CHAPTER 5—KPELLE MATHEMATICAL BEHAVIOR

In this chapter, I will summarize what has been learned thus far in the Kpelle mathematics project. Many of the conclusions so far reached are, as has been suggested in the previous chapter, strictly tentative, and based on inadequate data. They need much more study before firm assertions can be made. However, it seems useful at this point to make even tentative statements, since they will be useful in four ways. First, the process of making these statements will help us clarify and focus our ideas before continuing with the project. Second, the conclusions suggested here should prove useful in writing mathematics texts at the third Entebbe mathematics workshop. Third, these conclusion should help teachers who are engaged in experimental mathematics teaching over the next several months, and these teachers in turn should be able to give suggestions useful in further work on this project. Finally, the conclusions should prove suggestive to others who might wish to initiate similar work in other cultures.

Thus, this chapter will state what we at present consider to be pre-mathematical and pre-logical behavior on the part of members of the Kpelle tribe. It will then lead to the final chapter, which will state the implications of this behavior in the three areas suggested in the previous chapter: educational, social and epistemological, and then make recommendations for the implementation of these implications, as well as for the further research required for a successful completion of the project.

a. Kpelle Pre-mathematical and Pre-logical Behavior

(1) Linguistic

(a) Description of fields of attention. In the first place, it seems clear that the analysis of descriptions of fields of attention which was derived from

English usage is directly applicable to Kpelle usage. Statements made in Kpelle to describe the contents of that to which persons attend can be shown to be composed of one or more of the elements which we previously called content-names, presentation-names, aspect-names, measure-names and value-names. Not every statement, of course, contains words in each of these categories, but it is possible to elicit from a subject terms in all categories. In what follows, I will consider the Kpelle usage in each of these five categories, and give examples of uses which are relevant to mathematics.

i. <u>Content-names</u> are clearly used in Kpelle in very nearly the same way as in English, or probably in any other language. The content of the field of attention may be an object, such as /pɛ́rɛ/, 'house'; or a material, such as /mɔlɔŋ/, 'rice'; or a proposition, such as /tɛ́ɛ ká tí/, 'that's chicken'; or a quality, such as /lɛ́lɛ/, 'fine'; or an event, such as /tíi/, 'work'; or an activity, such as /pâi/, 'coming'. The ways in which these content-names appear in statements are in some ways different from the ways in which comparable names appear in English statements, but the fundamental usage is the same.

One basic observation about the use of these content-names in statements is important to this project, and that concerns the ways in which they are numbered. In English, there is a basic split between countable and non-countable content-names for the content of fields of attention. Objects, propositions and events can be counted; whereas material, quality and activity are not normally counted. Thus in English, we can count houses and theorems and marriages; whereas we usually do not count water and yellow and living.

In Kpelle, there is a similar division within the set of content-names, but the split is more complex. Not only is it affected by distinctions between personal

and impersonal nouns, as well as those between free and dependent nouns, but there is not a simple contrast between singular and plural. Thus certain nouns, which can be counted without difficulty, are simply generic, neither singular nor plural, in their root form. Thus the statement /séle káa à sua kétɛ/ means 'an elephant is a big animal', or 'elephants are big animals', or 'the elephant is a big animal'. The term /séle/, 'elephant', is itself generic, and the singularity or plurality must be supplied by the context.

Certain of these generic nouns can be counted, while others cannot be counted. The examples give above were /pérɛ/, 'house', and /mɔlɔŋ/, 'rice'. . The difference is one of construction, not a difference inherently present in the word itself. Thus the expression /pérɛ náaŋ/, 'four houses', is meaningful, but the expression */mɔlɔŋ náaŋ/,'four rice', s', is not under normal circumstances meaningful. The question of the countability or non-countability of events, propositions, activity or quality has not been studied yet.

The non-counted noun can be characterized by the fact that some explicit measure term must be placed between it and a value-term, whereas the counted noun has implicit the measure-name 'item'. Thus we can speak of /mɔlɔŋ kau náaŋ/, 'four rice-grains'. '. Likewise other non-countable nouns can be counted in terms of measures other than the numerated measure by item. Of course, some nouns are at times countable and at other times non-countable in Kpelle. Thus the word /yá/, 'water', is at times directly countable, when it means 'stream', and at other times must be counted in terms of a measure such as the bucket or the pint.

The form of impersonal free nouns which might be called a plural form, moreover, is actually an individualized form. It says that the objects pluralized by this term, which is a suffix /-ŋà/, are thought of as discrete items, considered

one by one. Thus a non-countable material would certain not be considered in this way, and a countable object would only be considered in this way in order to show that the objects were scattered and not in a uniform, collected, homogeneous pile. Moreover, a noun counted by a numeral sometimes uses this individualized plural form and sometimes not. For example, /ŋápérɛ saaɓai ŋí/, 'these my three houses', can be contrasted with /ŋápérɛ-ŋà saaɓai ŋí/, 'these three particular houses of mine', where the second expression focusses the attention on three individual, separate houses.

Only personal nouns have clear singular and plural forms, which indicate the number in the manner of English countable nouns. However, even in this case, if it is desired to indicate the precise number represented, there can be exceptions. For simple personal free nouns the stem form is used before numerals, as in the case /núu feerɛ/, 'two people', which is to be compared with /núu tɔ̀nɔ/, 'one person'. For personal dependent nouns and compound personal free nouns, however, the plural form is used with numerals higher than one.

Thus pluralization of nouns is complex in the Kpelle language, and care should be taken in working with numbers of objects. Confusion can arise if the teacher uses the noun plural in English, and the student fails to comprehend the difference between the English and the Kpelle forms.

Another fact to emerge about content-names in Kpelle is that they are hierarchically arranged. Not enough study has been done on this topic, but the pattern is clear. Thus the word /sɛŋ/ is a general term which includes under it most of what English calls inanimate objects, and thus can be translated 'thing'. Likewise, the word /wúru/ refers to most woody growing trees, as well as to sticks cut from them, but does not include most garden plants, even though some of them become large and

woody. This ordering of content-names should be explored more thoroughly, as the expanded dictionary of content-names is formed.

Another fact is that content-names are often compounded. This compounding at times seems to be related to the hierarchical structure, in that the compound represents a special case of the word from which it is formed. For example, /kwí-tou/ means 'pineapple', or literally, 'foreigner's palm-nuts'. In the compound, /kwí/ refers to 'foreigner' while /tou/ refers to 'palm-nuts'. Both halves of the compound are made specific in this way, thus bringing us to a lower level in the hierarchy than either separately represents.

Where the content of the field of attention is an activity or an event, verbs are normally used to refer to that content, in Kpelle as in English. In Kpelle syntax, verbs can appear in three forms, with pronouns indicating the person acting. They may also appear in combination with certain helping verbs, which have syntactical functions. It is difficult at this point to indicate any clear connection between the forms of the verbs and their meanings, with one exception. The progressive, continuous present form differs from the other verbal forms, and corresponds to an activity in progress. Thus we can say, for example, /a tuânii/, 'he is moving over', and wherever the form /tuânii/ appears, it indicates continuous action.

The terms for qualities are adjectival in Kpelle, as they are in English. Apparently, however, the adverbial function in Kpelle is performed by a special type of complement at the end of the sentence, this complement being similar to the English adverbial phrase. Corresponding to the quality is the proposition, the analysis of which occupies a later section in this chapter.

ii. <u>Presentation-names</u> are the names given to the form within which the content is presented. These are apparently not present in the same profusion in Kpelle as in English, but there are many of them which are useful to this discussion. The first fact about presentation-names is that they are ordered hierarchically. Certain terms apply only to a small number of different contents, while other terms apply to a large number of such contents. For example, the term /-seêi/ has to do with any very general collection of countable objects. Thus we can say /kɔni seêi náaŋ ká tí/, 'those are four sets of stones', where the stones may be in four random piles or in four straight rows. But /kɔni pere náaŋ ká tí/ can only refer to stones in four rows, and thus it must be translated 'those are four rows of stones'.

There are special terms which are applicable to material, such as /yá sane feerɛ ká tí/, 'those are two bottles of water', where /yá/ is here considered as non-countable. It is not yet clear, however, whether there are general terms which can refer to any non-countable material. This is a problem in English as well, and there we are forced to use some such word as 'continuum', which is certainly not part of normal speech, but which is apparently necessary as the most general term to express non-countable contents.

These form-names may also function in other ways in describing fields of attention. It is possible, for instance, to have a set as the content of the field of attention. For another example, it is possible to think of a bottle as a measure term, if it is a standard bottle commonly used to measure a liquid.

One type of form-name which is common in Kpelle, but which does not have a clear parallel in English, is that which appears as the second member in a compound word, converting a non-countable content-name into a countable content-name. Thus we can speak of /mɔlɔŋ-kâu/, 'a grain of rice', or /seɣe-kpûu/, 'a ball of thread'.

The terms /mɔlɔŋ/, 'rice', and /seɣe/, 'cloth', are themselves uncountable, just as they are in English, but can be counted by the addition of these compounding terms. Thus the compounding terms have to be considered as form-names since they express the fact that the attention is focussed on a particular object, or on several particular objects.

Analysis has not yet been made of the ways in which activities, events, qualities and propositions are put into presentations. It is important that such a study be made in the future and the results compared with those given above.

iii. Aspect-names in noun form are not common in Kpelle, since they represent a high degree of abstraction. It is possible to formulate such nominal aspect names by a process commonly used in the Kpelle language, namely, compounding. But the names thus formed are themselves not familiar to most Kpelle speakers, and do not seem to be used in conversation. This difficulty with aspect names appeared also in the psychological experiments we performed, in that persons who could identify to everyone's satisfaction that, for example, the more numerous of two piles of stones was that being considered, could very often not express their knowledge. Thus such terms as length, width, size, number, weight, and so forth, are not to be expected in ordinary speech. Moreover, even those terms which can be invented, such as /kɛ́tɛ-là/, are compounded from adjectival forms, which state qualities.

Thus the adjectival form of the aspect-name is that which is more used and more useful in Kpelle. The adjectival form states a particular quality of the content under consideration. For instance, we can say /géleŋ kɛ́tɛ̂i/, which can be translated 'the truck is big'. We can also say /ɲúrii wiɛɛ/, 'the stick is heavy'. Of course, these do not state precisely the size or weight of the objects considered, but only indicate the aspect considered. However, in such a sentence as /mɔrɔi tí

ŋòwiɛ fé seeri ní mòrɔi ŋí ŋòwiɛ pó/, 'the weight of that bag is not equal to the weight of this bag', /wiɛ/, 'heavy', seems to be used in a nominal way.

Another way in which the adjectival form of the aspect-name is used is in a sentence such as /bérɛi ŋí kétêi é tɛ́ɛ nyíti mà/, 'this house is larger than that one', or literally 'this house is big, it passes on that'. Normally such a comparison goes from the greater to the smaller, and only on rare occasions do we hear comparisons go from the lesser to the greater value. Thus the adjectival form of the aspect-name is biaṣed in favor of the higher value. This is also the case in English, of course, where the statement 'this house is big' implies that its dimensions are large.

One difference between Kpelle and English is that in English we have two ways of expressing the nominal form of the aspect-name. One of these, e.g., 'weight', is neutral with regard to large or small, whereas the other 'heaviness' is not neutral, but is biaṣed in favor of the larger value. In Kpelle, the only nominal aspect-names are those artificial words derived from the adjectival form, or perhaps an adjectival form used in a nominal way, and thus there is probably an inherent bias in them toward the larger value.

An aspect-name which has been borrowed from English is the word /tâi/, 'time'. It is possible to use the word in several ways to indicate aspect. Thus, for example, we can ask /lé tâi ɓe ya pâi pâi pôlu/, 'what time will you return?' Or we can say /tâi kélee ŋa pâ ɓéi ŋa gâloŋkâa/, 'whenever I come here, I see the chief'. In each of these cases /tâi/ is used as a general word for temporal measurement.

There is also a general term for money, /sɛŋ-kau/, which literally means 'piece of a thing'. We can say, for instance, /ŋa sɛŋ-kau támaa ŋwélîi/, 'I want a lot of money', or we can ask /sɛŋ-kau yɛɛlu káa mòlɔi sù, 'how much money is in the bag?'

iv. <u>Measure-names</u> are more common in Kpelle, although they do not arise where the Kpelle culture has no need for a measure. Measure-names are of two types: free nouns which are independent of and external to the thing measured; and dependent nouns which are possessed by the thing measured. In every case the measure is related to a particular aspect, even though the aspect might not be named explicitly. One example of a free measure-noun is the term /pãi/, which can be translated 'pint' or 'salmon-tin', the latter being the local means of measuring one pint. It is the common measure for rice, and thus a cup of rice would be /moloŋ pãi/. This is related both to volume and to weight, in that the size of a pint is dictated by the standard large salmon-tin and the weight of the rice in one such tin (well-rounded at the bottom and top) is approximately one pound. A typical measure which uses a dependent noun is /núu ŋwaŋ/, 'a person's outstretched-arm span'.

Measures are known for such aspects as money, where the terms are primarily borrowed from foreign languages; weight, which terminology is likewise mostly borrowed; volume, which terms depend on the thing measured, since most useful commodities, such as rice or water or palm-oil, are measured by visible amount; time, which is measured by the beginning points of certain gross units, such as the morning, mid-day, afternoon, evening, night, day, week, month and year; distance, which is usually measured by parts of the body for small distances, and by time of walking for large distances; and finally sets of objects, which are, of course, measured by number. This last measure, namely, number, is very important in the culture, but the abstract name for number is, as has been mentioned above, an artificial name, corresponding to the artificial term 'manyness' in English.

v. <u>Value-names</u>, which may also be called enumerators, include the entire number system in Kpelle, as well as certain other general terms. The number system is

based partially on five and partially on ten, and the numbers themselves appear in
two forms in sentences. The first form appears as an adjective immediately after
the noun it modifies. Thus we can say /téɛ lɔɔlu/, 'five chickens'. The other form
is in reality not different, since, except for /tɔnɔ/, 'one', the noun modified is
replaced by a pronominal prefix. Thus we can say /ŋɔɔlu/, 'five of them', or 'five
of it'. The numeral /tɔnɔ/, 'one', is replaced by a different form /táaŋ/, 'one of
it', in its free form.

The following list illustrates the principles of formation of the numerals in
Kpelle. The numerals are given in both forms, with the free form on the left and
the form modifying, in this example, /taa/, 'town', on the right.

/táaŋ/, 'one' — /taa tɔnɔ/, 'one town'

/veerɛ/, 'two' — /taa veerɛ/, 'two towns'

/zaaɓa/, 'three' — /taa saaɓa/, 'three towns'

/ŋáaŋ/, 'four' — /taa náaŋ/, 'four towns'

/ŋɔɔlu/, 'five' — /taa lɔɔlu/, 'five towns'

/ŋɔɔlu mɛi da/, 'six' — /taa lɔɔlu mɛi da/, 'six towns'

/ŋɔɔlu mɛi feerɛ/, 'seven' — /taa lɔɔlu mɛi feerɛ/, 'seven towns'

/ŋɔɔlu mɛi saaɓa/, 'eight' — /taa lɔɔlu mɛi saaɓa/, 'eight towns'

/ŋɔɔlu mɛi náaŋ/, 'nine' — /taa lɔɔlu mɛi náaŋ/, 'nine towns'

/puu/, 'ten' — /taa puu/, 'ten towns'

/buu káu tɔnɔ/, 'eleven' — /taa puu káu tɔnɔ/, 'eleven towns'

/buu káu feerɛ/, 'twelve' — /taa puu káu feerɛ/, 'twelve towns'

/buu feerɛ/, 'twenty' — /taa puu feerɛ/, 'twenty towns'

/buu saaɓa káu lɔɔlu mɛi da/, 'thirty-six' — /taa buu saaɓa káu lɔɔlu mɛi da/, 'thirty-six towns'

/ŋuŋ tɔnɔ pôlu buu lɔɔlu mɛi feerɛ káu saaɓa/, 'one hundred seventy-three' — /taa ŋuŋ tɔnɔ pôlu buu lɔɔlu, mɛi feerɛ káu saaɓa/, 'one hundred seventy-three towns'

From the chart the pattern of number-names is clear. There are separate number names for each of the numbers from one to five. Then six is written as five plus one, seven as five plus two, and so forth. Ten has a new name. Eleven through nineteen are written as ten plus the name for the proper number between one and nine. Twenty is written as two tens, and the numbers from twenty-one to twenty-nine as two tens plus the appropriate number between one and nine. The same holds true for all the numbers up to ninety-nine. Then hundred has a new name, which is the word for head, and the number of hundreds is specified by the appropriate numeral. The numbers from one hundred to nine hundred ninety-nine are all written in perfectly regular fashion. It has been reported to me that there is a numeral for thousand, namely, /wala/,, but I have never in fact heard it used.

There is no term for zero as such in the Kpelle language. However, it is possible to refer to an empty set in several ways. For instance, in a game called /kai-mo/, played by successively removing stones from piles, a pile with no stones is referred to by the phrase /tóo à lóa/, 'fall in the hole'. In another similar game, the player says of the pile with no rocks /kú té pélen-ná/, 'let's enter old-town site', implying that no one still lives there. Formally, moreover, it is possible to speak of /seêi-folo/, 'empty set', but this usage is not customary.

Fractions are not used as such, although there are some terms with roughly the meaning of a fraction. These terms will be considered in a later section, in connection with their anthropological setting.

There are three other value-names, which are commonly used in Kpelle. They are the terms /ta/, 'some', /támaa/, 'many', and /kélee/, 'all'. They are used where a precise value is not required, but where some value is to be given to the measure. Normally, Kpelle speakers do not specify precise values above approximately thirty, and some are forced to use forgotten terms for such large numbers as seventy.

The measure and value words together can provide an answer to the question /γεεlu Ɓe/, 'how much'. The answer to this question will depend on the context of the question. It might refer to money, or to weight, or to volume, or to some other measure. However, it is also possible to ask the question in more specific form, such as /pâi γεεlu káa hà/, 'how many pints are there?', the answer to which will be, for example, /gáa à pâi saaƁa/, 'it's three pints'. Thus the term /γεεlu/ can be translated both 'how many' and 'how much'. Likewise the value-word /támaa/ can also be translated both 'many' and 'much'. In the case of 'how much' and 'much', the words are being used as portmanteaus, since the terms imply both a measure and a value. To ask 'how many' is to ask only for a numeral, but to ask 'how much' is to ask both for a numeral and for a measure.

(b) Construction of prepositions. In the first place, it appears that the division of propositions into atomic and molecular is valid also of propositions in Kpelle. An atomic proposition asserts something to be true of the content of a field of attention, while a molecular proposition is one which has at least one complete atomic proposition as a unified proper sub-portion of itself. Thus the proposition /nûai di pérɛ tòɔ/, 'the people built a house', asserts of the people the fact that they built a house, and is an atomic proposition. On the other hand, the proposition /ŋá pà ŋá lóno ípɔ́/, 'I came to speak to you', or literally, 'I came I should speak to you,' is a combination of two atomic propositions, and thus is a molecular proposition.

It is clear that propositions of both types assert something to be true of the contents of fields of attention. In the first example above the proposition states something to be true about 'people', and in the second example about 'I'. Of course, a molecular proposition will often assert something to be true of the con-

tents of at least two different propositions, one for each atomic sub-proposition. We normally call that of which something is asserted the **subject** of the proposition, and that which is asserted of it the **predicate** of the proposition. Thus in the proposition /ñûaĪ dí pére tòɔ/, 'the people built a house', the subject is /ñûaĪ dí/, 'the people they', and the predicate is /pére tòɔ/, 'built a house'. What is asserted of the people in this case is the content of another field of attention, namely, the activity 'built a house'.

The predicate may also assert of the subject facts about the form, aspect, measure or number of the field of attention of which it is the content. For example, the proposition /bérɛi kétêi/, 'the house is big', asserts something, albeit imprecise, about the aspect and number of the field of attention. However, there are no further possibilities. Either the proposition relates another field of attention to that expressed by the subject, or it states additional facts about the given field of attention.

It may be that the proposition has a complex predicate or a complex subject or perhaps both. A complex predicate states more than one fact about the subject. For example, the proposition stated above, /ñûaĪ dí pére tòɔ/, 'the people built a house', has a complex predicate. It asserts first that the people built, and second that it was a house they built. The first part of the complex predicate, namely, /pére/ names an object, which is the content of a field of attention; and the second part of the complex predicate, namely, /tòɔ/, names an activity, which is also the content of a field of attention.

The complex predicate may also state two or more of the attributes of the given field of attention. For example, the statement /mɔlɔŋ pâi káa à kâpa puu/, 'a pint of rice is ten cents', states four of the five items in the description of

a field of attention, and implies the fifth. The subject of the proposition states
that the content is rice, and the presentation is a pint. The predicate states that
its measure is cents and its value is ten. It is implied, of course, that the as-
pect considered is money, even though the term /sɛŋ-kau/, 'money', is not used in
the sentence.

The complex predicate, finally, may state at least one attribute of the field
of attention itself, and may also relate that field of attention to the content,
form, aspect, measure or value of another field of attention. We need only add the
phrase /daai sù/, 'in town', to the statement /mɔlɔŋ pâi káa à kâpa puu/, 'a pint of
rice is ten cents', to make the statement /mɔlɔŋ pâi káa à kâpa puu daai sù/, 'a pint
of rice is ten cents in town', which states something about the content of the field
of attention and also relates it to another field of attention.

The subject of an atomic proposition may likewise be complex, as in the same
example /mɔlɔŋ pâi káa à kâpa puu/, 'a pint of rice is ten cents'. In this state-
ment the subject is /mɔlɔŋ pâi/, 'a pint of rice', which states two facts about the
field of attention, its content and its form. It is also possible to have a subject
with two members, as in the proposition /fúlomo da sumo da pâi/, 'Flumo and Sumo are
coming'. In this case, however, it may be asserted that the two men form the con-
tent of one field of attention.

Among the elements out of which propositions are formed are the structural ele-
ments. Some of these structural elements have no direct reference to any field of
attention, but are purely formal in character. For example, in the proposition
/è pà à mɔlɔŋ/, 'he brought rice',the particle /à/ serves as a marker to show what
it was that he brought. It can perhaps be translated 'with', but this is only an
approximation, and its role is more formal than that filled by the English word

'with'. Other structural elements have reference to content. Thus if we modify
the statement above to read /sumo è pà à mɔlɔŋ/, 'Sumo brought rice', the particle
/è/ is present as a pronoun marker indicating person and time, although it also in-
dicates a direct relation to Sumo, as the person to whom the pronoun refers.

The structural element may not be an independent word, but may be an element
added to one of the other words in the statement. For instance, we can say /Bá/ ɔŋ
Be sumo a ŋílîi/, 'it's rice Sumo is cooking'. In this sentence, there are several
structural elements. The term /Be/ indicates that /Bá/.ɔŋ/, 'rice', is the content-
centered subject of the sentence, even though in fact it is not the grammatical
subject of the comparable sentence /sumo a /Bá/ŋ ɣílîi/, 'Sumo is cooking rice'.
The second structural element is the prefixed low tone in the word /ŋílîi/, 'cook-
ing it', which indicates that the word which would ordinarily be the object of the
verb has been transferred ahead and will be found before the particle /Be/. It is
also possible that this statement could be interpreted as a molecular proposition,
with two atomic propositions, /Bá/ ɔŋ Be/ and /sumo a ŋílîi/. In this case also
the prefixed low tone is a pronoun marker which refers the hearer back to the pre-
vious atomic proposition

Certain markers are purely positional in character, and do not appear as
sounds in the propositions to which they belong. Thus the statement /sumo a pâi
à fúlomo/, 'Sumo is bringing Flumo', is different from the statement /fúlomo a pâi
à sumo/, 'Flumo is bringing Sumo', only in the position of the words /fúlomo/ and
/sumo/. The subject is first in the statement, and the complement appears after
the particle /à/, positions which have a fixed function.

The markers in atomic propositions which are most important from the mathema-
tical point of view are those which join terms together into complex coordinate

subjects or complex coordinate predicates. A complex subject or predicate is coordinate if the two elements are in the same category of attributes describing fields of attention. Thus the statement /fúlomo dà sumo da pâi/, 'Flumo and Sumo are coming', has a complex coordinate subject /fúlomo dà sum da/. The word /dà/ is related to the pronoun /da/, 'they', as in the statement /da pâi/, 'they are coming'. In the original statement, however, /dà/ functions as a conjunction, although not a conjunction of as great generality as the English conjunction 'and'. That /dà/ remains a pronoun even in this usage is indicated by the fact that a different term must be used if the individuals named by the complex coordinate subject are expressed in the first or second person, instead of in the third person, as above. Thus we must say /kà sumo ká lì/, 'you and Sumo went'. In this case, the pronoun /kà/ serves both to indicate 'you' and to indicate 'and'.

The conjunctive pronouns can also be used to mark a complex coordinate predicate. Thus in the statement /dí ŋgàa kwà yá/, 'they saw me and you', the prefixed high tone of /ŋgàa/ indicates 'me', the pronoun /kwà/ acts for the English conjunction 'and', and the pronoun /yá/ indicates 'you'.

There are more complex forms of this construction in the case either of the two members of the complex coordinate subject or predicate is itself plural. However, it is not useful to consider that case here. The details are unimportant, but the basic fact is important, namely, a complex system of pronouns serve as conjunctions under certain circumstances. There is no single, uniform way to join nouns together into a complex coordinate subject or predicate.

One further construction which can serve the place of the conjunction 'and' is the phrase /-pɛlɛ́ɛ ... mà/, which appears in a sentence such as this: /fúlomo pɛlɛ́ɛ tòkpa mà dâa pá/, 'Flumo and Tokpa have come'. Literally translated, the

sentence would read 'Flumo on top of him Tokpa they have come'. In this construc-
tion, /-pɛlɛ́ɛ ... mà/ acts as a conjunction in approximately the same way as do the
conjunctive pronouns mentioned above, since its form also alters with the person of
the members it joins. It is a useful term in mathematical operations, since it
suggests the idea of union, and thus of addition.

In English, we have the conjunction 'or', which can form part of a complex
coordinate predicate or subject. We can say 'John or James will come', or 'he will
buy apples or oranges'. But it is difficult to give an atomic proposition which is
the Kpelle equivalent of such a proposition. We must construct a molecular propo-
sition, which expresses the fact that Flumo will come, and, if he does not come,
Sumo will come. One such molecular proposition is the following: /fúlomo a pâi pâi,
kpaa sumo a pâi pâi/, 'Flumo will come; if not, Sumo will come'.

At this point, therefore, it is necessary to discuss the formation of molecu-
lar propositions, since it would not be fruitful for us to consider all possible
types of atomic propositions. We are not attempting to write a complete grammar
of the Kpelle language, but only to indicate those points which are relevant to the
learning and teaching of mathematics and logic.

There are two types of molecular proposition, the simple and the complex. The
former has only one unified proper atomic sub-proposition, whereas the latter has
at least two unified proper atomic sub-propositions. Before going farther it is
necessary to state precisely the way in which an atomic proposition appears as a
proper sub-proposition within a molecular proposition. The basic point is that it
does not change an atomic proposition into a molecular proposition to make an in-
ternal modification in it. The atomic proposition must appear as a whole within
the molecular proposition, and must be used in its entirety as a part of the mole-

cular proposition. Thus, to take an example from English, 'I bought onions and I
bought potatoes', is a molecular proposition, with two atomic sub-propositions. On
the other hand, 'I bought onions and potatoes', is not a molecular proposition, but
is an atomic proposition with a complex coordinate predicate.

It is a relevant question to ask whether there can exist a simple molecular
proposition, since it might be asserted that such a proposition can be reduced to
an atomic proposition. However, it is generally accepted in logic that the logical
operator which negates a proposition produces a molecular proposition, and thus we
will allow the existence of the simple molecular proposition. Thus we will call
the proposition in Kpelle /vé seêni/, 'he is not seated', a molecular proposition
formed from the atomic proposition /a seêni/, 'he is seated'. And we will say that
there is a negative operator which transforms the atomic proposition into the mole-
cular proposition. In this connection, it must be remembered that it is a direct
attribute of a field of attention only to be what it is, not to be what it is not.
Moreover, we can restate the above proposition in its English form, as 'that he is
seated is false'. In this way, we see that the negative statement is a proposition
concerning a proposition.

There are other simple molecular propositions, but apparently none of the same
importance as that showing negation. Simple molecular propositions can be con-
structed in artificial fashion, in the same form as the negative proposition. Thus
we can say 'that he is seated is irrelevant', which is a comparable simple molecu-
lar proposition. However, even though such sentences could doubtless be constructed
in Kpelle, we have not encountered any in our work with informants.

The Kpelle negative construction can assume many forms, most of which involve
the particle /fé/ in some way. However, the negative proposition does not have a
form parallel to the corresponding affirmative construction. Thus /ńélɛêi/, 'it

is good', corresponds to /vé lɛ́lɛ̀ ní/, 'it is not good', and /pɛ́rɛ ká tí/, 'that is a house', corresponds to /pɛ́rɛ fɛ́ tí/, 'that's not a house'. Again, /è tùaŋ/, 'he moved over', corresponds to /vé tuâŋ ní/, 'he didn't move over'; and /é tuâŋ/, 'he should move over', to /vɛ́ tùaŋ/, 'he shouldn't move over'. These examples should suffice to show the lack of fit between the affirmative and negative propositions, thus showing that there is no simple, uniform way to form negatives.

At this point, we turn to complex molecular propositions, which have at least two atomic propositions as proper unified sub-propositions. There are many types of complex molecular propositions in Kpelle, as there are in English. Although it would not be relevant for us to consider all these types, there are several of basic importance for mathematical and logical thought. In these cases, we are interested primarily in the logical connectives which bind the atomic propositions together. The connectives may be, as in the case of the organization of terms into atomic propositions, of several types. The connective may be a separate word, either purely formal or in part indicating content. It may be a part of a word, as in the case of Kpelle prefixes. It may be structural, indicating the connection by position. Or it may be non-syntactical, involving intonation, stress, pause or gesture. In what follows, we will give an analysis of the basic Kpelle connectives, and thus the basic types of molecular propositions, which we have found to be of importance to pre-mathematical and pre-logical thought.

Of fundamental importance to our discussion of the construction of complex molecular propositions is that the categories most familiar to us in English do not seem to be the most basic ways of forming complex propositions in Kpelle. Western logic has singled out four logical connectives for special attention, since they possess truth-functional content. The first of these is the coordinating conjunction

'and', which joins two propositions together into a complex proposition, whose
two parts possess equal structural value. Such a coordinating conjunction simply
does not exist in Kpelle. For instance, it seems to be impossible to say 'it is
raining, and yesterday I had eggs for breakfast', where the two atomic propositions
have nothing in common. Any Kpelle construction into which this was translated
simply would not make sense. The only possible way, apparently, would be to say
first 'it is raining', and then, after a considerable pause, to say 'yesterday I
had eggs for breakfast'. In this way the two propositions belong to entirely
separate and distinct discussions.

One construction which shows the conjunction of two related propositions is
the consecutive construction, as in the case /ŋá lì nà ŋá tíi ké/, 'I went there
and worked'. In this molecular proposition, the second action is consequent upon
the first, not independent of it. A proposition of this type can thus only be
formed of two propositions which are related in certain definite ways. One of
these ways, illustrated in the above example, uses the second proposition to show
what happened after the first. Another shows desire, as in /ŋa ɲwêlii é lí/,
'I want him to go'. A similar use shows purpose, as in /ŋá pà ŋá lóno ípɔ́/, 'I
came to speak to you'. More special uses of this construction are also possible.

Another construction joining propositions shows simultaneous or coexistent
action. Thus the proposition /è wɔ̀lɔ gé yèlɛ/, 'he laughed and cried (together)',
uses the verb stem /ké/ with a noun or pronoun object as a kind of conjunction.
A similar type of proposition states that two attributes of something coexist. As
an example, the proposition /gétêi gé Ɓò à nélɛɛ/, 'it is big and (also) good',
uses the same verb /ké/ with object as a conjunction. A very similar construction
is in the statement /a seêni kɔlɔ ké Ɓò nyéêi/, 'he is seated and has a book',
where the object of the conjunctive verb /ké/ is /kɔlɔ/, 'book', which is at the

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same time the subject of the second proposition.

These propositions are the closest analogues in Kpelle to the type of proposition in English in which two atomic propositions are connected by 'and'. Just as in the case of the complex coordinate subject or predicate, the functions which are served by the single English conjunction 'and' are served by a variety of terms and phrases in Kpelle. Moreover, certain of those functions, such as the conjunction of two unrelated atomic propositions, cannot be easily expressed in Kpelle.

The second important logical connective in western logic is that expressed by the English conjunction 'or'. This conjunction in English is ambiguous, since it can be either an exclusive or an inclusive conjunction. For instance, if a man says, 'I will take a pen or I will take a pencil', it would not violate the conditions of the proposition if he took both a pen and a pencil. But if he said, 'I will take a pencil or I will not take a pencil', then it is impossible for him to do both. In the one case the two alternatives can co-exist, while in the second only one can be present. In western logic, we normally use the connective 'or' in its inclusive sense, even though many common uses of the word are exclusive.

In Kpelle, this function can be expressed, but once again in an unsymmetrical way. Thus we can say /a pâi zeɣei wáâi à wàla kɛ́ tí vé pâi ɦáa mîi/, 'he will wash the clothes or he will not eat'. In this case the first alternative is preferred, while the second alternative will take place if the first is not fulfilled. It is not a symmetrical one-or-the-other situation. Thus the statement above should be translated literally, 'he will wash the clothes; if that does not happen, he will not eat'. Another similar way of expressing alternative uses the phrase /yíni fêi/, 'if that is not'. This phrase could replace the phrase /à wàla kɛ́ tí/ without change of meaning, for which reason it is not necessary to give a further example.

The important point is that in both these cases the alternatives are exclusive and unsymmetrical. It would be difficult, if not impossible, in Kpelle to make a molecular statement, in which the two atomic propositions were joined by a term equivalent to the English 'or', and in which the two propositions were parallel. And it would be even more difficult to express such a proposition where one or perhaps both of the two alternatives might be realized.

In all the cases considered thus far, in some way the first of the two atomic propositions has required the second as its consequent. There are forms of molecular propositions which make this even more explicit, that show the dependence of one proposition on another. Western formal logic has stated this as a third general logical connective, namely, implication. In English, the most familiar form of this is in such statements as 'if it rains, I will get wet'. However, there are many other ways of expressing such a relation between propositions, including the English terms 'because', 'therefore', 'only if', and so forth.

In Kpelle also there are many ways of expressing the relation of implication. Moreover, there is a good parallel between these expressions in Kpelle and the corresponding expressions in English, a parallel which we observed did not exist for the logical connectives 'and' and 'or'. We will consider several of the more important ways of expressing implication in Kpelle.

The first of these connectives is the phrase /kpéni fêi/, which conveys the idea of 'it is not for nothing, but for something'. Thus we can say /sumo è sàa. kpéni fêi, dí wúlu kè mà/, 'Sumo died, because they bewitched him'. Literally, this should perhaps be translated, 'Sumo died. It was not for nothing; they bewitched him.' An interesting set of examples of the use of this phrase in a basic sentence and sentences related to it by transformation is contained in Mr. Wealar's

article, "Expressions for Cause and Reason", in Appendix 6. All these examples show
the operation on the double negative in the phrase /kpéni fêi/, in that it shows
that the event was not fortuitous, and gives the cause for it. The cause may be
of various types, and, in fact, cause and effect, as they might appear to a western-
er, can in some cases be reversed, so that the antecedent and consequent of /kpéni
fêi/ in a given statement can be reversed to form a new, equally meaningful,
statement.

A second phrase marking an implication is the phrase /m̀aa-mêni mà/, which might
literally be translated 'on the matter of it', or, more freely, 'for this reason'.
Thus it is roughly the equivalent of the English 'therefore'. For example, we can
say /tuna fé pûi, m̀aa-mêni mà ǹoii kpálâi/, 'it is not raining; therefore, the ground
is dry'. We cannot, however, reverse the implication, as we could if the connective
were /kpéni fêi/, which thus functions as a more general connective. Often the
connective /m̀aa-mêni mà/ is used to give the conclusion for a lengthy argument,
while the connective /kpéni fêi/ is used to give a simple reason which can easily
be stated. The former of the two shows the consequences of statements, while the
latter suggests their reasons. The latter, in Kpelle, can include the former, that
is, the reason for something can include its consequences. However, the former
cannot include the latter, that is, the consequence of something cannot be its
reason.

A third expression which marks implication is the phrase /à kè tí/, which can
be translated 'if it be so'. This expression is a normal conditional construction,
and so can be used as an independent antecedent before a consequent. Thus we can
say /nyíɲi à kè tí, kú lí/, 'if this happens like that, we must go'. We can also
use /à kè tí/ to introduce a conclusion after a complex preparatory series of

statements. We can also use the phrase /à kɛ̀/ before another conditional, to express a greater degree of unpredictability.

Another expression which commonly indicates result or consequent is /a gɛ́ɛ/, 'so that', as in the statement /kúí gɔ́lɔŋ a gɛ́ɛ sumo è sàa/, 'we know that Sumo died'. We can also say /ŋá pà a gɛ́ɛ ŋá lóno ípɔ́/, 'I came to speak to you'. In this case the expression /a gɛ́ɛ/ indicates purpose or intention.

Another way of showing an implication does not involve the use of a connective phrase, but rather uses verb form and sentence position. For example, we can say /à pà, a pâi tíi kɛ̂i/ 'if he comes, he will work'. This construction is perhaps most similar of all those we have considered to the formal implication of logic. It can be made less definite by adding the further conditional /à kɛ̀/ before the antecedent. This usage is related to that of /à kɛ̀ tí/ considered above.

Another similar construction, with a temporal implication, is that illustrated by the proposition: /ŋá pà ɓéi, ŋá gâloŋ kâa/, 'when I came here, I saw the chief'. Often the English loan-word /tâi/, 'time', is prefixed to the statement in this form, but this is not necessary. Likewise there are expressions involving place, as in the statement /ɓéi è lì naai, fa pɔ̂ri líi ǹà/, 'where he went, I can't go'. Both the temporal and the spatial construction have a close resemblance to an implication.

A related type of molecular proposition is the proposition expressing condition or manner, one of the forms of which is similar to the syllogism. Thus we can say /berei núu kélee a pâi sâai làᵐ, berei máŋ sumo káa là à núui, berei ɓé sumo a pâi saâi là/, 'inasmuch as all men will die, inasmuch also as Sumo is a man, in so much Sumo will die'.

A proposition with a similar function is the relative proposition, which ex-

plains a particular term in the main proposition by the sub-proposition. Thus, for example, we can say /kpôlɔ ká ŋí da mɔlɔŋ pû zù/, 'this is a basket they put rice in'. In this as in all previous cases, there is a definite link between the two atomic sub-propositions, in this case one proposition amplifying a term in the other.

A contrary-to-fact condition is expressed by use of the desiderative form of the verb, used twice in succession. Thus we can say /îi pà, kûi íkàa/, 'if you had come, we would have seen you'. This is the same as the sequence of propositions: /ífé pá ní. m̀aa-mêni mà, kú fé íkáa ní/, 'you didn't come; because of it, we didn't see you'. This type of proposition suggests the converse of an affirmative proposition in western logic.

The final logical connective which is important to western logic is the connective expressing equivalence. It is, of course, possible in Kpelle to speak of two objects being equal or similar or equivalent to each other. However, the means of expressing the logical equivalence of propositions has not yet been discovered. It may be that this is another of the western forms which it is not possible to translate directly and easily into Kpelle.

Thus, to summarize the formation of propositions, there are two types of proposition, the atomic and the molecular. The atomic proposition is formed of a subject and a predicate, where each refers to some feature of one or more fields of attention. The subject and predicate can be either simple or complex, and if they are complex they can be either coordinate or not coordinate. We investigated the various types of logical connectives within atomic propositions, and found a certain difficulty in stating in Kpelle those which are expressed in English by the words 'and' and 'or'.

We then considered molecular propositions, which can be either simple or complex. The principal simple molecular proposition is that formed by negating an

atomic proposition. We found that there are many ways of expressing such propositions in Kpelle, and that their forms differ sharply from one another. We studied the various types of complex molecular propositions, and found that they fitted more or less within the three categories of 'and', 'or' and 'implies'. We did not find any molecular proposition which expresses the equivalence of two atomic propositions. We found that the propositions which perform the function in Kpelle of 'and' and 'or' do not behave in the same way as in English. In particular, we learned that propositions constructed by the use of these connectives in Kpelle are not symmetrical. We also found that the inclusive 'or' could not easily be expressed. We found, however, a wealth of means for expressing implication in Kpelle, even though we found no way of expressing equivalence.

(c) Construction of arguments. We have much less information available at this point concerning the construction of arguments. Less time was spent in research on this question both in English and in Kpelle. However, this does not mean that the subject is less important to the project. On the contrary, the preceding sections are not complete until more information is available on the construction of arguments.

An initial fact seems to be that propositions are connected into coherent sequences by using the phrases /m̃aa-m̃ȇni mà/, 'for this reason', and /à k̀ɛ tí/, 'if it be so'. After a series of statements are offered in evidence for the conclusion to be drawn, the speaker will commonly use one of these two connectives to introduce the conclusion toward which he was moving. Occasionally also, the phrase /zu kúla ká ŋí/, 'this is the reason in it', is used to introduce the reason lying behind a general conclusion stated at the beginning of the argument.

The only other fact we can now state about the construction of arguments in

Kpelle is that they are formed out of propositions. In fact, the form of most arguments seems to be that of one long proposition. Either a series of statements is given conjoined together and a conclusion is reached, or a statement is given, and a series of reasons then given to support the statement.

(2) <u>Anthropological</u>

(a) <u>Use of mathematical concepts in the culture</u>. In this section we will consider mathematical activities in the culture, rather than the pre-mathematical activities which have been covered thoroughly in the previous section. Here we will consider what measures and what values are in actual use within the culture, what mathematical operations are performed using these values, what problems can be done easily and what only with difficulty, what role precision and exactness as contrasted to imprecision and approximation play in the culture, where comparison is used, what shapes and figures are in common sight and use in the society, and what mathematical games are played.

In the first place, time is measured in amounts which are not themselves units of duration, but instead units of quality. Thus the terms /kóraŋ/, 'year'; /γáloŋ/, 'month'; /lôku/, 'week'; and /γele/, 'day'; are all indicative of the character of the time, rather than the passage of a certain definite amount of time. The year is marked by the return of the season for burning cut bush. Each month has a certain quality of its own, as indicated by the names used. The week is the time leading up to a market day. And the day is the time of light, when the sun is up. This fact is indicated, for example, by these statements concerning the month: /ŋ̀áloŋ aâ tɔɔ/, 'the moon has stood up', which indicates that the month is beginning; and /ŋ̀áloŋ aâ líi ̀nyéei pôlu/, 'the moon has gone behind the hill', which indicates that the month is ending. It is significant that the month is not ap-

parently used in calculation, and the number of months in a given period is not given much thought. Likewise, the number of years which have passed is not known. Almost no one that we spoke to, for instance, could tell how old he was.

It is also possible to name certain portions of the day, although not in precise quantifiable terms. For instance, we can say /fólo káa à tuɔ/, 'day is over'. And in the morning we can say /gáa à ɣele-Ɓɔ/, 'it is morning'. But at no point would we indicate that a unit of time is ended. The parts of the day are qualities of time, not units of time.

Money is measured in amounts which are more quantitatively precise. However, the units which are used are almost exclusively borrowed from English, showing that probably the money concepts known in the culture before the foreigner arrived were less precise than those now used. The basic monetary units are /kâpa/, 'cent'; /fóŋ/, 'five cents'; /néi/, 'ten cents'; /ée-tĩ/, 'fifteen cents'; /sêleŋ/, 'twenty cents'; and /dâla/, 'dollar'. Some of them have an obvious origin, such as /kâpa/ and /dâla/, which are derived from the English words 'copper' and 'dollar'. The word /sêleŋ/ comes from the word 'shilling', which had a monetary value of twenty cents a number of years ago, at the time when Liberia used British currency. The term /ée-tĩ/ apparently comes from the English word 'eighteen' and refers to eighteen half-pennies, which would have been worth fifteen cents at the old rate of exchange. The origins of the words /fóŋ/ and /néi/ are not known.

Other measures are also borrowed from English, particularly the measures /pâi/, 'pint', and /pâu/, 'pound', which measure volume and weight respectively. The measure /kɔ̂pi/, 'cup', is also derived from English usage, and refers to a standard measure of volume, which in some cases is equivalent to /pâi/, but for other commodities refers to several different containers. Thus rice comes in measures of one