔ̂pi/ has a definite value. Thus, for each of these borrowed measure-names, the measure is precise, objective and quantitative.

The case is different with certain apparently indigenous measures, which are based on imprecise quantities. Thus the measure /núu ŋwaŋ/ refers to a person's out-stretched arm span, and depends on the individual involved. These units can be counted, but, just as with the foot in English history, the number of units depends on the person involved. An imprecise unit still used today in western culture is the pace, which depends on the individual pacing the distance. Similar units of distance in Kpelle culture include /núu kpasa/, 'a person's arm-length'; /núu yée láa/, 'a person's hand laid out'; and 'núu kɔ́ɔ/, 'a person's foot'. These units are used to measure such things as length of a piece of cloth, length of a stick, and so forth.

Other less precise measures include some applied to commonly used commodities within the village situation. Thus the word /bɔ̂ki/, 'bucket', is at times used to refer to the way water is presented, but is also at times a unit of measure. Of course, there is no standard bucket, and thus the measure is highly imprecise. Another such measure is the /mɔlɔŋ-kɔ̂ŋ/, 'bundle of rice', which can be used to indicate the number of such bundles that are harvested on a given day. Likewise, /mɔlɔŋ-kɔ̂ni-kɔ̀lɔŋ/, ' a stack of rice-bundles', is an undefined amount of rice stacked in a small thatch hut for storage. If a person is asked how much rice he harvested from his farm, he might speak of it in terms of these stacks of rice-bundles, or more simply, by speaking of /mɔlɔŋ tɔ́ɔi/, 'rice-stacks'. Most probably he would have no answer to the question, but would consider it an impertinence. One informant, however, told me that he had /mɔlɔŋ tɔ́ɔi feere da hâvu/, 'two and a half stacks of rice', where /hâvu/ is, of course, a loan-word from English.

long distance measure not included

In summary, measures in traditional Kpelle culture seem to be in general loose and imprecise, and the idea of exact quantification a foreign idea. This conclusion is borne out by the fact that the more precise measures which are presently used in the culture seem in almost all cases to be expressed by borrowed terms, whereas the less precise measures use traditional Kpelle terms.

Thus the question of values actually in use in the culture becomes a fairly simple question. If few things are measured in precise units, there are then few occasions to use precise value-terms. The only real exceptions to this pattern are money and sets composed of small objects of persons. The number of objects or persons in a set of up to an apparent maximum of about thirty will be counted and referred to in conversation. However, the whole numbers above thirty seem almost never to be used. As mentioned above, there are Kpelle people who can speak enough English to use English numerals, but who do not know off-hand the Kpelle terms for numerals above approximately thirty. Some persons can make complex statements concerning money, but this seems to be the result of contact with the western, money-centered economy. Those persons who are able to reckon in dollars and cents with facility are those who have worked for the Firestone Plantation or some similar company.

Thus the more common numerals in Kpelle usage are the indefinite ones /ta/, 'some' /támaa/, 'many', and /kélee/, 'all'. It is common to speak of having some rice, or having plenty of rice. One can speak of all the people doing something, or plenty of people, or some people. These expressions are, of course, vague, but they have the advantage, from the Kpelle man's point of view, that they do not involve precise mensuration and numeration. It seems that the Kpelle people actively dislike quantitative precision and exactness.

Some use of terms approximating to simple fractions is also found. In ques-

tioning, one informant spoke of that part of a banana which one of two persons would receive when they shared the banana as /gwêi-kpua/, 'short banana'. In the situation that four persons share a banana, this same informant said that each person would receive /gwêi-kpua-kpua/, 'short-short banana'. Another informant, however, used the expression /gwêi-kpua/ to refer both to that which each of two persons receives, and that which each of three persons receives. It is worth noting that one informant responded to the question by saying that he would mash the banana up and give it out by spoonfuls!

Another expression used for half seems to be the word /gbûlɔ/, which suggests cutting in the middle. It is possible to speak of the middle of a road, and often a town half-way from one town to another is called the middle town. This middle town, in one case I experienced, was not in fact that middle but was well to one side of the middle, and seemed in fact simply to be the place where people rested.

In speaking of stacks of rice, as mentioned above, one informant said that he had harvested /mɔlɔŋ tɔɔi feerɛ da hâvu/, 'two and a half stacks of rice'. In this statement, the word /hâvu/ is clearly a loan-word from English, not a traditional Kpelle word, although the informant did not use it self-consciously as a foreign word.

Certain mathematical operations are performed using these value-words. These operations include the concrete analogues of simple addition, subtraction, multiplication and division, shorn of the abstractness with which we are familiar in western culture. Thus, for instance, there is no name for any of the operations, nor are they apparently performed on pure numerals, but rather on numerals referred to sets of objects. Thus when one informant was working with two piles, each containing three rocks, he said /ýi see káa saaBa, yí séei ké Bó saaBa--mɛi da/, 'this

set is three, this set is three--six'. This is a very rough transcription of the man's statement, but the reference to sets is clear. Another expression for addition is /téɛ feerɛ pɛléɛ téɛ saaƁa mà káa à téɛ lóolu/, 'two chickens added onto three chickens is five chickens'. This can be shortened to /veerɛ pɛléɛ zaaƁa mà káa à ǹóolu/, 'two of them added onto three of them is five of them'. However, the abstract statement, /feerɛ pɛléɛ saaƁa mà káa à lóolu/, 'two and three is five', where there is no reference to objects, has not been elicited from tribal informants.

Another expression for addition makes use of the phrase /púɔ ... mà/, 'poured on top of', to replace the phrase /pɛléɛ ... mà/, 'added on top of'. However, there is no essential difference in the way they are used.

There is an expression for subtraction /kuláa ... mà/, 'taken off from', as well as another expression for subtraction /seɣéɛ ... mà/, 'taken away from'. Both these expressions papallel the English 'taken from', rather than the English 'minus'. These Kpelle expressions put first the number being subtracted, as in the statement /veerɛi kuláa zaaƁai mà káa à táaŋ/, 'two of them taken from three of them are one of them'. The English term 'minus' reverses the order, as in 'three minus two is one'.

In both addition and subtraction, we conjecture that problems in everyday life do not use numbers beyond approximately thirty, since we have found no situations in village life which require a person to go beyond that number. Where artificial problems were contrived with answers much larger than thirty, the responses diverged widely from the mark, and showed that the informant had simply guessed a large number as the answer, not attempting to approximate to the answer or go through the complicated processes required for an exact answer.

An expression for multiplication is significant: /téɛ feerɛ seêi saaƁa káa à

ǹɔ́ɔlu mɛi da/, 'three sets of two chickens are six of them'. Multiplication does not use memorized multiplication facts, but uses instead repeated union of sets, just as the first addition procedure mentioned above used sets of stones to get the answer. However, it is significant that when informants were asked to explain how they answered multiplication problems, e. g., the number of cutlasses if a man makes two cutlasses a day for six days, they could not give a coherent answer. They simply figured it out, apparently by counting the number in the total union of the sets. This conclusion was supported when one informant was asked a complex problem, which reduced to 6 x 7. He tried to count up to the total in his head, and got lost on the way. As before, the limit of answers to multiplication problems was approximately thirty.

Division can also be stated in a fairly simple way, involving the use of sets. Thus we can say /gwêi puu ŋá kɔ́lɛɛ à zeêi lɔ́ɔlu, zeêi tɔ̀nɔ káa à veerɛ/, 'ten bananas divided up into five sets of them, one set of them is two of them'. The process seems to be to share into sets and find the number which can be put into each set to make them even. The sense of fairness and equality represented here is important in the culture, and in all likelihood reinforces the mental operations performed in dividion. No tests were done to find the upper limits of numbers used in division, but it is probable that the limit once again would be in the neighborhood of thirty.

The next question concerns the roles of precision, exactness, equality, inequality and approximation within the culture. It is, despite the cultural lack of interest in precision, possible to speak of equality and equivalence. The simplest expression for equivalence is formed by using the word /káa/, 'see'. Thus we can say /Ɓála feerɛ kɔ́ɔ káa à ǹɔ́ɔlu mɛi saaƁa/, 'the feet of two sheep are eight of

them'. Literally, this could be translated 'the feet of two sheep see as eight of them'.

Another expression for equivalence is /díkaa tɔ́nɔ́ɔ/, 'they are the same thing', or 'they are one'. In speaking of two objects which had the same shape, the informants would very often use the expression /díkaa tɔ́nɔ́ɔ/, to express this fact. It does not mean that two things are the same in every way, but that they are the same in the particular way being considered.

A more strict expression for equality used in comparing two fields of attention is the term /-pɔ́ɔriɛɛ/, 'to be of the same strength as'. Thus we can say /ŋùríi ŋí dà ŋùríi tí kɔ̂ɔŋ á kɛ̀ dí pɔ́ɔriɛ̂ɛ/, 'measure this stick and that stick if they are equal'. Another example is /sumo dà kɛkúla dí fé pɔ̂ɔri ní tɔɔ-lâa sù/, 'Sumo and Kekula are not equal in wealth'. This expresses the fact that the two men are unequal, the term /fé/ negating the equality.

Another expression which is commonly used for expressing equality is /káa zù/, 'is in the same class'. Thus we can say /kwà yà kú káa zù/, 'you and I are in the same class', or 'you and I are equal'. This term is used to compare things which are equal in some specific respect, such as height, strength, importance, and so forth.

A further expression which is used in this way is the word /seri/, 'reach'. Thus we can say /m̀ɔrɔi tí ŋɔ̀wiɛ fé seeri ní m̀ɔrɔi ŋí ŋɔ̀wiɛ pɔ́/, 'the weight of that bag is not equal to the weight of this bag'. The converse case, where the two weights are equal, can also be expressed. The important thing is that /seeri/ in this sentence indicates which of the two is bigger and which is smaller. The other terms, /káa zù/ and /-pɔ̂ɔriɛɛ/ do not indicate which is bigger and which smaller, and are thus ambiguous when used to express inequality.

It is possible to express similarity as well as equality. The expression /mélenɔ̂i/, 'active' or 'smart', for example, is used to show that two things are similar in appearance. Thus we can say /tókpa kôya-père Bélenɔ̂i fúlomo mà/, 'the tallness of Tokpa resembles that of Flumo'. This word implies even less precision than the words used above. It shows only that, in the case given above, the two persons give an impression of similar height.

Another expression which acts in a similar way is the phrase /dí kulâi à gêe/, 'they are taken out together'. Literally, it is an awkward expression, but it is used idiomatically in such a statement as /noai dà kɔ́too dí kôya-père kulâi à gêe/, 'the manner of the tallness of Noai and Kotoo is similar'. Once again the sentence shows only resemblance and similarity and not equality.

The means of expressing comparison are related to the ways of expressing equality and inequality. If two things are not equal or similar or equivalent, there are ways of expressing which has the higher value and which the lower value. The word /seeri/, for instance, enables us to compare two things in value. Another term for this is the verb /tɛɛ/, 'pass by', 'surpass', 'excel'. The verb is completed by the expression /-mà/, 'on top', so that we can say, for example, /bɛ́rɛi ŋí kɛ́têi é téɛ nyíti mà/, '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. However, it is possible to say the following: /bérɛi ŋí kurotêi é téɛ nyíti mà/, 'this house is smaller than that one'. The statement says literally 'this house in smallness it passes over that one'. Another way of expressing inferiority is to say /bérɛi ŋí tɔ́ɔ̂i nyíti mù/, 'this house is fallen under that one'. However, in normal conversation, Kpelle speakers will tend to transform these sentences so that the higher in value is first in the statement.

Not much study has been made of explicit ways of expressing approximation in Kpelle culture. Since almost the entirety of Kpelle mathematics is approximate, there are very few occasions when a person would make a conscious approximation, related in turn to a more exact form. However, it is possible to use two words /kelaa/ and /titi/, which express approximation and precision, in that order. It is necessary to learn more about the way these terms are used in ordinary conversation and life.

The next matter to be discussed concerns geometric shapes and figures which are commonly observed and recognized in Kpelle culture. We can report first that circular shapes are more immediately recognized and easily expressed than rectangular shapes. For one example, when we presented a set of stones arranged in a circle, the informants generally named it a circle, or at least a row. But when the same collection of stones was altered from a circular shape to a square array, by sliding away from the center , the stones at the four corners, informants made no such clear response. One person suggested that the stones were now scattered, a term commonly used to discuss rocks which were not arranged in a pattern. Another person said that they were in four parts or sides, and only after some prodding said that they now resembled the type of hut built in these modern times. In this connection, it appears that the traditional hut was circular in shape, but that with the coming of civilization, first the square one-room hut was constructed and then finally the rectangular multi-room hut was introduced. The older, more conservative people, such as the head of the bush school in Gbanzu, still use round huts, whereas the younger people are building square huts. The rectangular multi-room huts are only built by wealthy, somewhat ~~westernized~~ persons, since they are more expensive and more elaborate.

Stones arranged in a row are also recognized as falling into a geometric

pattern. However, it does not seem to matter whether the row is straight or not. The same term /pere/ 'path' is used for both. It seems evident that the straight line does not play a significant role in the culture. For example, a field was leveled by a bulldozer and then graded for an athletic field at Cuttington College. The field was then surveyed carefully to ensure that it was as level as possible, with a slight grade so that rain would not tend to stand on the field but would run off. There had been a path used by tribal people which crossed the field from one corner to the corner diagonally opposite. This path was completely obliterated by the bulldozer and grader. However, the people still needed to cross the field, and thus a new path was worn down within a few days. The significant thing is that the path was a meandering curved line, which deviated at one point more than twenty feet from a straight line. It can almost certainly be said, that, except where absolutely necessary, the Kpelle people dislike straight lines and prefer irregular curves.

There seems to be a similar preference for irregular arrays of objects. When I asked informants to organize rocks into patterns, the patterns they produced were invariably irregular and unsymmetrical. In the same way, there is never any attempt to lay out a plan for a town. Houses are clustered in irregular and uncoordinated ways. There are no rows of more than three houses, even in a large town, and such rows seem fortuitous rather than planned. Likewise, in rice fields, corn fields, or other farms, there are no straight rows. Only rubber farms, which are, after all, planted by relatively wealthy and westernized persons, use the straight row pattern which is so familiar to western culture.

There are some shapes which confront persons every day. The house roof is conical, and the house floor plan is either square or circular. There seem to be traditional ways of constructing these houses, and the people do not need to

give thought to them. Apparently, they know the trick of setting the two diagonals of a quadrilateral equal to ensure its rectangularity. However, it is clear that they do not know or care why this is true, or even expfess the fact in general terms.

We did some exploration of games they play which seem to have a mathematical character. In one game, for instance, the person is required to give a complicated series of directions for the successive removal of stones from an X - shaped pattern. With his back turned to the pattern, he states the number of stones at each point in the pattern correctly before removing a stone. He must empty the pattern without a mistake in order to succeed. The skill involved in the game is, of course, memory. Another game of this type involves removal of stones from a pattern by a person who again cannot see the pattern, but who must name lines and empty spaces correctly.

A rather different game involves setting sixteen stones into two rows of eight each. One person leaves the area and the rest choose one of the stones. The person then returns, and by a process of successive reorganization of the stones into dif_ ferent rows of eight, with the group pointing out each time the row containing the stone, he finds the chosen stone. I played the game myself, and astounded the people by making my moves in such a way that the stone ended in a position dif- ferent from the one to which they were accustomed. Thus it was clear to me that they gave the correct answer by following a canonical series of moves rather than by reasoning out a procedure for finding the stone. It was a test of memory, not of reasoning power.

Another game involves drawing pictures in the sand, and then drawing a given length over and over, several times. Two persons play the game, and attempt to reach into the other's territory. The one useful concept which can be learned

from this game is the concept of uniform measure.

A game of question and answer is played which is similar to the game of "Twenty Questions" in American culture. However, this Kpelle game has those who are attempting to find the unknown object guess item by item, not category by category. We in the west, when playing "Twenty Questions" narrow the field down by eliminating categories, until we locate the object. I tried to use this technique with a Kpelle informant, and he objected that it was not the proper way to play the game. I simply had to guess thing after thing until I hit the correct one by chance.

A board game which requires considerable skill is played by the people. We have not analyzed it properly yet, but it seems that the game involves a skill rather like that of Go or chess, in thinking several moves ahead. There are two sides to a board, with a number of troughs in a row on each side. At the beginning each person has stones which he puts down in the troughs, one at a time. The attempt is to capture the opponent's stones without having one's own captured.

(b) Role of argumentation in the culture. The most important fact we discovered in this connection was that argumentation and discursive reasoning are not thought of in connection with mathematical operations. Thus, when I asked informants how they had learned some mathematical conclusion which they had reached, I received over and over again the answer that it was their business, or it was none of my business, or God had told them, or they just knew it, or how did I know what I knew. The idea of giving a justification for a mathematical statement was simply alien to those with whom I worked. There may be, and I am sure there are, procedures which people use in their minds as they work out mathematical problems. For example, addition, subtraction, multiplication and division clearly are performed using sets. But this procedure is not made explicit by those using it. It is simply the way people do things, not something

they figure out for themselves.

This reluctance to discuss procedure or to give a justification for knowledge is not merely based on an inability to express that procedure or justification. It seems to go deeper, to involve a distrust of the question 'how do you know?' How a man knows something is his own business, and he does not wish to share that knowledge with another person. Another person, moreover, will have his own knowledge, and he will not want to share it either. The only point in my investigations at which I seemed to provoke real anger or hostility was when I asked the question "how do you know?" In this respect, as in many others, Kpelle culture seems highly individualistic, not given to sharing and cooperation.

However, public argumentation is used in at least two areas of tribal life. The first is settling quarrels between persons. The chief has the task of hearing both sides of a matter, and then giving a decision on the case. The people present their evidence as clearly and cogently as they can, and try to persuade the chief of their righteousness. We have not gone into this topic as deeply as we should as yet, but we plan to do more study in it as time permits. In particular I hope to make use of a doctoral dissertation on court procedures in Kpelle life which was done a few years ago by an anthropologist from the University of Minnesota.

The second area is arguing what resemble mock court cases. Many of the traditional folk stories and legends involve a question posed to the hearers at the end. For example, one of the most common of these situations is the case of three men who find a woman in the forest. Each man has a particular skill, and the skills of all three are required to capture the woman. The story goes into great detail as to how the three men each contribute to her capture, and then asks the listeners to which man she belongs. In one such story the three men are a

trap-maker, a palm-wine maker and a cloth-weaver. In another similar story, the three men are Intelligence, Fighter and Adulterer, who fight to win a reward. Men will spend many hours together arguing over such situations, and the cleverest man will win recognition from his brothers for his defense of one or another of the characters in the story.

In a similar way, we found that many persons used parables and stories with human interest to express mathematical situations. In many cases, persons would describe a pattern of stones in terms of a story. Thus in one case, where I had hoped to elicit expressions of comparison using two piles of stones, the informant referred to the piles as two families, one stronger and the other weaker. Likewise, one said stones in a circular pattern were friendly, but those in a square pattern unfriendly. In another case, a person described a triangle drawn in the sand as an honest man's road and a rectangle as a dishonest man's road, because the latter had many paths.

The exercise of intelligence in the ordinary conduct of affairs is organized according to traditional patterns within Kpelle life. Only in situations which lie radically outside the scope of the old way of life are Kpelle people flexible and adaptable, showing ability to solve problems which arise in the struggle for existence which were not previously encountered. Our problem, however, is not that, but concerns the role of argument and discursive reasoning in the culture. And our answer must be that such reasoning and argumentation are not commonly used, except for the two situations, themselves closely related, mentioned above.

(3) Psychological

(a) Mathematical concepts attended to in experience. It is too early to state final quantitative results from the psychological tests which we administered in

Gbanzu. In the first place, we do not have enough data from Gbanzu itself. In the second place, we require comparative data from other cultures. And in the third place, we have not applied the necessary statistical tests to the data we already have, partially because of lack of time and partially because it will be more fruitful to apply these tests when there is more complete data.

However, for the sake of this preliminary report, we will hazard a few generalizations, with the proviso that they are not stated with proper statistical safeguards. The results we have thus far obtained are at most suggestive, must not be taken as definitive, and are quite likely to be supplemented or even reversed. Still, what we can say will be useful at this preliminary stage, and in this tentative spirit the results are offered to the reader.

The first series of tests we administered, as stated in the previous chapter, concerned recognition of various shapes drawn in the sand (see Figure 8). The five tests of this type which were given tested the following pairs of concepts: straight line vs. curved line, circle vs. ellipse, right angle vs. non-right angle, triangle vs. circle, and triangle vs. rectangle. In every case we had a series of sixteen pairs of pictures, one of each of the two types. The alternation of the favored concept between right and left side was as nearly random as we could make it. We would choose one of the concepts, and ask the subject to state which of the two we had in mind, when we drew the two pairs in the sand. His first answer would, of course, be based on pure guesswork. We would tell him whether he was correct or not, and then draw the second pair, and ask the same question. Our criterion that he had correctly identified the concept was that he would correctly state the one of the pair we had in mind for eight trials in a row. We set a maximum of 32 errors, after which we turned to the next experiment. If the subject gave a correct response, we asked him to state why he chose the particular picture of the two, and

recorded his response.

We administered the tests to a total of 20 persons, seven of them under 20 years of age and thirteen of them over 20 years of age. Half of the tests favored one concept and half the other concept of a given pair. All subjects were Gbanzu residents, and only one could speak any English. We kept precise records on the subjects as to age, place of birth, and contact with western civilization.

In reporting the results of the tests, we state in the following chart average numbers of trials up to and including the last error, and we have given the average for the group over 20 years of age and the group under 20, as well as for the total.

Average Number of Trials up to and including Last Error

	straight vs. curved	circle vs. ellipse	rt. angle vs. other	triangle vs. circle	triangle vs. rectangle	
UNDER 20	15.1	10.6	21.6	6.4	4.8	7 subjects
OVER 20	14.9	7.0	15.1	3.9	10.6	13 subjects
TOTAL	15.0	8.2	17.3	4.7	8.7	20 subjects

With one exception, the group over 20 scored better than the group under 20, that exception being the case of triangle vs. rectangle. It may have been, of course, that the difference between age groups is statistically insignificant, a possibility which we will explore when more data is available.

The concepts seem to divide themselves into three distinct groups according to difficulty. The easiest test requires recognition of the distinction between a triangle and a circle. The average subject made approximately five errors before identifying the correct concept. The next group consists of the two pairs of concepts, circle vs. ellipse and triangle vs. rectangle. The most difficult group

consists of the two pairs of concepts, straight line vs. curved line and right angle vs. non-right angle. We do not yet know the comparative average numbers of trials up to and including the last error for persons in other cultures, but these data will be obtained.

It is useful to consider the verbalizations given by those who succeeded on each test. In the case of the circle vs. triangle, one said that one picture goes around. Another said that one has four (sic!) corners and the other is just round. Another said that it has something to do with finding something hidden. Another said that the one is round and the other entangled. Another said the one is round and the other made in a different way. Another said one of the figures is open like a forked stick. Another said that the one is flat and round, while the other has three corners. The one who knew some English identified the one with an O and the other with an L. Another said the one is round and the other has three limbs. Another said the one is round like the sun. Nine of the other ten persons were unable to verbalise the difference, while the last did not identify the concept. Those who were unable to verbalize gave answers such as "God told me", or "I just know", or "it is different".

In the case of the circle vs. the ellipse, four persons were unable to identify the correct member of the pair. Of those who made the correct response, one stated that the one is round, but that the other figure is long. Another said that the one was in the shape of a pumpkin. Another spoke of finding something that is hidden. Another said the one is /kɛlɛ-kɛlɛ/, 'round', and the other is a bit long. Another said the one is round like the sun and the other figure bent. The remaining eleven were unable to state how they got the correct answer.

In the case of the triangle vs. the rectangle, three persons were unable to

get the correct member of the pair. Of those who got the correct answer, one stated that the one has three corners and the other four corners. One said the one is the path of a fair person, but the other that of an unfair person because he has several paths to escape on. One said the one resembles a hole, but the other a forked stick. One referred to the triangle as /pêɛlaâ/, and said that the other figure does not have this property. One referred to the triangle as three and the rectangle two. One said that the triangle has three sides and the rectangle four. The one who knew English referred to the triangle as an A and the rectangle as a D. One said the one resembles a bow. The other nine could not verbalize their correct response.

In the case of the straight line vs. curved line, ten were unable to identify the correct member of the pair. Of those who got it correct, one said that the one looks like a new moon. One asserted that the curve was better drawn than the straight line. One said the one is twisted and the other straight. One said that the fair man goes straight, and the unfair man is crooked. One said that the one line is bent and the other straight. Another said the same thing. The one who knew English said the one is like a C. The other three could not verbalize their correct response.

In the case of the right angle vs. non-right angle, eleven persons could not identify the correct concept. Of those who got it correct, one asserted that the right angle was made well and the non-right angle made badly. One asserted that the right angle resembles a forked stick, whereas the other angle is open. One referred to the right angle as a hook. The remaining six could not verbalize their correct response.

Thus we can see that not only did the correct identification of concepts cause difficulty for many persons, but also the description of the correct answer caused

trouble for those who passed the first test. In particular, we see that there is a correlation between the concepts more difficult to recognize and those more difficult to verbalize.

It is possible to see a pattern in the three levels of difficulty. The triangle and circle are familiar in the society and are the simplest examples of straight line and curved figures. The next two pairs were more subtle because one consisted of two rectilinear and the other of two curved figures. The two most difficult pairs involved concepts which the people were not likely to meet in the culture, and certainly not likely to have to distinguish.

The next two tests administered were constructed in the same way as the tests mentioned above. In this case, however, the problem was to identify one of two sets of stones, for one subject the greater in number and for the next the less in number(see Figure 9). Then for each subject the tests were reversed. The same criterion was applied as in the previous tests, namely a run of eight correct responses. No one failed to get the correct result in the test requiring identification of the larger set, while one person failed to get the correct result in the test requiring identification of the smaller set. The same thirteen persons of 20 years and over and seven persons under 20 years took the test and the results are recorded as follows.

Average Number of Trials up to and including Last Error

	greater vs. smaller	smaller vs. greater	
UNDER 20	5.1	6.3	7 subjects
OVER 20	2.6	2.7	13 subjects
TOTAL	3.4	3.9	20 subjects

In this case, most of the subjects were able correctly to verbalize the concept, although some expressed it in a special case. Thus some put down stones in sets and said that the one set had more (or less) in it than the other set. However, even in this case, six persons were unable to state what characterized the sets they had chosen as correct. The same split favoring the older group appeared in this series of tests.

A third series of tests was then given, to a total of 42 subjects, six on each of seven tests. Each test had two parts, which consisted of fitting four pieces into simple cloth jig-saw puzzles. There were six puzzles altogether, as follows: A was all one color, with four circles of different diameters, matching four holes; B had four sectors, in green, blue, red and yellow, with four circles of different diameters, matching four holes, so that each circle fit into the hole in the sector of its own color; C had the same four colored sectors, and four circles with four holes, but each circle fit into a hole in a sector of a different color; D was all one color, with an equilateral triangle, a right triangle, a rectangle and a non-rectangular parallelogram, fitting into holes of the same shape (see Figure 11); E had four sectors, of green, blue, red and yellow, and with the four figures given in D, fitting into holes in sectors of their own color; and F had the same four colored sectors, and the same four figures, but fitting into holes in sectors of colors different from their own.

The members of each group were timed with a stop-watch to determine how many seconds it took them to do each puzzle. Each group had to do two puzzles, in order to find how one puzzle reinforced or interfered with another. The seven groups were as follows: group 1, A followed by B; group 2, A followed by C; group 3, B followed by C; group 4, D followed by E; group 5, D followed by F; group 6, E followed by F; and group 7, F followed by E. As mentioned above, there were six subjects for each

group. The results of the tests, given in average time for the members of the group, are given in the chart below.

Average Time in Seconds for Puzzle Solution

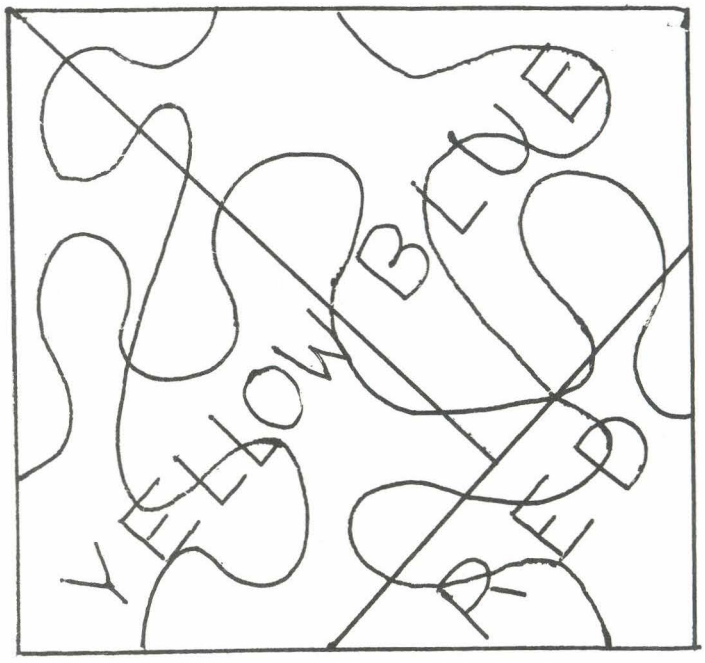
1		2		3		4		5		6		7	
A	B	A	C	B.	C	D	E	D	F	E	F	F	E
22.5	19.3	27.5	28.1	31.0	52.7	20.8	20.4	52.7	25.6	41.9	31.6	42.6	27.9

These times are difficult to interpret, primarily because not enough subjects were tested to give them statistical validity. Thus, for instance, both groups 4 and 5 began their tests by doing puzzle D, but the times reported for that puzzle are radically different. Likewise, groups 1 and 2 began by doing puzzle A, and the times reported are different, although not so radically different. It may be that these tests are not useful instruments for determining the relative strength of color and shape in determining a person's response.

A tentative conclusion is possible, namely, that it is easier to perform such puzzles where there is not an additional color factor. However, even this conclusion is dubious because of the limited amount of data. There does not seem to be any significant difference between straight-line figures and circular figures. However, more work will have to be done with these and other similar tests before any definite conclusions can be drawn.

A more significant test is a third test, which studied the time required to put together a six-piece jig-saw puzzle (see Figure 10). There were two puzzles of identical pattern made for pre-kindergarten children by Playschool Company, of overall dimensions 9 inches by 8 1/2 inches. One puzzle was plain--we used the reverse side since the pictures were culturally irrelevant for the Kpelle situation--while the other puzzle had a simple three color pattern on it as shown in the figure below.

Puzzle Used in Tests



Each person was shown each puzzle in assembled form before being put to work with the disassembled pieces. Half the persons were asked to do the plain puzzle first, and then asked to do the colored puzzle. The other half worked in the reverse order. The time required to complete the puzzle was recorded by stop watch in every case, and the average times computed. These average times are reported on the following chart.

Average Times Required to Assemble Puzzles

	plain first 7 subjects	color first 8 subjects
plain	7:13	2;09
color	2:42	3:20

Whereas the number of subjects was insufficient for real statistical validity, because of the wide fluctuation of the times (the best was 55 seconds, and the worst was 15 minutes and 7 seconds), it is perhaps possible to conclude that color helped

the person to complete the puzzle, since those in the first group required an average of 7 minutes, 13 seconds, to complete their first puzzle, which was plain; while those in the second group required an average of 3 minutes and 20 seconds to complete their first puzzle, which was colored. Moreover, the first group improved much more radically than did the second group in moving from the first to the second puzzle. Thus shapes alone were insufficient to make the solution of the puzzle easy, and color was a useful aid.

No comparisons have yet been made with persons from other groups in performing the same puzzles. However, it is to be expected that persons raised in a western or transition culture will have much less difficulty solving the puzzle. Certain specific difficulties were observed on the part of many of the individuals attempting the puzzle. In the first place, even though all of them were shown the puzzle in assembled form before they began to work on the disassembled pieces, no person made use of the fact that the puzzle had a straight-edge border. Thus almost every subject made attempts to fit a straight edge-piece into a round hole, not observing the difference in shape (see Figure 13). In some cases, as indicated above, color was a stronger factor in solving the puzzle than the shape of the pieces. Thus, when color was absent, the puzzle was extremely difficult for many of the subjects. However, other persons made little use of color (see figure 14). A further observation on techniques of assembling the puzzle is that persons apparently did not fit the pieces together in their minds before trying them in the physical situation (see figure 15). Moreover, some would fit one part of a piece at a time, without attending to the whole shape (see figure 13). Their solutions were largely by trial and error at first, and only later on did some of them begin to look for characteristic shapes and sizes of pieces.

One final test used pieces of colored cloth cut to certain shapes. There

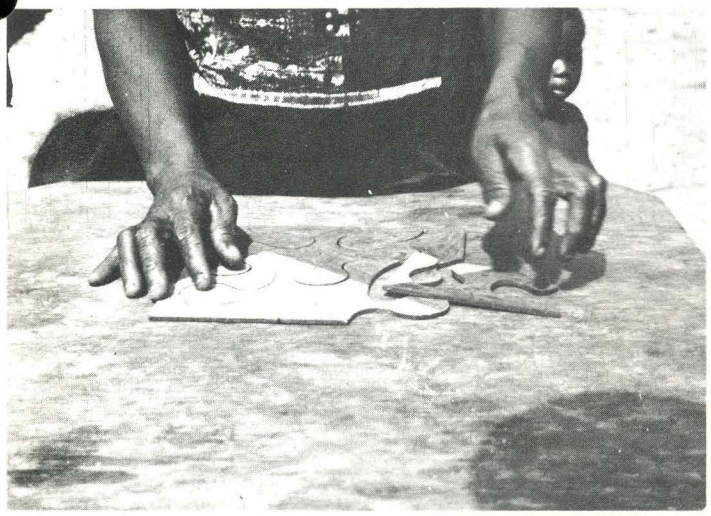


Figure 13.

Figures 13, 14 and 15.
Assembly of
jig-saw puzzle
in Gbanzu.

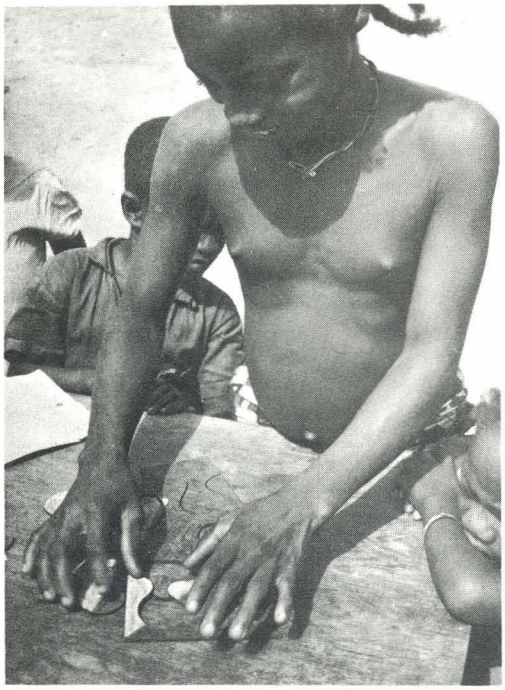


Figure 14.

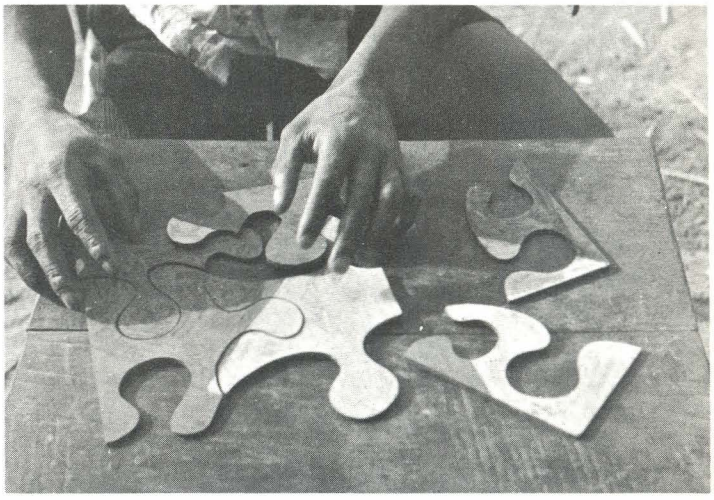


Figure 15.

were three colors, red, yellow and green, and three shapes, square, circle and triangle. Each subject was shown two pieces of cloth and required to tell whether they were the same or different. In half the trials, the subject was to attend to the shape, and in half the trials, the color. Only six trials were completed, for lack of time. But the results of those six trials were sufficiently clear that it may not be necessary to perform many more trials. Where color was that to which the subject was to attend, there was only one mistake made by the three subjects. Where form was that to which the subject was to attend, one subject totally failed to get the right answer, and the other two subjects made two errors each. Thus we can conclude that color dominates over shape in this test, and probably also in the whole culture.

These conclusions are both preliminary and incomplete, as has been mentioned several times. More work needs to be done among Gbanzu residents, as well as among outside groups. Further tests need to be designed, and the tests already designed need to be administered to other persons, both to make comparisons and to gain statistical validity. A statement concerning the work still to be done will be made in the final chapter.

(b) Values, fears and desires influencing mathematics in Kpelle culture. It is clear that there are non-rational factors within the culture which influence the role mathematical concepts play in the lives of individuals. For example, it seems to be true that mathematical knowledge and skill are perquisites possessed by persons in certain positions within the tribal group. The blacksmith is a man of importance in the community, and seems to require a small degree of mathematical skill as part of his job. He must buy materials, make cutlasses and sell them, and for this he requires some simple acquaintance with business arithmetic. The

blacksmith whom we interviewed stated, with both defensiveness and pride, that it was his business to be able to solve the simple arithmetic problems we put to him.

Another factor is that women have a status within the community which inhibits their using the abstract ideas of mathematics. They are expected to do their own work, and leave the men's affairs alone. Only within their secret society are they free to function with full rights. The one professional role open to women within the whole group is that of making medicines.

Finally, mathematical knowledge is influenced by the early development of the child. There are definitely relevant fears and blocks associated with childhood, which this project should explore more thoroughly. For instance, children who ask their parents questions are considered "frisky", and thus the inquiring mind so essential to mathematical competence is discouraged.

We know very little as yet on this topic, and more work needs to be done, because emotional factors are very important in learning and teaching. It may be that we will discover certain basic antipathies toward western culture or mathematics learning or logical reasoning which seriously affect the learning process. But as yet we do not know.

(4) Educational

(a) Patterns of childhood learning. We have little information thus far about the ways in which Kpelle children learn, whether in mathematics or any other area of life. Learning seems to take place in two situations: the ordinary village life, and the bush society school. We will consider these two situations and state what little we know about them in relation to mathematics learning. The results are meagre, and much more work needs to be done on this subject.

We had an extended conversation with chief Benjamin and the evangelist Veseli

concerning the ways in which children learn. The chief stated, "our children know counting with the knowledge given them by God." He implied, moreover, that they learn by making mistakes. The parent will send the child for a certain number of sticks, and, if the child is wrong, he will be sent back for more. The chief agreed that the townspeople play only a slight role in the mental growth of the children. They care for them, see that they have food, and keep them out of trouble—but they do not consciously train them in intellectual matters. The children simply imitate the parents, and, if they make mistakes in important matters, they may be beaten. However, it does not appear that physical punishment is often used.

The other place where education takes place is in the Poro society. But, from what little we as outsiders know about matters in the bush school, it appears that almost none of the education is formal or abstract. Children generally enter bush school between 6 years and 10 years of age (see Figure 16). The instruction is concerned with practical matters of hunting, fishing, making farm, and all the hundred other everyday details of village life. It is also concerned with ceremonial matters, including the respect due to the elders of the village and the tribal masked devils, as well as the making of masks and implements. Finally, certain children are chosen to go higher in the bush school and learn specialized trades, such as that of the blacksmith or that of the country doctor. Included among the specialized trades in some areas, unfortunately, are such activities as witchcraft, poisoning and sorcery, but these practices did not seem to be carried on in a significant way in Gbanzu. However, none of these matters is related to mathematics, with the possible exception of black-smithing.

Whether in the bush school or not, it seems clear that children are not to ask their elders embarrassing questions. If they do not understand something, they can

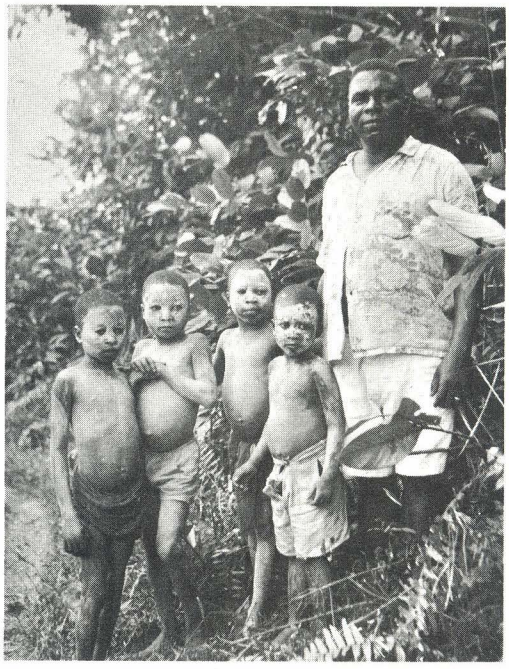


Figure 16.
Chief Benjamin of Gbanzu and
his children leaving bush school.

only hope to learn by passive observation, or else they must forget the matter. The primary source of knowledge in the culture is tradition. For an example, one woman was asked why houses are constructed as they are, and she said that they had learned it that way from their parents. It was not that the parents explicitly taught them, but they observed their parents in action, and learned also not to challenge the old ways.

Thus the scientific method is not respected within the society. The idea of approaching a problem, whether old or new, with a fresh and curious mind is alien to the Kpelle culture. There are time-honored ways of making farms, tying bridges, building houses and solving disputes, and change is not welcomed. The totality of the customs is not so great or complex that a child cannot learn them by observation. But one thing that is not learned, whether by observation or any means, within the Kpelle culture is a procedure for learning how to solve new problems.

(b) Patterns of cultural change. From what has been said above, it is to be expected that the Kpelle culture will change only very slowly under its own impetus. This seems to be true from our observations, even though the society has not been observed over a long period of years. But, during the period of Liberian history, it does not appear that Kpelle culture has developed new patterns on its own initiative. Whatever changes have been noted seem to have come through the influence of the outside world.

It seems fairly clear that this outside influence has had and is continuing to have a radical effect upon the traditional culture of the Kpelle people. Where the road has come into Kpelle country, the old patterns have disappeared or are in the process of disappearing. The money economy, the ability to move rapidly and cheaply to other sections of the country, the government legal system, the educa-

tion offered in government and mission schools, the new religions of Christianity, Islam and nationalism, the opportunities to make an easy living in crime, the new agricultural techniques—all these things have combined to beat down the traditional way of life. Only far from the main road are there towns where the traditional rhythm is maintained, where the town and farm life continue as they were hundreds and perhaps thousands of years ago. Gbanzu approximates to the old pattern, even though there have been already many changes in that pattern. But the old pattern present in Gbanzu, alive as it is in 1964, may be dead by 1970. And it is quite likely that Kpelle culture will be a thing respected only by old people within a decade or two.

Thus it is important to note the adaptibility of Kpelle people to new ways. And, in this connection, there is definite evidence, from observations of scattered individuals, that members of the tribe can become detribalized and integrated into western society without too great personal dislocation. Mr. John Wealar, the principal informant and research assistant for this project, grew up in a traditional Kpelle village, but now is effectively a member of the western, world-wide, cosmopolitan society. Of course, there are some aspects of traditional life, both superficial and deep-seated, which will remain vital and viable for many years to come. There may be some which become thoroughly fixed as parts of the new Pan-Liberian or even Pan-African culture which is coming into being. But the members of this new society will not be Kpelle people in the traditional pattern, and the Kpelle people in this new society will have adjusted and adapted to the new situation, as they are now proving they can do.

However, in a few areas, such as that of mathematical and logical reasoning, there is a cultural lag between the tribal life and the westernized life. Our problem in this research project is to find out why, and to suggest answers to

the difficulty. The same problem exists at other points in this transition period, and a procedure similar to the one outlined in this study should prove useful at each of these points. In this project, we have a problem to solve, and we hope that we can solve it—and that others may learn from our procedures. Thus, in the chapter that follows, we will suggest certain implications of the data outlined here, as well as certain recommendations for future action.