Learning to Apply Numbers to Nature

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LEARNING TO APPLY NUMBERS TO NATURE

A Comparison of English Speaking and Yoruba Speaking Children Learning to Quantify

ABSTRACT. Working within the framework of a Wittgensteinian view of number, I explore the learning of English speaking and Yoruba speaking children as they work towards meaningful use of number names. I find that English speaking children and Yoruba speaking children appropriate different types of concepts in their development towards number use. The concepts differ because the types of material objects that English speakers and Yoruba speakers talk of differ. It seems that monolingual Yoruba speaking village children might be slower in appropriating concepts associated with number use in Yoruba than their bilingual compatriots and monolingual English speaking children, and that the bilingual children's learning is enhanced by their bilingualism.

INTRODUCTION

An English speaking child learns to chant "one, two, three . . . ", and a Yoruba speaking child learns "*eni, èjì, ẹ̀ta.*" Gradually the songs of number names become meaningful tools for manipulating the material world. What are the meanings that these words take on as they cease to be a mere chant?

To gain insight into the conceptual basis of number usage is not easy. Adults have forgotten how they learned to quantify. Those who use numbers everyday are not given to analysing what it is they mean when they use number. People will talk about numerals and what it is to manipulate them, but not what it means to use number in talk about the material world. Quantification is a process of analogy, and people forget this. Generally they are not even able to recognise the intermediate steps in making the analogy between the things that are said to be in the world, and the series of numbers, let alone any presuppositions which may be inherent in the process. The group which is of most help to the curious person who wants to talk of what it means to use numbers, is children. During their learning of quantification, children often make mistakes, and these mistakes can be informative.

It has been common practice among those who wish to investigate children's thinking over the last thirty years to establish dialogues with children. Often discussion will centre around physical matter which is manipulated during the course of the discussion to pose a puzzle for the child. Explaining this puzzle gives the child the opportunity to display behaviour (verbal and non-verbal) from which mental mechanisms used in solving the puzzle (to the child's satisfaction) may be inferred. To determine the strengths and extent of a child's conceptual constructs several related puzzles may be

Educational Studies in Mathematics **18** (1987) 339–357.

presented, and the manner of their presentation will be determined to a certain extent by the child's responses to previous puzzles. It follows that no two children will receive exactly the same interview. There are two essential concerns when devising puzzles to present to children: the interviewer must have good cause to suppose that either successful, or unsuccessful, solution of the puzzle (in conventional terms) will provide insight into the thinking processes of the child. Secondly, the puzzle should fit the reality of the child. It should be seen as a legitimate puzzle from the child's point of view, as well as the adult's.

Picture a young English speaking child who watches as water is poured from one of an identical pair of tumblers. She has previously agreed that the tumblers contain similar amounts of water. The water is divided equally between two small tumblers, and the child asserts, "Now there's more water in that one [the remaining original tumbler] because it's very tall and these two are low." A Yoruba speaking child who watches a similar demonstration may assert "*Ó pò nínú èyìí torí pé méjì ni wọ́n sùgbón ọ̀kan èyìí.*" ("there is more water in these because this is two and this is one.") Both these children are making unreasonable judgements. They are each commenting on a feature of the water; the English speaking child mentions a dimension of space, and the Yoruba speaking child refers to the number of units in which the water manifests. But, neither child construes the feature as an enduring characteristic of the water. The English speaking child assumes that when the vertical space that the water occupies changes, then the total amount of water necessarily changes. The Yoruba speaking child assumes that when the number of units in which the water manifests changes, then too the total amount of water will change.[1]

THE CHILDREN

The first statement was made by Lucy, who was five at the time. She and other members of her family speak only English. They live in a small detached house in an inner suburb of the Australian city of Melbourne. Lucy's mother is a housewife, and her father is a factory worker. Lucy spends most of her non-school life in adult company, or watching television. The second statement was made by 'Dupe, a Yoruba speaker who was six years old at the time. 'Dupe lives in a village in Oyo State in Nigeria, and although she learns English at school, she rarely speaks it outside English lessons. Her parents are farmers, and she too spends many of her non-school hours working on the farm. She lives in an extended family[2] and passes most of her time in a 'children's society'.[3] Older sisters have tended 'Dupe's growing-up

as she has tended those who have come after her. Both Lucy and 'Dupe made unreasonable judgements about change in the amount of physical matter, because like many of their age-mates they had not yet accepted that in certain conditions, features which matter is said to have may be taken as enduring, even though perceptions of the material changes. Lucy and 'Dupe made as-it-seems-to-me-at-this-moment judgements because they had not accepted this convention.

Lucy and 'Dupe were two of two hundred and forty-four children I spoke with about the features of physical matter which they thought they could take as the basis for quantification judgements. Lucy, and sixty-two of her Australian school mates were interviewed in English, and 'Dupe and fifty-eight others in her school were interviewed in Yoruba. Sixty-two bilingual children attending a University campus school in Nigeria were interviewed in English, and sixty in Yoruba. For interviewing, our table was usually set up under a tree in the school grounds, and each of the children was individually invited to discuss five separate demonstrations where physical matter was manipulated so that its appearance changed yet the total amount of matter remained constant. Water, coca-cola and peanuts, or what Yoruba speaking children would call *omi*, coke and *èpà* were used in the demonstrations. The material was treated in an everyday manner, and puzzling questions relating to quantification were asked.

THE RESPONSES

The children's responses could be classified in several ways. One categorization was created around whether children ascribed permanence to the feature of physical matter they were taking as a basis for quantification judgements. By classifying each child's responses on this basis I could calculate what percentage of children in each age group ascribes permanence to the features of physical matter they talk of.

Monolingual Children

The Nigerian village children learned English at school, but their competence in English was low and English talk was confined almost entirely to English lessons. For the purpose of my study, I consider them as monolingual Yoruba speakers. The English speaking children came from homes in which English was the only language spoken. They were not learning a second language.

I have graphed the percentage of responses given by monolingual children

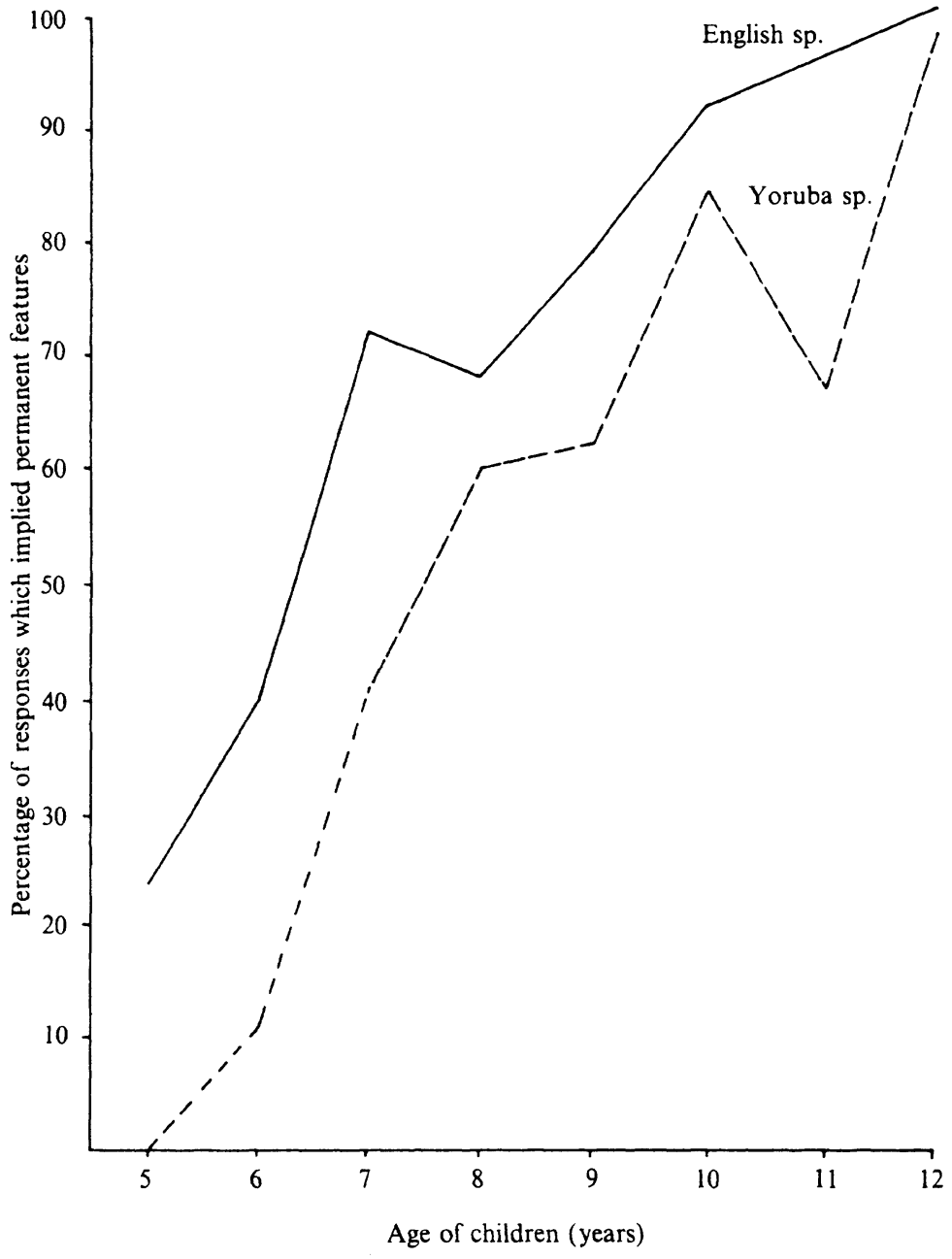

Fig. 1. The age related increase in the ascription of permanence to a feature of physical matter by monolingual English speaking and Yoruba speaking children.

which indicated they were talking of a feature of physical matter as enduring across space and time, against the age of the child making the response (Figure 1).

It can be seen from this graph that between the ages of five and 12 years, the percentage of both English speaking and Yoruba speaking children who ascribe permanence to a feature of physical matter increases, so that at

around 11 or 12 years of age nearly all children will talk of a feature of physical matter in this way. The group of Yoruba speaking children seems to be slower in coming to speak of a feature of physical matter as permanent, when compared to the English speaking group.

The groups differed too in the *type* of feature spoken of when the children's responses to questions indicated that they were making successful quantification judgements (that is ascribing permanence to a feature). The responses given by the children speaking English were of two distinct types, and the responses given by Yoruba speaking children constituted a third type of response. The three different types of response indicated three quite different features of physical matter which children talked of and said they used, for making quantification judgements about 'total amount of stuff'. By way of elaborating on the different types of features that the 'the stuff' of the world is said to have by the English speaking and Yoruba speaking children I will quote the children's responses. The features that the English speaking children talk of will be easy for us to comprehend. The nature of the features that Yoruba children talk of will be more difficult for us (as English speakers) to grasp, for English and Yoruba are fundamentally different in their semantics.

This is how English speaking Tony, aged nine years, accounted for his judgement that a large flat bowl and a small teacup contained the same amount of peanuts. "That must be the same as that [the peanuts in the bowl and the cup] because that came from there [pointing to one side of a simple beam balance] and that came from there [pointing to the other side], and they were the same before you put them into the cup and the bowl". Tony is regarding each separated manifestation of matter as an individuated thing. He is allocating the feature of 'thingness' to each separate 'piece of stuff' he sees before him.

Wendy (eleven years) knows too that you can solve the puzzle if you think of any 'collection of stuff' as a thing. But, she also knows that is often more useful to construct the feature of volume. Imagine Wendy watching as a small tin, which had formerly contained condensed milk, is filled with peanuts and emptied into a wide shallow bowl, and then filled a second time and emptied into a small glass teacup. I ask Wendy if the peanuts in the bowl and the cup look the same to her and if she thinks they are the same. She replies, "When I look at it one way they look the same, then when I look at it another way they don't look the same. That's when I think 'It's just a tin of nuts', But when I think of the space inside the bowl I can see that if I squash that [indicating with her hands the diameter of the surface of the peanuts in the bowl], it will make it higher and I can see that its the same as

in the cup." Wendy is attributing two different features to the collections of peanuts: the feature of thingness ('a tin of nuts') and the feature of volume. Wendy could even comment on the usefulness of 'thingness' and 'volume'. I was asking Wendy if she would think that the peanuts in the cup were equal in amount to the peanuts in the bowl, if she had not watched when I emptied the tin. She replied that "if you're thinking about the space that the peanuts fill up, you can try to imagine if they will look the same when the peanuts in the bowl are squashed up the same way as they are in the cup." In other words if Wendy is thinking of the volume that the peanuts take up she can mentally manipulate collections, because volume is continuous, and make reasoned informal judgements about 'total amount of stuff'.

The responses given by English speaking children who imputed permanence to the feature by which they could quantify, could be categorised into two types. Younger children mostly postulated a 'thingish' feature in manifestations of physical matter, but older children talked of a spatially defined feature, volume. These changes with age in the type of feature which English speaking children ascribe to matter and use as a basis for quantification, are shown in Figure 2. We see that the percentage of English speaking children's responses which indicated that they were 'seeing' the feature of 'thingness' in matter increases up until children are around nine. After this it decreases sharply. Reference to volume, which is easily recognised because of the spatial element inherent in the explanation, increases after children have attained nine years of age.

When Nigerian village children who ascribed permanence to a feature of matter they used as a basis for quantification, spoke of that feature, they never mentioned a spatially situated feature. Instead they indicated a process related feature involving the definition of some sort of unit. Here is what 'Bola (eleven years old) had to say. 'Bola watches as full tins of *èpà* (peanuts) are emptied into a plastic bowl and a cup. I ask if there are the same amounts of peanuts in the bowl and the cup ("*Ǹ ję́ iye hóró èpà kan nàà ló wà nínú kọ́ọ̀bù yìí àti koto yìí?*"). 'Bola laughs and replies "*Ọ̀kan wà níbí ọ̀kan wà lóhùn-ún*" ("There is one here and one there"). I ask 'Bola if she is quite sure that there is the same amount of peanuts in the two containers, she almost scoffs, "*Eyo kan ni ẹyọ kan, àfi tí a bá pín in sí méjì bę́ę́ ni mo ní wò ọ́okò pín in*" ("One is one unless you divide it into two, and I watched and you didn't divide it"). Then I ask her whether she would know they were the same if she had turned her back while I poured the peanuts out ("*Tó bá se pé o wo èhìn ní gbà tí mo ní da èpà nàà ni, ò bá mò pé iye kan nàà ló wà nínú kọ́ọ̀bù àti koto nàà?*"). "No, she said "you might have divided it and taken some away to sell to another person" ("*Rárá ó seése ki o ti pín in ki o si ti mú diè lo tà fún*

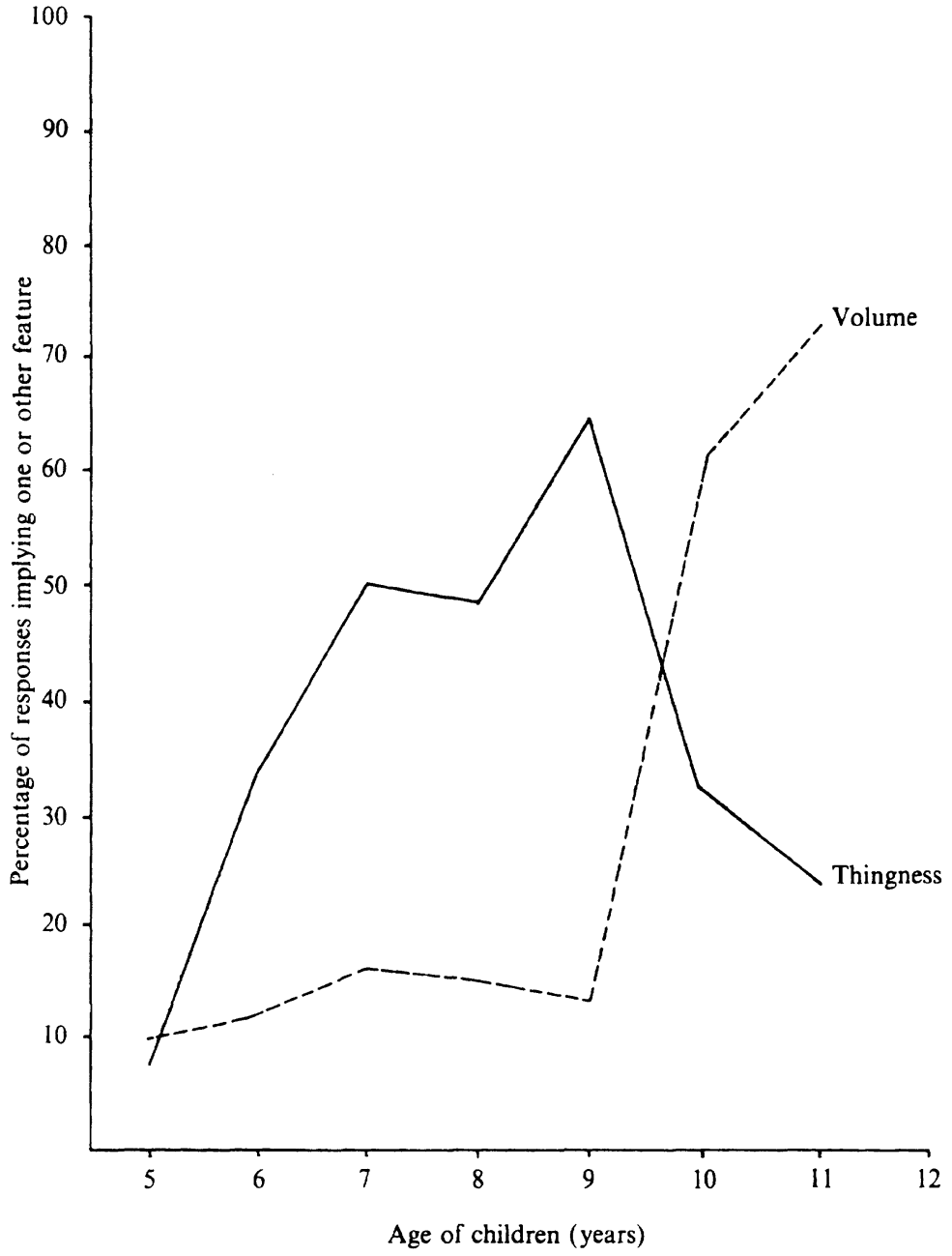

Fig. 2. The change, with increasing age, in the type of feature which monolingual English speaking children who impute permanence to features, use as a basis for quantification.

elòmíràn"). When I ask 'Bola if the peanuts in the bowl and the cup look the same amount, she replies that they look different "*Won kò dọ́gba*". When I repeat the question putting emphasis on "amount" ("*N jẹ́ ó dà bí eni pé iye kan náà ni wọ́n*"), 'Bola asserts that you cannot know whether it is the same amount by *looking*, "*Ó nira láti mò bóyá iye kan náà ni wón nípa wíwò*". I take 'Bola's meaning here to be something like "One must perform certain

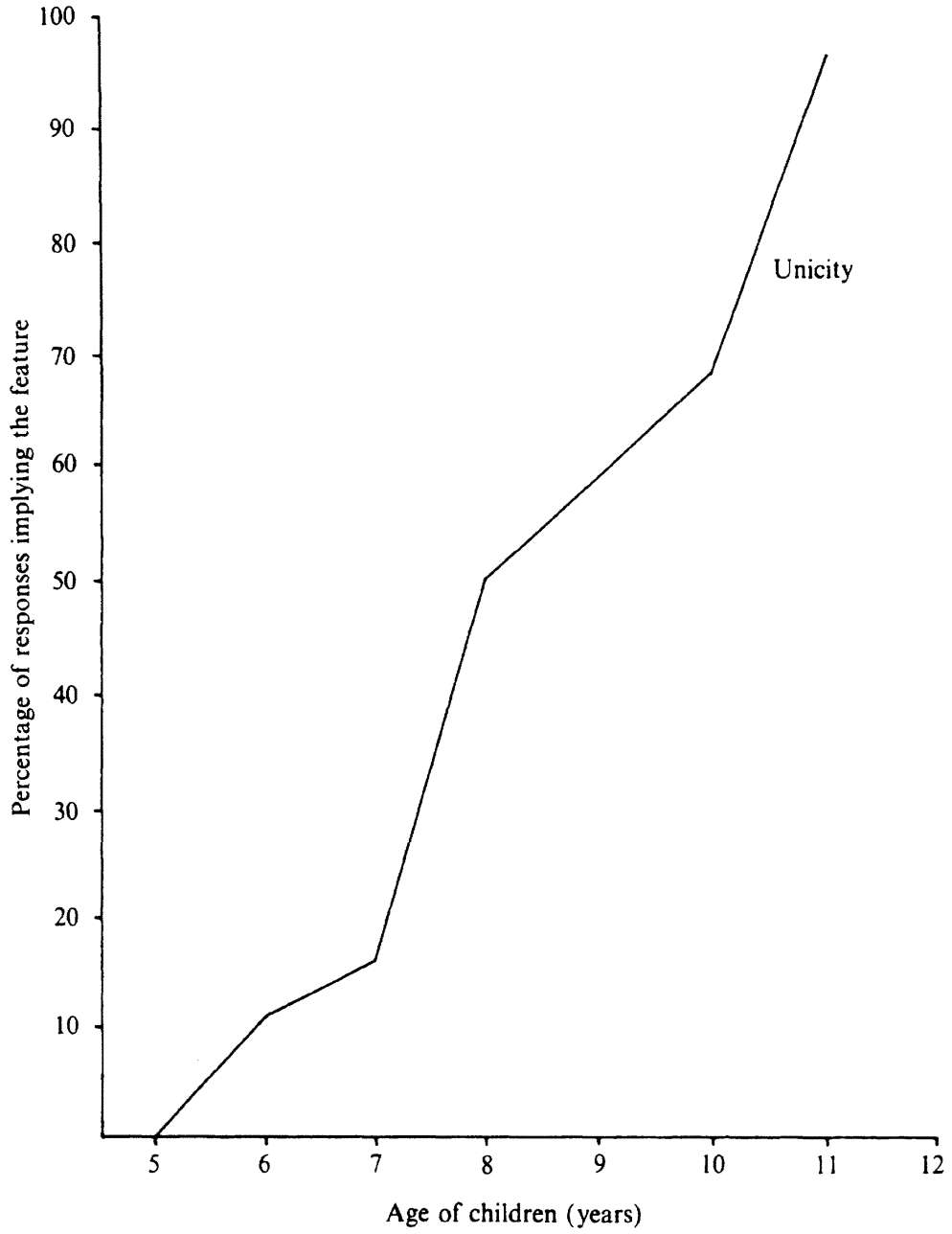

Fig. 3. The age related increase in the ascription of the feature of unicity, and its use as a basis for quantification, by monolingual Yoruba speaking children who impute permanence to features of physical matter.

actions in order to know amounts". It seems that for 'Bola a feature which may be called *ẹyọ* (*ìdí*), and which I have called 'unicity' in English is created in the process of quantification, in this case *won*, by Yoruba speakers. *Èpà* as such does not have this feature, but we may physically allocate this feature to collections of *èpà*.

The percentage of responses made by monolingual Yoruba speaking

children which indicated that they were 'seeing' a permanent, process related, 'unitary' feature, steadily increases as children grow older (see Figure 3). By the age of twelve all the children ascribed such a feature to the substance before them.

The responses of monolingual Yoruba speaking and English speaking children differed in two respects. Considering first the features of physical matter referred to, we see that young English speaking children put the status of 'a thing' on all manifestations of physical matter, regardless of whether it is enclosed by an enduring boundary (as English speakers normally expect 'a thing' to be). They then proceed to take this feature of thingness as an analogy for 'total amount of matter' in making quantification judgements. Later in their lives most English speaking children discard thingness as a guide to 'total amount of matter' and take up the notion of three dimensional spatial extension of matter (volume), as a new and possibly more utilitarian way of conceiving of 'total amount'. Monolingual Yoruba speaking do not follow this pattern of development. From the context of the quantification procedure, they appear to settle upon a 'unit of manifestation'. The number of these units then becomes an analogy for 'total amount'.

In using their concepts successfully, English speaking children must learn that sometimes the relation between 'thingness' and 'total amount of matter', and later, the relation between 'volume' and 'total amount of matter', remains constant, even though the 'look' of the matter may change. And, Yoruba speaking children must accept that once a unit has been allocated, the relation between that unit, and 'total amount of matter' remains constant. It seems that the group of Yoruba speaking children accept the constancy of the relationship between the feature of physical matter which they conceive of and 'total amount of matter', later than the group of English speaking children.

Bilingual Children

The bilingual children were attending a University campus school in Nigeria. All these children came from Yoruba speaking families, and Yoruba may be considered their first language. However these children were all English speakers before they began school. They had learned English from their parents as a second language. All lessons at their school were in English.

Considering now the responses of the bilingual (Yoruba/English) children: I classified their responses with the same criteria that I used for the monolingual children. Figure 4 shows the increase in the percentage of responses which implied ascription of permanence to a feature of physical

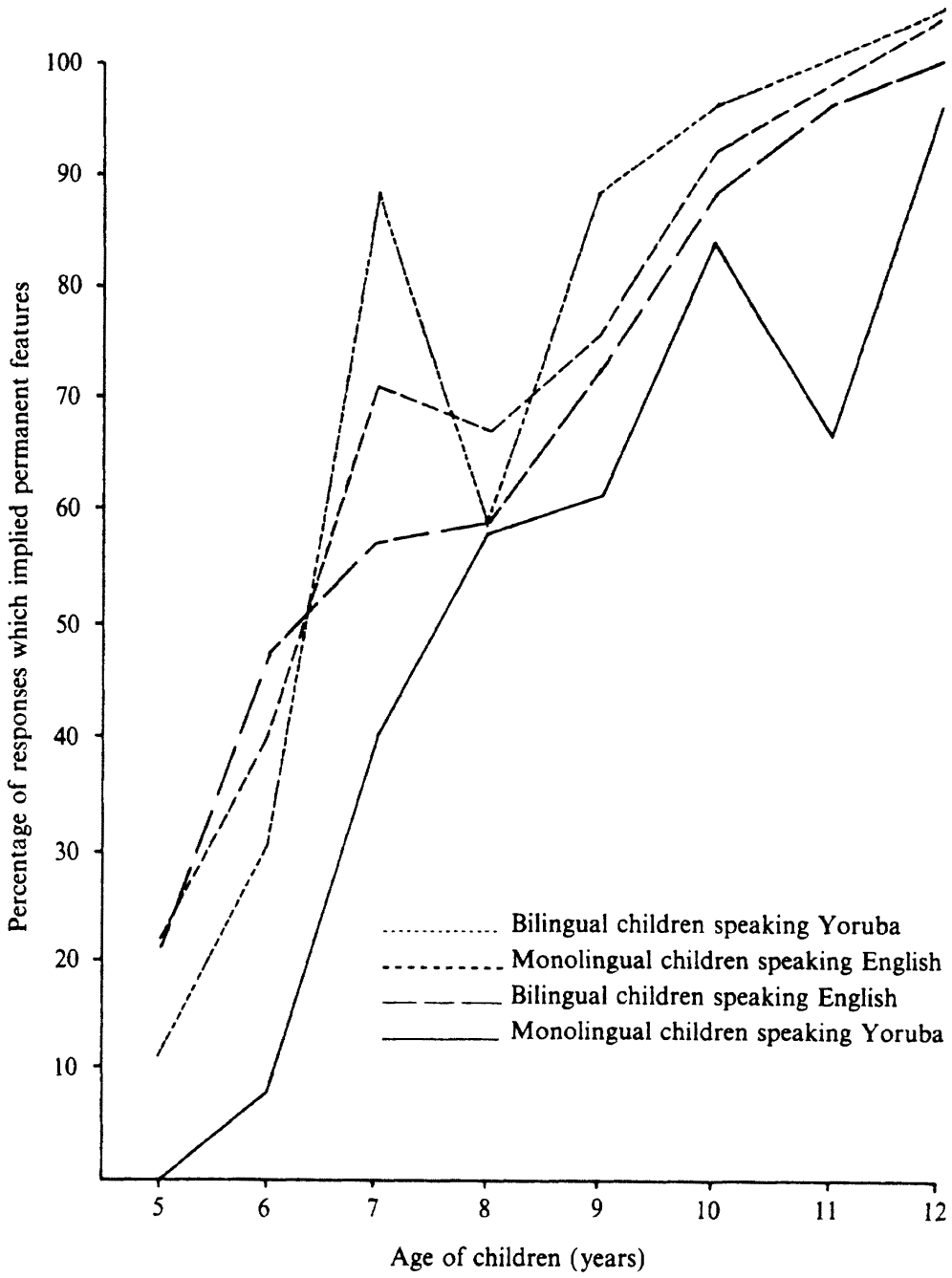

Fig. 4. The age related increase in the ascription of permanence to features which form the basis of quantification judgements by English speaking and Yoruba speaking children.

matter, with increasing age, of all four groups of children who took part in the study. The bilingual children showed a similar pattern of development towards ascribing permanence to a feature of physical matter as the monolingual English speaking children. This pattern was evident irrespective of whether they were speaking Yoruba or English. The monolingual Yoruba speaking children lag behind the other three groups of children in their ascription of permanence to features of physical matter.

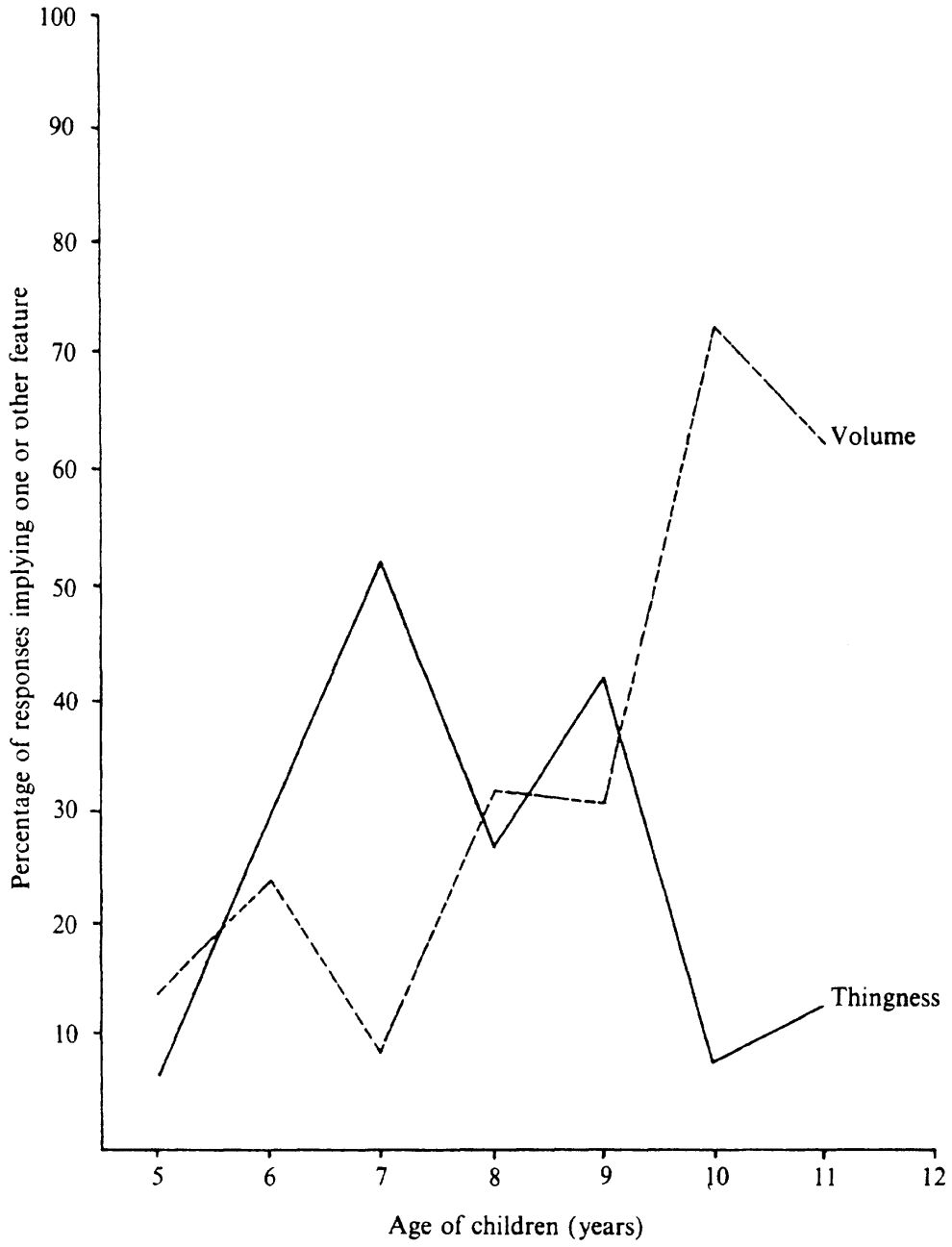

Fig. 5. The change, with increasing age, in the type of feature which bilingual children speaking English ascribe permanence to, and use as a basis for quantification.

If we turn our attention to the feature of physical matter which the bilingual children mentioned in their responses, we see that when speaking English these children spoke of similar features, and showed a similar pattern of change in the feature they spoke of, with increasing age, as monolingual English speaking children (Figure 5).

When speaking Yoruba, the bilingual children clearly speak of, and impute permanence to, a 'unitary' feature, just as monolingual children

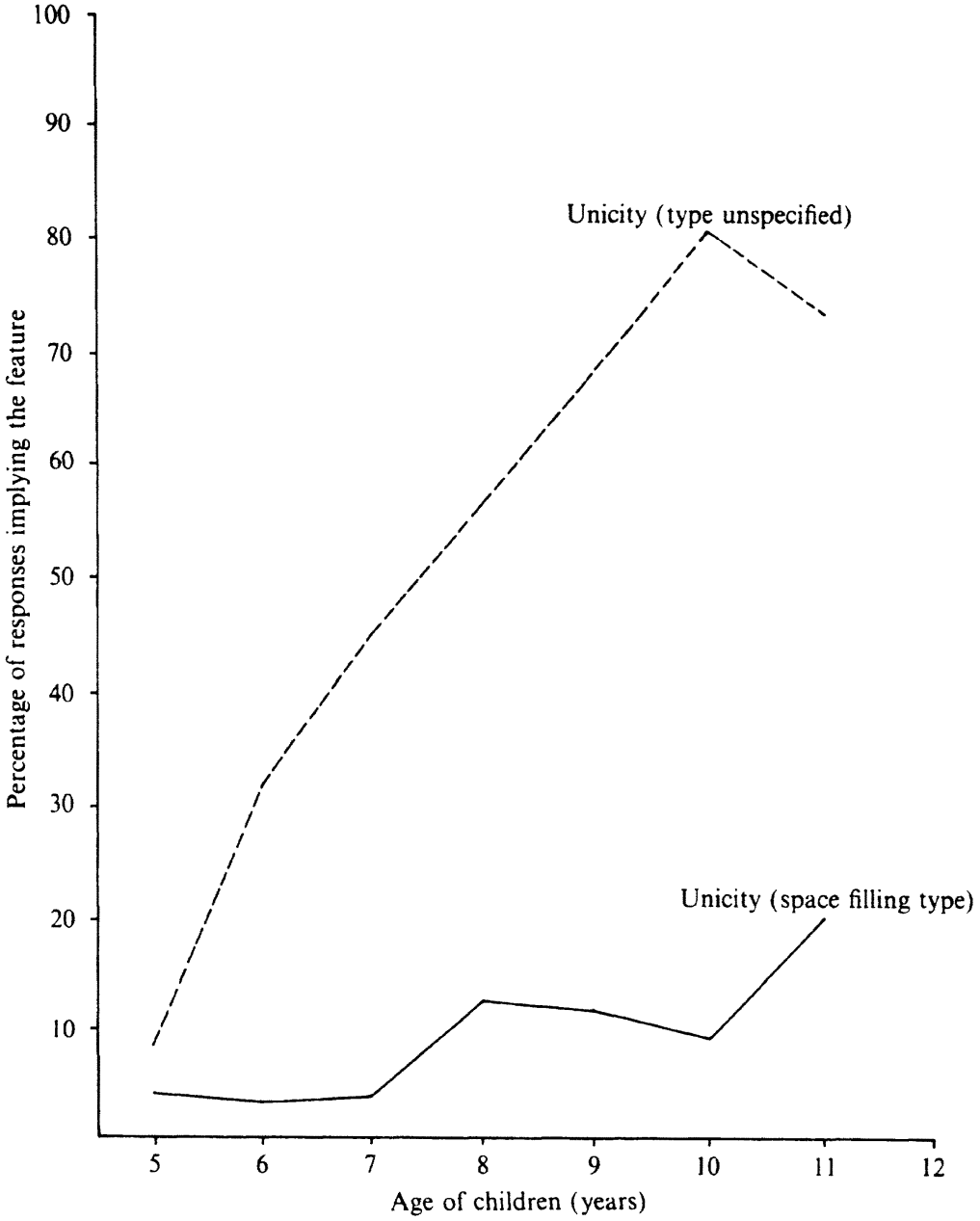

Fig. 6. The increase in the ascription of the feature of unicity and its use as a basis for quantification judgements by bilingual children speaking Yoruba. The proportion of children who indicated a 'spatially' defined unit is shown.

speaking Yoruba do (Figure 6). The bilingual children do not show the same 'slow' development towards conceiving of this feature and imputing permanence to it (compare Figure 4 and Figure 6). But, around 15% of bilingual children speaking Yoruba who make successful quantification judgements (that is, ascribe permanence to a feature), introduce the mention of spatial dimension into their response. Previously, spatial concepts had been

mentioned only by older English speakers, referring to the English language concept of volume, in justifying their judgements.

Here is Folake, aged nine, explaining in Yoruba why the coke in a bottle is the same amount as that contained in a plastic mug filled with the contents of a second bottle of coke. "*Ara kan nàà ní wọ́n tóri pé inú ìgò kékéré nàà ní won fi si, o si jé kí o jọ́ èyìí sùgbọ́n àpapọ̀ èyìí àti èyìí jẹ́ ọ̀kan nàà.*" (It is the same one, you put it in this small container and made it look different, but this [indicating the difference in width of the two containers] and this [indicating the difference in the two heights of the liquid] means it's the same one.) Folake is prepared to comment on the nature of her unitary feature, indicating that it is a unit of 'spacefillingness', but she still talks of it as "a one".

APPLYING NUMBER TO THE 'STUFF' IN THE WORLD

Talking of Things in the World in English and Yoruba

How does this account of children talking of their judgements concerning 'total amount of stuff' help us in understanding how English speaking children, and Yoruba speaking children, come to use the names of numbers meaningfully in their talk of the physical world?

> . . . There is a temptation to suggest that we get number by abstraction from the things. What we actually get by such means is the concept, and in this we discover number. Thus abstraction does genuinely precede the formation of a judgement of number.
>
> The concept has a power of collecting together far superior to the unifying power of synthetic apperception . . . numbers are assigned only to concepts under which are brought both the spatial and temporal, and the non-spatial and non-temporal.
>
> Frege, 1974, 61e

To understand how children come to use number meaningfully, we must first understand what 'the concept' is in English language talk and Yoruba language talk. When we understand the type of abstractions which underlie the children's talk, we will better understand the 'natural history' of learning to make these abstractions. We must ask about the origin of 'the concept'. Like Wittgenstein I assert that 'the concept' is linguistic in origin.

Number, according to Wittgenstein comes not from the world, but from our *talk* of the world. We talk of things as comprising the world, and we say they have features. Through these features that we say things have, we come to number. 'The concept' may be paraphrased as 'some feature of the basic unit we talk about as comprising the world'. It may seem a foolish question, but it is apposite to ask at this point whether English speakers and Yoruba speakers talk of the same type of 'basic unit' when they talk of the world, and come to ascribe features. This apparently foolish question can be answered.

The way to the answer is through considering *singular terms* and their use in discourse (see Quine, 1960).

In discourse, singular terms name the basic things which are taken as comprising the speakers' world. The types of particular things they name are the types of material objects that speakers of a language are committed to saying there are in the world. Identifying singular terms in discourse in different languages, and imputing their referents, is a task which is problematic yet possible (see Watson, 1985, and in preparation). Such a linguistic analysis has led me to a conclusion that some may find startling. It is that English speakers and Yoruba speakers usually talk of different types of things when they refer to the physical world. The types of objects which English speakers and Yoruba speakers say they quantify differ.

Using ideas of the inherent characteristics of matter, and ideas of space-time, speakers of both languages synthesise ideas of material objects to talk about. But, the types of objects they end up postulating are different. It seems that Yoruba speakers use these categorizations in a reverse order to English speakers. This reversal of the order of applying criteria through which the world is symbolically sliced up, results in different types of material objects to talk of.

English speakers talk primarily of spatiotemporal particulars. In a second level categorization, spatiotemporal particulars may be taken to exhibit various qualities to varying extents. English speakers talk of different sorts of spatiotemporal particulars, and name them accordingly. Yoruba speakers talk primarily of sortal particulars, physical matter grouped around sets of characteristics. The sortal particulars that Yoruba speakers talk of can manifest in various modes. In Yoruba language discourse, modes name abstract objects, and types of spatiotemporal manifestation that sortal particulars might exhibit. The differences in the types of material objects (and related abstract objects) talked of are important when it comes to comparing the ways that English speakers and Yoruba speakers quantify over matter.

I am now in a position to explain my use of the phrase 'features of physical matter'. I choose the word feature for its neutrality. An English speaker, who talks of spatiotemporal particulars may say that these particulars have qualities. A Yoruba speaker however talks of sortal particulars, and since these particulars have been defined by categorization around sets of characteristics, these objects cannot be said to have qualities, but they can be said to have modes. The 'thingness' and 'volume' referred to by English speaking children are qualities of spatiotemporal particulars. The 'unicity' referred to by Yoruba speaking children is a mode in which a sortal particular may manifest. A quality and a mode resemble each other in being

features that the material objects talked of are said to have, that is, in being abstract objects. Or, in Frege's language 'concepts'. In each case they are 'concepts' through which number comes to be applied to the physical world. But, 'thingness' and 'volume' are different types of abstract objects to 'unicity'. The 'concepts' through which number is applied to the world by Yoruba speakers differ from the 'concepts' through which number is applied to the world by English speakers.

Learning About 'Concepts' in Coming to English Language and Yoruba Language Quantification

The issue of permanence. The first categorization I made of the children's responses centred around the issue of the permanence of the extent, or degree, of a feature that a manifestation of physical matter may be said to have. Before they can make analogy between number and feature (that is, formally quantify), children must learn to construe the extent or degree of a feature that a particular manifestation of physical matter may be said to exhibit, as permanent through certain episodes of perceptual change. These episodes of perceptual change are of two types. Those incidents where the spatial situation (shape) of a manifestation changes while observation of the manifestation is (temporally) continuous, and those where the spatial distribution (shape) remains constant when observation has been (temporally) discontinuous. This learning is an extrapolation from the inductive generalization that most infants make concerning the permanence of bodies that they see and feel but do not yet talk of.

The commonsense idea that since there is what there is in the world, people will necessarily talk of the same types of things, is a seductive one. My conclusion that Yoruba speakers and English speakers talk of different types of objects when they talk of the world, defies this commonsense idea. On the other hand, *saying* that there are different types of things in the world does not necessarily imply that other aspects of people's behaviour towards the surrounding stuff of the world will differ. People will walk around, or sit upon chairs, and put their arms around people, irrespective of the types of things they might talk of. Children learn quite early on about 'bodies'. From their experience most babies appear to make an inductive generalization about the permanence of bodies. They come to behave as if they accept the convention that unless there is concomitant discontinuity in both the temproal and the spatial situation of a perception, that it is the same body they are dealing with. But, behaving as if separated bodies are permanent, and

talking as if the features that the things that are said to be in the world are said to have, are permanent, are different types of conventions.

Features are abstract objects, constructed through linguistic transformations. They are accepted as objects to talk of in strict analogy with the material objects talked of. In construing these abstract objects as permanent they must be construed as foreground against a background in exactly the same way that material bodies must be conceived of as foreground against background (time and space). In construing features as permanent, children must learn to trade off time and space in *talk of abstract objects*. They must transfer conventions about foregrounds when backgrounds change, from perceived foregrounds and backgrounds to abstract foregrounds and backgrounds in talk.

This transference is apparently made most easily with features associated with spatial separatedness in matter, like the features of 'thingness' and 'unicity'. For the ascription of permanence to these features occurs when children are still in the middle stages of learning to talk. Those features which centre around spatial extension and its continuity (like volume) are more difficult to isolate as foreground, and retain as such, when background changes. And ascription of permanence to these features occurs late in the child's learning to talk.

The features talked of by English speaking children. Young English speaking children I talked to made informal quantification judgements on the basis of assigning the status of 'a thing' to the manifestation they had before them. I have said that they allocated the feature of 'thingness'. On the basis of this feature many children made successful quantification judgements, by accepting that when there is continuous observation 'the thing' remains the same, even though its shape changes. 'Thingness' is actually a degree of 'numerousness'. 'Things' (usually, though not necessarily, entities enclosed by enduring boundaries) can be taken as analogous to the integers of number, and the manifestation quantified by counting, even if it is a 'one'. For quantifying continuous matter like that I used in my demonstrations, a feature which is a continuum is usually considered more appropriate; either volume or weight. But, it was only the older English speaking children who construed a continuous feature in the spatial extension of the matter before them and spoke of volume. (None of the children chose to talk of weight, although in one case I utilized a beam balance in setting the puzzle for children.) Around 20% of the eleven year old English speaking children that I spoke with did not construct a continuous feature in what English speakers normally call 'continuous material' they clung to putting the status of 'a thing' on the

manifestation before them. This is quite appropriate for informal quantification of continuous material although it is inappropriate for formal quantification.

The feature talked of by Yoruba speaking children. In any quantification context, Yoruba speakers appear to settle upon 'a unit', this unit may be an aggregated unit *ẹyọ* (*ìdì*) (for example, a tin of peanuts); or an integrated unit *ẹyọ* (*ohun*) (for example, a single peanut). On the basis of this unit a 'degree of dividedness' is allocated as a mode in which the sortal particular is manifesting in the here and now (or then and there). Through analogy to the number series, this degree of dividedness is reported as a numeral.

In coming to talk of the features that the material objects talked of may be said to have, Yoruba speaking children extrapolate from perceiving bodies separated in space, and generalizing about their permanence. Yoruba speaking children come to talk of degree of dividedness as a mode; a feature of matter, to which the same conventions about permanence apply. The situation that I presented to children called on them to identify a 'one unit' (*ẹyọ kan*) mode and use this as the basis for their informal quantification judgements. Both monolingual and bilingual children speaking Yoruba showed an increasing ability to identify and use this 'concept' as they grew older.

The slow 'conceptual' development of the monolingual Yoruba speakers. The Nigerian village children, monolingual Yoruba speakers, lagged behind their bilingual compatriots, and monolingual English speaking Australian children, in coming to appropriate construction of "the conceptual" basis of quantification. Since bilingual children speaking Yoruba showed, if anything, an accelerated development in this regard, we cannot put the slow development down to the nature of the Yoruba language.

Explanation is more likely to be found in the circumstances of the children's lives. Village children's exposure to socially interpreted experiences of quantification is low compared to the other three groups of children (urban dwellers), for whom quantification is a commonplace social activity.

Cross-language conceptual transfer by bilingual children. In talking of the unit which could form the basis of the abstract feature through which quantification becomes possible in Yoruba language talk, around 15% of bilingual children talking Yoruba, introduced mention of spatial dimensions, although *ẹyọ* (*ìdì*) implicitly has no qualitative taint. It is purely a process defined unit. If one talks about these process created units in English of

course one may allocate them a qualitative existence, they may be space-filling (have volume), or pressure exerting (have weight).

In talking in Yoruba of units as space-filling, it seems that bilingual children are transferring insight important in the conceptual system of English language quantification, to inform their understanding in using the Yoruba language system. None of the monolingual Yoruba speaking children showed this characteristic, they were enclosed within the confines of one conceptual system, as all monolinguals are. This transference characteristic of bilingual children seemed to be associated with a general developmental enhancement. Bilingual children speaking their first language, Yoruba, appear to learn to make successful quantification judgements earlier than the three other groups of children (see Figure 4). We must remember, however, that the bilingual children were a special group. They were, for the most part, the sons and daughters of Nigerian academics. The monolingual children were selected from the general school population. Nevertheless it seems likely that bilingualism, as such, enhances children's development in learning 'the concepts' of quantification in one or both their languages.

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NOTES

[1] The format of the puzzles was that of the common Piagetian 'conservation' tasks, but the theoretical framework of the study is not Piagetian. I do not share the view of number which underlies Piaget's work. I take a Wittgensteinian approach to number and assert that it is not necessary to postulate numbers as extra-linguistic objects. Numbers are not entities beyond what is written down or said. Numbers provide a linguistic machinery for making detailed and precise observations and descriptions. They arise in linguistic transformations.

[2] An extended family may consist of three generations living in the same compound, typically these may be a man and his wives and children, together with members of his parents' generation.

[3] Children of a compound tend to constitute a society which in many ways keeps its affairs separate from adult society. The older children fulfil the roles of care-givers and teachers for the younger ones.

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