THE PERCEPTUAL BASIS OF THE UNDERSTANDING OF SOME SPATIAL ADJECTIVES IN PRIMARY SCHOOL CHILDREN.

by

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SUMMARY.

To comprehend words adult listeners use a series of psychological processes, which children learn to apply as their cognitive structures develop.

Children acquire full comprehension of spatial adjectives by mapping the words onto the a priori knowledge they already have about space. The order of acquisition is determined by the perceptual salience of certain features in spatial concepts, and is mediated by language. The salient features are, for humans, the primary and secondary reference points, the vertical plane, and the upward and forward directions. The secondary reference point is an implicit standard against which the comparative measurements implied by spatial adjectives are made. To assess comprehension of the secondary reference system the comparative forms of spatial adjectives are tested.

Previous work suggested that comprehension of the system has not been acquired by children aged 8,0 years. The first hypothesis of this study states that comparative forms of spatial adjectives are acquired by children between seven and ten years of age.

Linguistic theorists have proposed that unmarked, or positive terms are acquired before their marked, or negative counterparts. The second hypothesis of this study states that because of the perceptual salience of the upward and forward directions, unmarked spatial adjectives are acquired before marked spatial adjectives.

Some spatial adjectives e.g. tall, refer to the most extended dimension of their referents, or apply only to measurement along the vertical plane. The third hypothesis of this study states that these one dimensional spatial adjectives are acquired before those e.g. wide, which refer to a less extended, or non-vertical dimension.

The three hypotheses were tested using a sample of 210 children. The results support the hypotheses, and indicate that children's difficulties in acquiring comprehension of spatial adjectives occur as their increasing knowledge of linguistic constraints is applied to developing cognitive structures.

Such conclusions suggest that teachers ought to take account of linguistic and perceptual factors when using spatial adjectives to teach the concept of relations, which underlies the child's ability to understand and perform important mathematical processes.

KEY WORDS. Language acquisition, comprehension, spatial adjectives.

C O N T E N T S.

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LIST OF FIGURES.

LIST OF TABLES.

INTRODUCTION.

Any parent can quote as anecdotes peculiarities of language which they have heard from their own children. For example "His piece of cake is higher than mine" - from a boy of five, and "His toffee is more longer than mine" - from an indignant girl of seven. The first statement is grammatically correct, but clearly the adult meaning of "higher" referring to the vertical dimension has been misappropriated and used instead of "thicker." The error is in the semantics, or meaning of the words. The second comment leads one to assume that the child knows what she wants to say, but her command of the syntax of language is not well enough developed to enable her to express her feelings in a grammatically acceptable adult form.

For parents the occurrence of speech, along with walking, is one of the most exciting developments in the early life of their child. They wait anxiously for the appearance of the first words, yet subsequently take for granted the enormous amount of language learning that occurs in the next few years. One factor in this learning is imitation - but the sentences quoted above had not been heard by the children. To form them the youngsters had extracted rules from language and then applied them to their own utterances. Children may thus have certain innate capabilities which pattern incoming language, much of which will be spoken by their parents.

Although it seems that parents, by expanding, rephrasing and correcting a child's language (Ferguson and Snow, 1977,

de Villiers and de Villiers 1978), use teaching strategies which are effective in certain contexts, the pattern of acquisition is particularly affected by the level of the child's intellectual development. Children thus arrive at adult competence by individual routes which may relate to the way they organize their knowledge, (de Villers and de Villiers 1978), (Bloom, Hood and Lighthouse 1974). Parents correcting inappropriate use of language may think that there is no need to do so after the conclusion of the infant school years, but the more complex forms of some terms may not be fully comprehended until after the age of eight (Chomsky C. 1969, Ehri 1976). The origin of these comprehensional difficulties encountered by older children may be found in the meaning, or semantics of the words, in the syntactic or grammatical constraints which rule their correct use in sentences, or in the level of cognitive development of the child.

The meaning of some words may be disguised by the nature of the words themselves, which allows apparently correct usage when the child does not in fact have full comprehension. Questioning may reveal dilemmas of language which contribute to misunderstandings and are confusing to children. One such dilemma occurs with spatial adjectives, for example, "large" and "small". The child may see these words as independent antonyms, a fact which throws into relief a problem of which Plato was aware. If they are independent opposites, one may be committed to attributing two opposite qualities to the same thing, for a "small" building can also be a "large" house. The terms then, cannot be independent opposites but are

lexical devices for grading "less than" and "more than" within a common dimension (Lyons J. 1968). Other spatial adjectives also have implicit assumptions in their structure which cause difficulties in comprehension.

Piaget characterised cognitive development as occurring in stages, with children between the ages of seven and eight years passing from the perceptually dominated pre-operational stage to the stage of concrete operations, and becoming capable of understanding relations between objects of different classes, and objects within the same class. (Williams and Shuard 1976). The attainment of the concept of relationships is of fundamental importance to the mathematical processes of ordering, sorting, seriation and measurement. The words which refer to this concept are spatial adjectives.

The teaching of appropriate language has a role to play in assisting cognitive development, and in the attainment of full understanding (Herriot 1970). Nevertheless, the teaching of language per se is probably not essential to the understanding of the underlying concepts, although a theory of Benjamin Whorf (1956) suggested that such was the case. He claimed that language determined the way people organise the world about them. "We dissect nature along lines laid down by our native language". (p. 213-214). From this it would follow that our mode of categorising could not be determined primarily by what is perceived, but by the linguistic system which the listener uses to organise the incoming perceptions. Each person would be subject to an absolute, implicit agreement which would hold throughout the speech community.

In general, however, it is accepted that cognitive development leads language development, and that children cannot use a linguistic form appropriately until they understand the underlying concept (Sachs 1976). Initially language can only reflect knowledge, although subsequently it will help to shape that knowledge and hence has a role to play in guiding the child's discovery of meaning. Thus a teacher must endeavour to convey the particular implications of word meaning and not pass on a simplistic assumption that a word is only a label.

The order in which words are used, and their order of acquisition, may have something to teach us about the organisation of the human mind, and the process by which its initial organisation occurs. In turn this may have implications for teachers in schools. The language user follows specific conventions of language, one of which, for instance, dictates the use of adjectives. We say "a high, red, brick wall" not "a red, high, brick wall." We say "a, big, black, sheep", not "a black, big, sheep" (Crystal 1971) (p.130.131). A child learns to order his adjectives correctly, and he attains understanding of spatial adjectives in a certain order. "Big" and "small" appear first, and are the most general of the adjectives. Initially a child will judge the size of an object by comparing it with familiar objects, or with his own body (de Villiers and de Villiers 1978). Other spatial adjectives are acquired later, but in a predictable order (Donaldson and Wales 1970), and are subsequently used as a hierarchy. For instance, a table is "six feet long, and two feet wide" - not "two feet wide, and six

feet long". A pole is not "thin and tall", but "tall and thin", (Lyons 1977). Grammatical forms of these adjectives, for instance, the comparative and negative comparative forms, may also be acquired in a predictable order.

These factors of meaning acquisition and use of spatial adjectives, have been seen theoretically (Clark 1973, Miller and Johnson-Laird 1976) as having origins in the earliest perceptions of the child, for humans have the capacity to organise and categorise perceptual information (Bruner 1973). This leads to universal ways in which words are used to refer to spatial relationships.

It is possible that the difficulties which children have in attaining full comprehension of spatial adjectives lie in the process of matching their developing knowledge of linguistic constraints with the underlying perceptual features of spatial terms. If some of the words and grammatical forms of the words have varying complexity due to differences in the underlying perceptual features, then they will be acquired after the words and forms of the words which have less complex underlying features (Brown and Hanlon 1970). Consequently one would expect the less complex words and grammatical terms to be taught before their more complex counterparts. Some teachers confine such words as big, little, large, small, wide, narrow, deep, shallow, larger, shorter, etc., to the catalogue of "mathematical language", and are well aware of the importance to mathematics of the concepts which they represent. If the significance of relationships is not understood, the study of measurement has little chance of success,(Bryant 1974).

The Fletcher Scheme (1970), widely used in schools, begins at Level 1 Book 1 with work on sets, related to colour, shape and size. Reception children are asked to draw squares, circles and triangles based upon the adjectives large, small, tall and short. In Level 1 Book 3 there is a whole section labelled "Pre-Measurement Relations." The adjectives which the children are required to use include those from Book 1, plus high and long, but in their comparative form, e.g. longer and higher. Negative comparatives are not mentioned in these early books. For practice in the application of large, the child has to compare two objects and choose the larger. Next he must draw a larger object than the one shown. In one of the work books looked at by the author of this study one child had, for example, drawn an ambulance as being larger than a glass tumbler. Another child had drawn a container lorry, as being larger than a car. These children clearly understood the concept larger. The objects for comparison in response to the stimulus taller, are pieces of furniture. However, objects drawn as taller than yourself included a tractor, and objects represented as not taller than yourself, included mice, hamsters and pigs, creatures which would not normally be associated with the word tall.

The scheme clearly denotes the difference between the words high and tall. Using aeroplanes in the sky to identify higher, it goes on to point out pictorally that a child who is taller than her companion, may not be higher when they stand on the bottom and top steps respectively of a dais.

The language adviser for the New Nuffield Maths Scheme, Mrs. P.R. Burke, noted in an unpublished lecture (1977) that there was a certain language list which she felt should be taught to children as an integral part of their early mathematical experiences. The full list included big, small, long, short, high, low, tall, wide and narrow, in that order and in their comparative forms.

The Worcestershire Mathematics Progress Guide (Worcestershire Education Committee 1974) having a syllabus "based on the findings of Piaget" (p.1), includes sorting exercises for seven year olds, using such criteria as thick, thin, large, small, etc. Similarly, children of the same age working through the Schofield and Sims Alpha and Beta Scheme (1970) are expected, in the Mathematics Record Card, to have competence in the language of length, width and height, although even the initial book "Ready for Alpha and Beta" has only one specific exercise which employs these terms.

The Primary Mathematics Scheme (S.P.M.G. 1979) includes work on spatial adjectives in the Stage 1 work book. The comparative forms of the words are used in the order - longer, shorter, taller, higher, lower, thicker, thinner, wider, narrower and broader. The exercises on these words immediately precede exercises on measuring, using first arbitrary standards, and then metres and centimetres. The exercises take the form of comparisons between pictures of objects - rulers, nails and pencils for example using the words longer and shorter; men, trees, cylindrical containers and satchels, using taller and shorter; snakes, books and boxes using thicker and thinner; strips of paper, people, roads and

trees using wider, broader and narrower. These examples, which include antonyms clearly differentiate between tall and short. However, it may be rather confusing to the child to find the words taller and shorter referring to cylindrical containers, broader referring to people, wider referring to trees, and thinner referring to boxes. Neither negative comparatives, nor the words deeper and shallower, are used in the S.P.M.G. books.

Our First School Maths (Edwards, Newton and Smith 1975) introduces the words long - short, tall - short, wide - narrow, high - low, and thick - thin in Book 1 of the series, and the comparative forms in Book 2. Negative comparatives are not included in the series.

It is clear from this examination of commonly used mathematics schemes that spatial adjectives are not introduced in a consistent order, that antonyms are not always included, that negative comparative forms are rarely present, and that some schemes omit some spatial adjectives entirely. There is no mention in any of the Teachers Books which accompany the above schemes, of any account being taken of perceptual factors which might underlie the choice, or order of introduction, of the spatial adjectives in the schemes. The Piagetian concepts of staged development, and active participation in the learning process, are accounted for, but the School's Council Bulletin No. 1 (1965) "Mathematics in Primary Schools", emphasised that teachers need to take account of the child's ability to understand the concepts behind comparative adjectives, because the study of measurement, which is dependent upon that ability, is an integral part of junior

school mathematics. Indeed the Report of H.M. Inspectorate (1978) found that ninety per cent of all classes of junior school children studied measurement.

If the full implications of size relationships are to be understood and applied to the teaching of measurement, a careful analysis of the perceptual and linguistic bases of spatial adjectives is required. It is to this task that this study is addressed, in the hope that some tentative conclusions may be drawn which will contribute to the teaching of children throughout the primary school.

REVIEW OF THE LITERATURE.

This is a study of how primary school children acquire full comprehension of those spatial adjectives which are of particular relevance to the mathematical skill of measuring. Spatial adjectives refer to the dimensional relationships which exist between objects. As children learn to understand such relationships they learn to use and understand the appropriate syntactic forms of the words.

The ability to use and understand language is a skill which virtually every child acquires. Initial babbling sounds develop over a period of years until the attainment of a level of language which may be characterised as possessing a definite "rule" system of grammar. Lenneberg (1966) showed that of his sample of five hundred children, ninety per cent could, by thirty-nine months, be said to have developed their language skills. But although the child's responses to words, phrases and sentences make it appear that he comprehends in adult fashion, sophisticated adult comprehension may well be lacking (Crystal 1971). The understanding of certain linguistic forms may not, in fact, occur until well into the primary years. Chomsky C. (1969) found that sentence forms such as "The doll is easy to see" and "Donald promises Bozo to hop up and down", which go counter to general expectations, are not completely understood before ten years of age. She argued that the semantic information was available, but that the ability to handle a complex syntactic structure was not developed. Clark E. (1973) suggested, however, that the complete meaning of the sentences had not been acquired by the subjects and that the errors being made were semantic in origin. It may, indeed, not be possible

to identify an age by which the full semantic system of a language is acquired, (Herriot 1970).

A theory of language acquisition must attempt an explanation of how children learn to understand, as an adult does, verbal communication in which semantic and syntactic elements interact, and to which speaker and listener bring mutual expectancies and knowledge of contexual information. Language users implicitly conform to a system of rules which were seen by Noam Chomsky (Lyons 1970) as a complete grammatical description of the language, and capable of generating all possible sentences within a language. These grammatical rules encompass the phonological, syntactic and semantic aspects of the language.

The phonological aspect concerns the sounds of a language and their structure. The syntax concerns the way in which words can be combined to give the surface structure of sentences. Semantics is concerned with the deep structure or underlying representation of the meaning of the sentence which is stored in memory.

Provided the listener knows the rules to which the language speaker conforms, comprehension of a language will in part entail a comparison between what is already known and what is heard (Miller and Johnson-Laird 1976). Therefore, it is necessary to investigate how meaning is actually stored in the listener's memory. Chomsky proposed that the underlying meaning of sentences is represented in the deep structure and includes reference both to transformational rules, such as passives and negatives, and to the grammatical constructions

such as verb, object, subject, predicate, modifier and head of the kernal string. Transformations are applied to deep structure in order to generate a surface structure which correctly represents the underlying meaning. This theory allows sentences of different syntactic construction to have the same underlying meaning - as in "Lynn hit the ball" and "The ball was hit by Lynn." Experiments by Savin and Perchonock (1965) supported the view that transformational information is stored with the kernel strings. They found that different types of sentences take up varying amounts of space in the memory, depending upon how many transformational instructions had to be stored with the deep structure strings. The amount of extra storage space available was calculated by recording the amount of unrelated words which subjects could recall after they had recalled a target sentence. Nevertheless, although transformations may be stored in short-term memory, Anderson (1974) found that subjects being read a story could recall verbatim passages immediately after their use, but when two minutes was allowed to elapse before testing, only the meaning of the passages was remembered. Experiments by Jarvella (1971) indicated that memory for the actual wording of a sentence begins to fade as soon as the complete sentence has been heard. Sachs (1967), using an experiment in which subjects had to judge whether a sentence inserted into a passage had been seen before, found that although the meaning of sentences was remembered over considerable periods, syntactic structure was lost after about twelve seconds. Thus it would seem that storage of sentence meaning does not involve the storage of syntactic structure in long term memory.

Transformational information may, however, have a function, in comprehension. For instance, in the sentence "The ball was hit by the boy", the object of the sentence is brought to the beginning of the sentence, and hence, emphasised. The surface structure can thus be used to make a particular emphasis which the speaker may wish to communicate (Greene 1975).

Kintsch (1972) suggested that sentences can be divided into units of meaning which are stored in long term memory. A sentence expresses propositions which represent the underlying meaning of the sentence, and consist of verbal units and nouns. Thus the sentence "Ben is in the city" expresses a proposition that has two nouns, "Ben" and "city" and the verbal unit "is in". If meaning is represented in memory as propositions, then the time taken to read and understand a sentence ought to be a function of the number of propositions in the sentence. Kintsch and Keegan (1973) found that when subjects were asked to read sentences, the length of time required for the task varied in direct relationship to the number of propositions in the sentences.

Fillmore (1971a) analysed propositions into six types of case relationships which express the semantic role of the noun, in relation to the verb. He called these Agentive, Instrumental, Experiencer, Goal, Locative and Objective Cases. They represent the meaning relationships which reflect the ways humans see, and act upon the world. Thus in the sentence "Anna-Jane hit the ball", "Anna-Jane" is the agent of the action expressed by the verb "hit" and "ball" is the experiencer. The same fundamental meaning relationship of

the underlying proposition is evident, even when the syntax of the surface structure is different, e.g. "The ball was hit by Anna-Jane."

Although the previous discussion about what is stored in the listener's long term memory has been concerned with the underlying meaning of sentences, this is a study of the comprehension of words. Propositions which represent the underlying meaning of a sentence are formally identical to propositions which represent the underlying meaning of words (Clark H. and Clark E. 1977). Elementary theories of meaning, that a word means what it refers to, or means the image that it evokes, are not satisfactory because they do not account for synonyms. The first implies that when different words refer to the same object they will be synonymous, the second that words which produce the same image will likewise be synonyms. Clearly neither is the case. Nor do these theories satisfactorily account for the so called "function" words of language such as "because, "if", "not", etc. In addition they fail to allow separately for sense and reference, i.e. the difference between knowing a word and knowing what the word applies to in the reality of the world.

Clark E. and Clark H. (1977) refer to sense and reference as the "dictionary" and "encyclopedia" aspects of "knowing" a word. The "encyclopedia" contains general information about the set of things the word applies to in the world, for instance, appearance, origins, history etc. The "dictionary" contains information in three subsets, pronunciation, syntactic category, and meaning.

Long-term memory may be thought of as having a lexical entry for every word of which an individual knows the meaning. The entry may contain all the information that is known about an item, or simply a list of attributes by which the word is conceptually related to other words in the lexicon. These relationships, which indicate the way in which the language user categorises words, may be analysed to identify semantic features which have the same implicit verb-noun relationship as the propositions which represent the underlying units of meaning of sentences. Thus, in the sentence "Tom is a boy" the noun "boy" can be analysed into the features male, non-adult, human. These do not appear to have the same properties of nominal and verbal relationship present in a proposition which expresses the underlying meaning of a sentence, but they are properties of being - a boy is male, is human, and is not adult. Hence the components have an identical form to the propositions underlying a sentence (Clark H. 1977). In order to make an analysis of a word the investigator selects intuitively a semantic field of words that seem related, then makes analogies between words within the field, and finally identifies the semantic features. These features enable words to be categorised in the mental lexicon.

One feature which often occurs in the sense of words is a positive - negative contrast. It is sometimes indicated by the use of a prefix e.g. kind - unkind, but is likely to be present but invisible, for instance, in dimensional adjectives such as long - short and deep - shallow. Adjectives which have this feature are referred to as unmarked or marked,

Such adjectives, which are antonyms, are often assymetrical in their relationships (Bierwisch 1967, Greenberg 1966), for the positive member of the pair, e.g. long can be used contrastively or it can be neutralised, i.e. used in a nominal sense. The question "how long is it?" is merely asking about length and does not imply that the object referred to is excessively long. The question "how short?" however, implies that the object is shorter than one would normally expect. The positive, or unmarked member of the pair doubles as the scale name e.g. long - length, deep - depth. The marked word is always used contrastively.

Katz and Fodor (1963) proposed that the categories to which words belong are arranged as a hierarchy of sub-categories. The grammatical form is the super-ordinate category with each word then being marked by features which it has in common with other words, and distinguished from other words by its own individual features. An analysis of the word spinster, yields the basic features noun, human, adult, female, never married, where never married, is the distinguisher, and human, adult and female are the markers.

A semantic feature analysis of this type, however, makes possible a decomposition of words into an enormous number of features, for there is no clear distinction between markers and distinguishers. Human memory, which has a limited capacity, would not be able to store so many features (Herriot 1970).

Formal linguistic theories of semantic analysis tend to be too abstract for those seeking the psychological implications of semantic theory. Componential analyses of more relevance to the psychologist can be devised with the purpose of seeking universals which stem from basic human experience (Deese 1976). These analyses are based on objective assessments by groups of

subjects about what constitutes a semantic field, and have been termed "the quantificational approach" (Clark H. and Clark E. 1977). This theory characterises word meaning as having components. As the meaning of two words coincide by greater or lesser amounts, so they will have more, or less, common components.

Componential analyses cannot be applied, however, to all words. Wittgenstein (1953) suggested that some words, e.g. games, have no common properties, but only a "family resemblance", and therefore they will resist analysis. Where analysis is possible, it cannot bring out the nuances of the language, e.g. "girls" when used to mean older women.

No decomposition of words into components, whether subjective or objective in origin, can claim to be a "true" or even unique analysis which is representative of the psychological state of the language user. Different analyses of the same word may be equally valid.

In addition, it has become clear that whilst componential analyses of some groups of words, e.g. colour terms and kinship terms, give semantic components which seem intuitively to be similar in meaning, other groups of words, such as those referring to personal identification, and to spatial dimensions, either yield components which cut across other semantic fields, or, since they do not have a fixed value on a scale of relationships, cannot yield any formal components at all.

Thus "a red" may be identified as a member of the communist party, and "a blue" as an Oxbridge man (Miller and Johnson-Laird 1977). The language of personal identification

has cut across the semantic field associated with colour. The concept associated with a person is not central to a semantic field and comprehension of terms of personal concepts are dependant upon context.

Spatial adjectives also depend on context for their meaning. Whereas colour and kinship terms are anchored to fixed landmarks on scales of relationships of colours and individuals, words like tall and high refer to different distances, depending upon whether one is talking about a wall, or a block of flats, an aircraft or a satellite.

So componential analyses cannot serve to represent a complete theory of meaning of words, for a mental lexicon must be able to represent all the words in a language, and it must be compatable with the operations which people use for classifying and recollecting experience (Fillmore 1971 b).

Comprehension of lexical elements whose meaning depends upon context, may arise from the application of a set of "mental operations" to experience. Many such "operations" may be possible, and should include the kinds of operations used to generate portions of the lexicon. For example, relations of magnitude, and two dimensional and three dimensional representations,are possible in thought and ought to be reflected in semantic relations (Deese 1976).

In an attempt to construct a theory of meaning which took into account these operations, Miller and Johnson-Laird (1976) began with an associative theory of meaning, seeing themselves as having little alternative, given the strength of empiricist tradition. Associative learning may occur

between some percepts and the propositions which express the underlying meaning of some words, but whilst such a theory is a possible explanation of the way in which the meanings of substantive words are known, it is not a satisfactory explanation of an adult's ability to comprehend the infinitive number of combinations of propositions which the generative nature of language makes possible. Greene (1975) pointed out that although Stimulus - Response Theory could account for convergent thought it was not an adequate model for divergent or creative thought, of which language production and comprehension are examples. Bruner (1974) also dismissed the S - R model as an explanation of language learning. He suggested that when a language is learned, a coding system is first extracted from initial input and then applied to new input. It is altered when hypotheses, generated by application of the code, are found to be inadequate.

Herriot (1970) disagreed with those who criticised the S - R model on the grounds that it could not adequately explain a language system capable of creating an infinite number of sentences. He proposed that if mediating responses contained numbers of differing features, then an immense number of combinations of these features was possible. However, the transition from deep to surface structure entails a hierarchial process of selecting, ordering and insertion which, he conceded, cannot be explained by an S - R model.

It seems more likely that a listener derives meaning by a series of mental operations which use stored knowledge, and which take into account the context of the words and the intentions of the speaker (Searle 1975). Spoken language may be acted upon by the listener rather in the way that a computer acts upon a programme (Davies and Isard 1972). The input is converted into routines containing control instructions, and these are then used as the basis upon which action may be taken. If the input is not understood, the conversion cannot begin (Harrison 1972). In pursuing the analogy of the computer, Miller and Johnson-Laird (1976) suggested that the control instructions must initiate strategies which include a search of memory for the percept, memory, or concept indicated by the input, and a test to determine whether the incoming percept, memory, or concept is true when compared with that stored knowledge. If linguistic input expresses propositions consisting of nominal and verbal units (Clark H. 1977), then for a listener to gain comprehension of a word, both parts of the proposition must be subjected to a verification test against already existing stored knowledge. The tests determine whether the word belongs to a particular category. Acceptance or rejection will depend upon the rules, or mental operations by which the listener determines appropriate categories. The semantic components discussed previously reflect the attributes by which the human cognitive system defines these categories of knowledge and perceptions of the world (Sachs 1976). Consequently, categories named by language will depend on concepts of the world, and language will be acquired by children as conceptual components are learned.

However, even though a computer can simulate the processes of checking and integrating syntax and semantics, it cannot account, as humans can, for deviant meanings, e.g. "girls" for older women, or derive understanding when the actual input is imprecise. It cannot use contexual clues (Winograd 1971). In practice, verification is often dependent upon context, for it can only proceed independently for formal logic, or mathematics. As a process it must allow for two stages.

(a) an assessment of a proposition on a particular occasion or in a particular situation.

(b) a judgment of whether the proposition is true or false.

For example, "2 x 2 = 4", is always true, "the cat sat on the mat" is sometimes true and sometimes false, depending upon the circumstances. Furthermore, even substantive words do not have exactly defined meanings, so that for instance, a stool may be called a table, or a bench a chair, depending upon their immediate function. Consequently, there can be no definitive verification of what is true or false. It is the context of the word that leads the listener to its meaning (Herriot 1970).

A verification process applied to propositions which express the underlying meaning of spatial adjectives is particularly dependent upon context in arriving at a true or false evaluation. When using near, for example, people may have quite different sets of norms for buildings, vehicles, interior measurements and exterior measurements. A tall tree will be quite different in height from a tall man. An

adjective specifies a value of a characteristic property of a noun, and the evaluative process is constrained by the concept of the noun. The noun determines the range of adjectival values, but the process must be flexible enough to enable comprehension to occur even when the words are used for a variety of purposes, e.g. in sarcasm, or with poetic licence. For spatial adjectives the characteristic property of the noun is a dimension, (Miller and Johnson-Laird 1976).

Contexual factors are not the only aids to comprehension that need to be taken into account in discussing communication. Shared assumptions between speaker and listener also act as a significant aid to comprehension. A listener assumes that the speaker makes his language as informative, truthful and relevant as possible (Greene 1975). Slobin (1966) found that a sentence such as "The doctor treated the patient", is more rapidly understood than "The patient treated the doctor", even though the sentences both have the same syntactic and underlying propositional form. The first sentence conforms to the expectations of the listener. In a study by Clark H. and Chase (1974) subjects were shown the words "Star is above plus" opposite to a pictorial star above or below a plus sign. The subjects were timed in making an assessment of the truth or otherwise of the statement on the card. Results showed that when the sentence was confirmed by the positions of the star and the plus sign, subjects processed it more quickly than when the sentence and the picture did not correspond. This result was seen by the experimenter to support the view that the processes of comprehension occur in conjunction with an

expectation that the incoming information is true. Delay in processing occurs when this expectation is not confirmed. These results were substantiated by another study (Clark and Chase 1972) which took into account the processing of sentences containing a negative or denial factor, e.g. "A is not above B." The presence of a negative element meant that there was an additional process involved. Listeners checked the affirmative version first and then cancelled it. (Just and Carpenter 1976).

Clark H. (1977) concluded that comprehension derives from a series of mental operations which represent sentences and all the relevant information before making a comparison. On hearing a sentence listeners decompose it for its propositional content and search their memories for matching or congruent information. This is retrieved from memory and an appropriate reply composed.

This model, incorporating a "given-new" contract (Clark and Haviland 1977) was implicit in a procedure formulated by Carpenter and Just (1975). A listener was thought to:-

1. Represent the interpretation of a sentence.
2. Represent relevant evidence.
3. Compare the representations of one and two.
4. Respond with an answer derived from three.

If asked "Did Tom hit the ball?" a listener is assumed to have information that someone hit the ball. He searches his memory for the antecedent i.e. X hit the ball, and then having retrieved it matches it to the original question. If there is correspondence between Tom and X then the answer is "Yes", - if

a mismatch occurs, the reply is "No."

The procedure can be applied to words in a similar fashion. When a word, for example,"tall' is spoken, to gain full comprehension, the subject must know that

1. it concerns vertical distance (a dimensional feature)
2. it is relational.
3. it represents a deviation from the norm if it is used in a contrastive sense.

The subject must also be able to understand the concept of relations, for although the order of conceptual development does not predict the order of linguistic development, knowledge of the relevant concepts is a necessary condition of appropriate linguistic development,even though it may not be a sufficient condition for it (Tanz 1980). To answer correctly a question which uses a comparative form, e.g. "which object is taller", or "which object is not taller" the subject must have the information listed above and understand that the linguistic form demands that the object be checked against a standard. The complexity of the language or the stage of cognitive development of the subjects may restrict access to meaning, for although knowledge of a language may be separable from knowledge of the world, the process of comprehension requires their simultaneous application (Smith and Wilson 1979).

Procedural approaches to meaning may not, however, be applicable to comprehension of all words. For example, propositions which demand subjective judgments to be made. It is also questionable whether procedural steps are always finite in number and whether the same processes of verification

necessarily imply synonymity. Although a process can allow for received knowledge and contexual variation, with procedural semantics still in its early stages many problems remain (Clark H. and Clark E. 1977).

It has been proposed, then, that in order to comprehend words adults use a series of operations by which incoming language is broken down into propositions by the listener and, taking into account contexual and other factors, is compared with already existing stored knowledge in order that an appropriate response may be formulated. In acquiring language children have to learn to apply these strategies. Humans have a predisposition for cognition, and seek to find an underlying pattern in incoming stimuli, even if none exists (Posner 1973). Bruner (1974) suggested that even in the youngest children, learning occurs by processes which are intentional and provide a feedback of information which allows knowledge to be acquired, rules of organisation to be hypothesised, and the adequacy of the rules to be tested.

A semantic intention may exist before a child learns to use, or understand, the role of syntactic devices in a language. The intention may be operational from birth, for even the youngest children accumulate knowledge about themselves and their roles in relation to their environment. They, and other people, are movers acting upon movable objects like toys and building blocks. They use instruments, or tools, and act upon other objects, and people (Piaget 1951.1955). They thus accumulate knowledge which may be incorporated in the meanings which they give to their first words (Bowerman 1973).

Brown (1973) found that similar sets of semantic relationships exist in the speech of young children speaking a variety of languages. These relationships are between agents and actions, actions and objects, actions and locatives etc., and correspond with Fillmore's (1971a) analysis of propositions into case relations. They express functional relationships which may be derived from the early period of development of children characterised by Piaget (Gruber and Veneche 1977), as the sensori-motor stage of learning.

Early speech expresses in language the schema which children, as the agents, build by their own activity in, and upon, the environment. They learn meaning by interpreting the integration of language and the context in which it is spoken (Tanz 1980). They continually revise their propositional knowledge, stored in long term memory, which forms the criteria against which they verify incoming language in order to attain full comprehension.

To comprehend words such as spatial adjectives, as Deese (1976) has pointed out, the propositional content which has to be acquired, is of a somewhat abstract nature. The information in long-term memory which enables a word like tree to be recognised is fundamentally different from that which underlies the meaning of spatial adjectives which refer to distance along a dimension. It has been shown that humans do learn and use the abstract relationships between dimensions. In a task involving transposition, subjects were rewarded for selecting 100 cm rectangles, rather than 25 cm rectangles.

Afterwards they were required to choose between a 100 cm rectangle and a 200 cm rectangle, and in choosing the latter, demonstrated that the cognitive system had extracted the dimensional feature and was using it to make relational judgments (Deese 1968). It is knowledge of this dimensional feature which is stored in long-term memory and which must be used as the criterion against which spatial adjectives have to be compared if comprehension is to occur.

Syntax has a role to play in the acquisition of comprehension of words in a language. Slobin (1973) proposed that universal semantic and syntactic operating principles are employed by children in learning language. Children assume, as adult listeners do, that language input makes sense, and in order to make semantic coherence they

a. note systematic modifications in word forms.

b. look for grammatical indications of semantic variation and

c. avoid exceptions to rules.

These early principles are systematically replaced by the strategies which an adult listener employs to attain full comprehension of language input.

By employing these principles children use syntactic clues to enable themselves to organise words for a semantic purpose. They make hypotheses about possible meanings associated with different grammatical devices and learn about the regularities and subsequently the irregularities of language. If an 's' is heard on the end of a known word, and it is seen to be used to refer to more than one object, children will hypothesise that 's' must be applied to any noun

when it is used to refer to the plural form. Only when their hypothesis leads them to use incorrect words like "sheeps", will children realise that there are exceptions to the rule (Clark H. 1977).

A similar process may apply to spatial adjectives, and to their various grammatical forms, but the ability of children to comprehend certain linguistic forms will depend on the degree of match between their cognitive level and their linguistic competence. Children, if they are to comprehend a word such as "taller" by use of the operations that it was previously suggested adults employ to reach comprehension, need to understand the concept of relations, and to know that the word

1. concerns vertical distance.
2. includes a linguistic form which indicates that a relational judgment is required.

Consequently, it is by the bringing together of stored propositional information, developing cognitive structures, and increasing knowledge of appropriate linguistic devices, that comprehension occurs. However, children's thinking strategies are dominated by their perceptions until the age of about seven years, when the processes of logical operations begin to be employed (Gruber and Veneche 1977). It is at this age that language may begin to have its most significant influence, for it is a symbol system which allows its users to manipulate their knowledge, to refer to past and future, and to refer to the relationships between objects.

The initial perceptual preferences of children may cause difficulties in comprehension as developing knowledge of

appropriate linguistic devices is mapped onto developing cognitive structures. They may also dictate the order in which word meanings are acquired. Clark and Clark (1977) pointed out that work on biological specialisation, meaning, and the acquisition of language suggests a link between language and other cognitive abilities which may best be explored by an examination of universals which are based on innate characteristics of the cognitive - perceptual system. Such natural abilities have well defined developmental histories which are not associated with practice, learning or culture.

One such universal is determined by the fact that the human eye and its complex physiological make up find certain colours more salient than others, and thus every language surveyed by Berlin and Kay (1969. 1975) was found to derive its colour terms from a hierarchy of eleven colours. Another set of terms which the human perceptual apparatus leads us to treat separately irrespective of culture are those which make reference to spatial dimensions (Greenberg 1966). Since language is a device capable of expressing these perceptual universals, an exploration of the origins of the perception of space should point to a universal set of semantic primitives, which will be defined from less primitive semantic features.

English has a group of spatial terms by means of which man expresses the size relationship between objects, e.g. big - little, large - small, long - short, high - low, deep - shallow, thick - thin, wide - narrow. Our employment of these terms has been hypothesised by Clark (1970. 1973) and Miller and

Johnson-Laird (1976) to have a perceptual basis in the fact that human beings have a natural upright posture. This identifies for them the vertical dimension, and a reference point at ground level from which the upward direction is normal and hence positive. The force of gravity and the surface of the planet make the horizontal and vertical planes immediately significant (Gibson 1969) and indeed discrimination between horizontal and vertical lines is very easy for young children, whereas discrimination between oblique lines is difficult at an early age (Bryant 1974). This pattern is so specific that it is very valuable to the psychologist, "because it might offer a direct clue to the underlying perceptual mechanisms." (p. 63). A human body is assymetric about the plane dividing front from back. The major perceptive organs face forwards, which is usually the direction of movement. Upward and forwards then are normal or positive directions, whereas backwards and downwards are negative. The body itself is the origin of measurement, or the reference point, in these planes (Clark 1973).

Having identified these features of dimensions, reference points and polar directions, and used them to define perceptual or P space, Clark (1973) proposed a Correlation Hypothesis that P space would be preserved in L or language space, i.e. that the child would acquire spatial terms by learning how to apply language to the a priori perceptual knowledge he already had about space. In his own world man is seen as the measure of all things, his language reflecting his biogical make-up, his natural habitat, his mode of locomotion and even the shape and

properties of his body (Lyons 1977). L space can be analysed in relation first to the reference points implicit in such words as high and low. These words have a primary reference point at ground level, but they also have secondary reference points above which a high point is found and below which a low point falls. The words contain an implied standard against which relative terms, with their inbuilt assumptions of "more" and "less" are measured (Lyons 1968). This standard applies to particular objects in particular circumstances - it varies with the context. A small elephant may still be a large animal, and a high point in a room may be low in the garden. Spatial adjectives like high and low, which are positional, may be distinguished from those which are extensional like far and near, but such a distinction may be discounted for our purposes, since the notions are interrelated. They all refer to measurement. Thus two points may be a metre from each other, in which case a line joining them will be one metre long. Extension and distance have obvious perceptual links (Lyons 1977).

As a result of the two reference points, spatial adjectives have considerable complexity, and in order to demonstrate full comprehension of them it is not sufficient for children to achieve high scores on a simple antonym elicitation task. They must show that they realise that antonyms like tall and short are words which refer to the same dimension and that they can understand the role of the secondary reference point. In order to do this, comprehension of comparative forms of the polar names of the dimensions must be demonstrated e.g. longer, shorter, not longer, not shorter. According to a study by Ehri (1976) such comparative forms are only poorly understood by children aged eight years.

If comprehension derives from a series of operations, then whereas experiments to investigate adult processing procedures have used the length of time taken to respond to the presentation of a stimulus as a measure of the complexity of the processes involved, an investigation to show whether children have attained comprehension of a word or particular form of a word requires a carefully constructed test in which the children have to answer appropriate questions, containing the word, or form of word being tested. (Clark H, 1974). Ehri used a test in which four pictures were presented to groups of children aged between four and eight years. The pictures illustrated five objects identical except for size. As a standard, a cut out version of the middle sized figure was supplied. The subjects had to indicate the figures which were bigger than and not bigger than the standard, and smaller and not smaller than the standard. Results clearly indicated that mastery of the secondary reference point system as it is represented in language had not been achieved by the age of eight.

Evidence from Donaldson and Wales (1970) supported these conclusions. They attempted to relate language acquisition to other aspects of cognitive knowledge, and posed the question whether some relational terms are acquired early, and if so, what features distinguished them from other relational terms. Subjects were presented with two dimensional pictures of rectangles and, having been referred to a standard, asked to point to the bigger, wee-er, longer and shorter items. But of a possible fifteen correct responses, these were the

results.

bigger	wee-er	larger	smaller
7	5	10	8

The pictures of the rectangles may have been confusing to some subjects in this experiment, for as the vertical dimension of the rectangles decreased, the horizontal dimension increased. Bartlett (1975) noted that in testing for features of dimensionality it is necessary to ascertain whether children can extract from the properties of the stimulus the correct dimension around which to organise their comparisons. Such a stimulus needs to vary inversely along two dimensions, whereas a stimulus to test for polarity should only vary along the relevant dimension. Only terms which describe overall size can be assessed using stimuli which co-vary along more than one dimension simultaneously. Nevertheless, in spite of the possible distortion of these results, if we consider that Nelson and Benedict (1974), using two choice comprehension tasks with pictures, found comparative forms harder than standard forms for children of up to 6 - 7 years, then the weight of evidence points to complete acquisition of the understanding of secondary reference system in the junior rather than infant school years. Thus I make my Hypothesis One that children learn to understand the affirmative comparative and negative comparative of the terms long, short, far, near, high, low, tall, short, wide, narrow, thick, thin, deep, shallow, between the ages of seven and ten years.

The polarity aspect of L space must be seen in relation to the marking factor discussed earlier as a feature in some adjectives, where for example, unkind is marked compared with kind, and short is marked compared with long. Clark H. (1970) noted that by a remarkable coincidence, in spatial adjectives

in English, the unmarked term always refers to the extended dimension, not the dimension showing lack of extension. Although there appears to be no a priori reason for this, he suggested that it is not simply adventitious that the unmarked or positive terms are acquired first. Our initial percepts make us more readily familiar with the positive end of the scale. This perceptual influence affects the order of acquisition of words, but its influence is mediated through language. De Soto (1965) and Huttenlocher (1968) proposed alternative explanations based on theories of spatial imagery. When faced with problems involving, for example, comparative terms, De Soto suggested that a child builds in his mind a spatial representation, constructing it from the top downwards. But as Clark H. (1969) pointed out, this cannot account for experiments which showed that the word deep is easier than shallow for a child to comprehend. Huttenlocher theorised that difficulties in tasks involving the spatial organisation of objects would be reflected in the child's comprehension of language forms. Thus arranging objects from an instruction is easy only when the movable object is the logical subject of a transitive verb or the grammatical subject of a "relational" sentence. Such a theory was being employed, however, to account for three term series problems, and cannot be used to account for the differences in results of tests of the child's comprehension of simple, comparative statements of identical grammatical form.

Osgood and Richards (1973) put forward a principle which, they suggested, governed the order of acquisition of words.

The principle was that basic to human cognition is a bi-polar factor of organisation, where positive polarity is attributed to one pole. The universality of this organisation means that in language the words which refer to the positive pole are learned before words which refer to the negative pole. Osgood's criteria for assigning polarity to spatial adjectives included linguistic factors, for instance, the use of one term to name the whole dimension, and a consideration of which of the two terms refers to a point nearest to the Ego. Experimental tests, including the use of the semantic differential technique have shown that this approach is not always a reliable predictor of the order of acquisition of words (Tanz 1980).

Evidence to support Clark's (1970) marking theory has also been uncertain, particularly from experiments where there was no limit to the number of choices of response. Townsend (1975) rejected linguistic arguments for the unmarked and marked distinction in comparative adjectives, after asking children questions containing comparative and superlative forms of adjectives. The answers required a choice of one out of five objects. This type of test was used because studies by Palermo 1973, Townsend 1974, Donaldson and Balfour 1968 had shown that children had difficulty with "less" compared with "more", but in tests which only used two choice situations. The subjects when selecting "more" rather than "less", may have simply been choosing the greatest amount. This was a strategy clearly demonstrated in Townsend and Erb (1975), although it "becomes relatively weak at five years of age." (p. 276). Work by Bartlett (1975) also cast doubt on the

theory that positive terms are acquired before negative ones. Brewer and Stone (1975) and Donaldson and Wales (1970) found evidence that positive terms are acquired before negative terms, e.g. more before less, long before short, but Clark H. (1970) criticised the methodology of the latter experiment, because a question referring to greatest extent was always asked prior to one referring to negative extent. He suggested that, since they found the children, having correctly chosen the biggest figure, pointing to the next adjacent for the wee-est, the subjects might in reality have wanted to refer back to the biggest, but were inhibited from doing so because they had already used up that option. However, the children in the Donaldson and Wales experiment, although having been offered a standard by which to judge biggest and wee-est, might in fact have used the biggest as the standard for their answer to the second question. If children are confused about a standard by which to measure they will be at a loss (Bryant 1974), which is likely to lead, not to a demonstration of confusion, but to an attempt to answer the question in the "apparently" best possible way, (Donaldson 1978).

The marking theory related to adjective acquisition states that the meaning of comparative adjectives consists of a dimensional feature and a polarity feature, which will be acquired in that order. In its strongest form, (Clark H. 1970), the view was taken that children would interpret both members of a dimension pair to refer to the positive pole. Alternatively, the polarity feature may be acquired separately for each pair. Thus a child's meaning for both members of a

pair may include reference to the positive pole, i.e. he will use long correctly, and overextend its meaning to include short (Clark E. 1973), or his meaning for both members may consist simply of the dimensional feature, but he will respond to the positive pole due to his use of a non-linguistic strategy. If the child acquires the dimensionality feature first, and then applies the polar feature later, it can be argued that tall enters his vocabulary as a synonym for big and short as a synonym for little if the terms big and little are the terms acquired first (Bartlett 1975). Other spatial adjectives may follow a similar pattern of acquisition. The findings of Earl and Ammon (1972), which suggest that children continue to use the terms tall and short for big and little, even after acquiring appropriate dimensional information, add weight to this hypothesis.

Tanz (1980) proposed that any theory of order of acquisition of words which did not take into account the context of the words was unlikely to gain experimental support. She hypothesised that a principle of fitness, or good form in language context relations could be determined which would assist in forecasting the order of acquisition. For example, length is a conspicuous property of long objects, but not of short objects. Consequently, when children hear the word long used, it will be obvious what dimension is being talked about, so long will be learned before short. When, however, children hear the word far used, the referent will not be as immediately obvious as an object referred to as near. Thus near will be

learned before far, an eventuality which is contrary to the predictions of the theories of Clark H. (1970) and Osgood and Richards (1973). Thus salient features, and iconic relationships between language and context are seen to contribute to the acquisition of meaning. This theory, however, as yet has no firm experimental evidence to support it.

In the light of the previous discussions concerning the secondary reference point and the polarity of P and L space, I would conjecture that if the name of the dimension poles, e.g. long and short, are acquired early, then the affirmative comparative and negative comparative of the unmarked term will be acquired before its counterpart - not because of a "marking theory", but because if the secondary reference point is fixed then the understanding of the words shorter and nearer for example, entails the application of more complex psychological procedures than the understanding of the words longer and farther. The latter words refer to a positive extension beyond the secondary reference point. Such positive extension is in the "normal" direction within P space. The former involve negative or perceptually "non-normal" distances measured along directions from the secondary reference points back towards the origins, or primary reference point.

Thus if P space and L space coincide the child will be able to understand longer before shorter, and farther before nearer. Correct applications of the terms not shorter and not nearer will ultimately lead to the selection of a line the limit of which reaches to the positive side of the secondary reference point. Applying the conclusions of

Just and Carpenter (1976) the procedures involved in reaching correct choices to satisfy these negative comparative terms will be ones of attempting to verify the affirmative versions and then negating them (Clark H. and Clark E. 1977). For example, in selecting lines which are "not longer" than a standard the child will, as in selecting a "not shorter" line, attempt to verify the affirmative, and then apply the negation factor. However, the initial perceptual discrepancy between positive and negative distances from the secondary reference point is present between "not longer" and "not shorter" just as it is between the positive terms. These perceptual origins of the levels of complexity will lead to the more complex terminology being acquired later than the less complex terminology (Brown and Hanlon 1970). Thus I make Hypothesis Two - that the unmarked terms are acquired before marked terms. The group longer, further, taller and higher are acquired before shorter, nearer and lower: the group wider, thicker, fatter and deeper are acquired before thinner, narrower, skinnier and shallow, the group not longer, not higher, not taller and not farther are acquired before not shorter, not lower and not nearer, the group not wider, not thicker, not fatter and not deeper are acquired before not thinner, not narrower, not skinnier and not shallower.

"Language" or "L" space is reflected in the conditions of application of the spatial adjectives to objects. The terms tall, long and short refer only to the vertical or salient dimension of an object with at least three dimensions. High, low and far, near, need only refer to a point on the salient dimension. Wide, broad and narrow need two

dimensional referents. Deep and shallow clearly are measured along the salient, vertical dimension, but negatively. They refer to three dimensional objects, but only when inside dimensions of hollowness are demonstrable. Solid three dimensional objects are thick, or thin (Clark H. 1973). Put in a procedural sense by Lyons (1977), if a three dimensional object is viewed with the aim of giving it a description, it is called big, little, large or small when it does not have a maximal dimension, e.g. a round ball . If a maximal dimension does exist then this is called length, tallness or height, and when the other two dimensions are small, they collapse to give thickness or thinness, e.g. a long thin pole. The interrelation of long - short, and far - near, have been discussed previously in this chapter. If, however, one of the secondary dimensions is significantly more extended, then the term employed is wide or narrow. Deep and shallow are employed if hollowness is an attribute of the referent. For two dimensional objects the same criteria apply, but obviously thick, thin, deep, shallow are not appropriate. The important thing to note is that we do not say that the width of an object exceeds its length and we do not say that it has length if we have already given the term width to its most extended dimension (Lyons 1977).

Using a Complexity Hypothesis Clark H. (1973) predicted an order of acquisition of spatial adjectives which was as follows -

1. Long-short, far-near, tall-short, high-low.
2. wide-narrow, broad-narrow.
3. thick-thin, deep-shallow.

- with the marked word in each case being acquired later than the unmarked word.

Whilst not differentiating between the words within the pairs Lyons (1977) predicted the order

1. Long-short, far-near, tall-short, high-low.
2. thick-thin, wide-narrow, broad-narrow.
3. deep-shallow.

Applying a Semantic Feature Hypothesis Clark E. (1972) added big - small and predicted an order of

1. big-small.
2. tall-short, high-low, long-short.
3. wide-narrow, thick-thin, deep-shallow.

The Semantic Feature Hypothesis states that a child's acquisition of initial word meanings is based on existing perceptual knowledge, and that these meanings can be described in terms of semantic features indicating the relationship between terms in the same semantic field. For example, spatial terms have general features of size, polarity and dimension. The terms with more general features are acquired before those with more limited application. Thus big - little and large - small, applying, as Bierwisch (1967) theorised, to any number of dimensions of an object, precede in acquisition tall - short, high - low, long - short, and far - near, which refer to a particular dimension. Wide - narrow, thick - thin, and deep - shallow, however, are not used to specify the most salient dimension and will be acquired later. This order was supported by the experimental findings of Clark E. (1972) and Bartlett (1975). Clark's experiment took the form of a word

game in which children had to respond with opposites to the presentation of spatial adjectives. She found that the level of difficulty of the responses was related to the complexity of meaning of the term involved, and that simpler words were often used as a substitute for a more complex word. Bartlett's experiment had subjects responding to questions of the type "Give me the X one" where X was one of a selection of dimensional adjectives. The subjects had to select from pairs of objects, for example, toy houses, whose dimensions were varied.

Taking into account the theoretical work of Clark H. (1970, 1973) and Miller and Johnson-Laird (1976), together with the experimental findings discussed in the previous paragraphs, I make Hypothesis Three, that the so called one dimensional adjectives are acquired before two dimensional adjectives. Thus the words longer, higher, taller, further are acquired before wider, thicker, deeper and fatter. The words not longer, not higher, not taller and not farther are acquired before not wider, not thicker, not deeper and not fatter. The words shorter, lower and nearer are acquired before narrower, thinner, shallower and skinnier. The words not shorter, not lower and not nearer are acquired before not narrower, not thinner, not shallower and not skinnier.

THE EXPERIMENT.

Design.

It has been hypothesised that children learn to comprehend spatial adjectives in a hierarchical order, which has its origins in the initial spatial perceptions of the child. (Clark H 1973). The salient features of these perceptions are the vertical plane, the primary and second reference points, and the forwards and upwards directions.

The spatial adjectives used to test the specific hypotheses in this study were tall, short, long, high, low, far, near, wide, narrow, thick, thin, fat, skinny, deep and shallow. They contain implicit secondary reference points against which comparison has to be made for full comprehension, and they can be divided into pairs of unmarked and marked words.

The unmarked words are those which have positive extension beyond the secondary reference point. Generally they give their names to the dimension, e.g. long and length, high and height, deep and depth. The marked terms are those which imply a shortfall in relation to the secondary reference point, e.g. short, low, shallow. It has been hypothesised that for both linguistic and perceptual reasons the unmarked words are comprehended before the marked words.

The so called one-dimensional adjectives, tall, short, long, high, low, far and near are used to refer to points in the vertical plane or to objects having an extended vertical dimension. The so called two-dimension spatial

adjectives, wide, narrow, thick, thin, fat and skinny are not normally used to refer to the vertical dimension. Deep and shallow, also termed two-dimensional, can be applied to the vertical dimension, but are measured downwards, or negatively, from the primary reference point.

If children do reach full comprehension of spatial adjectives by applying their developing knowledge of language to their a priori knowledge of space, then acquiring comprehension of these words will be a developmental process. To investigate whether this is so, with particular reference to the role in comprehension of the secondary reference point, it is necessary to use those forms of each spatial adjective which refer to extension beyond it, and shortfall from it, e.g. taller, not taller, shorter, not shorter.

Previous research on the acquisition of the secondary reference system had shown that it was not fully comprehended by children of eight years of age (Ehri, 1976) and in consequence the first hypothesis of this study states that understanding of the comparative forms of the words, fat, skinny, wide, narrow, thick, thin, deep, shallow, is acquired between the ages of seven and ten years.

If the forward and upward directions are salient in initial perception (Clark H. 1973) then when comprehension of the secondary reference point is being established unmarked terms will cause the child less difficulty in comprehension than marked terms. Thus the second hypothesis of this study states that the affirmative and negative

comparative forms of the spatial adjectives used in the study are acquired before the same forms of their marked counterparts.

If the vertical plane does provide the salient dimension in perception (Clark H.1973) then, in acquiring spatial adjectives, the words which normally refer to positive direction on that dimension will be acquired before other spatial adjectives. The third hypothesis of this study states that the affirmative and negative comparative forms of the words long, short, tall, far, near, high and low, the one dimensional words, are acquired before the same forms of the words thick, thin, fat, skinny, wide, narrow, deep and shallow, the so called two dimensional spatial adjectives.

To test these three hypotheses an experimental design involving independent groups at three age levels was employed. A schematic outline of this design is shown in **Table 1**. The vacant columns show the forms of adjective upon which subjects were tested, and in addition show whether the forms were of unmarked or marked terms. The affirmative and negative columns can be integrated to give single columns for unmarked and marked terms.

Table 1.

Design of the experiment to show the effects of age and dimension on the comprehension of unmarked and marked spatial adjectives in their affirmative and negative comparative forms.

Age Group.	Dimensions of Adjectives.	Unmarked terms. Affirmative.	Unmarked terms. Negative.	Marked terms. Affirmative.	Marked terms. Negative.
A	2				
B	2				
C	2				
D	1				

Hypotheses One and Two were tested using the two dimensional spatial adjectives, thick, thin, wide, narrow, fat, skinny, deep and shallow. The section of the design for testing these hypotheses incorporated twelve cells of subjects, four cells for each of three age groups of junior school children. In **Table 1** these age groups are referred to as A, B and C.

Comparisons between overall year groups and between year groups tested on each of the different categories of adjective are relevant to Hypothesis One. Significant increases in mean scores from lower to higher age groups would constitute evidence for an age related process of acquisition.

Evidence in support of Hypothesis Two would be obtained if, within age groups, mean scores on unmarked adjectives are significantly different from those on marked adjectives, both overall and in respect of their affirmative and negative comparative forms.

To test Hypothesis Three a further four cells were employed, referred to in **Table 1**, as having subjects drawn from age group D. These subjects had, in fact, to be from one of the other age groups, A, B or C, and tested on the one dimensional spatial adjectives long, short, tall, short, high, low, far and near, in their comparative forms.

Hypothesis Three would be supported if, within one age group, subjects perform significantly better on the one dimensional spatial adjectives than on the two dimensional adjectives, both overall and in respect of their affirmative and negative comparative forms.

The section of the design which enables the testing of the third hypothesis also allows a further comparison to be made within the compass of Hypothesis Two. The mean scores of subjects tested on the unmarked one dimensional spatial adjectives can be compared with those of the subjects tested on the marked one dimensional spatial adjectives. Similarly, within these groups mean scores of subjects tested on the affirmative and negative comparative forms of the unmarked words can be compared with those of the subjects tested on the equivalent forms of the marked words.

Since eight cells from one age group were being employed to test Hypothesis Three, and the largest age group in the school contained 110 children, the number of subjects in each cell was certain to be less than 14 subjects.

Although the selection of subjects was to be carried out on a random basis, cells with such small numbers of subjects could have contained unrepresentative samples. Consequently it was decided that before the experiment began, the Reading Age of all the subjects in the study would be taken on the Burt Reading Test, and an Analysis of Variance carried out to ascertain whether significant differences were to be found within any year group between the mean

Reading Ages of children in the individual cells. Any such differences which occurred would show up cells which might contain unrepresentative samples of subjects, and this fact could then be taken into account when discussing the results of the tests of the comprehension of spatial adjectives.

When testing primary age children sex differences always need to be considered (Freeman and Isaacson 1980). In verbal and written tests girls generally score higher than their male counter-parts. In tests of spatial and mathematical ability, however, the boys generally score higher than girls, (Serbin 1979, Fenneman 1979), as demonstrated by the N.F.E.R. Manual of Instructions for Mathematics Test A (1972). Results from similar tests to those used in this study had not, in the work of Ehri (1976) or Donaldson and Wales (1970) led them to remark upon any significant discrepancy between the performance of the boys and the girls. This may have been due to the fact that the tests clearly contained linguistic and mathematical features, and consequently the difference between the scores of boys and girls on tests of only mathematical, or of only linguistic skills, were cancelled out. Nevertheless appropriate Analyses of Variance were applied to the results of this study to enable any discrepancy due to a "sex" factor to be taken into account.

Previous experiments carried out in this field had been mainly concerned with children up to eight years of

age, and the work of Ehri (1976) had concluded with the remark that "even by age eight, mastery of the reference point system as it is represented in language, has not yet been achieved" (p.379). In order to test the three hypotheses, evidence was needed of the chronological age by which primary school children reach that understanding, so that a choice could be made of the three most appropriate age groups to test. It was therefore decided to carry out pilot tests with groups of children from each age group between seven and ten years, using the same tests as those to be employed in the main study.

The pilot tests also enabled the researcher to discover any problems which might occur with the test materials or the testing procedure.

Subjects.

The subjects of this study were 210 children from one school in the Midlands.

The school was situated in a residential area on the outskirts of a large industrial city. It was built on one side of a busy dual carriage way, the other side of which bounded a large car construction factory.

The catchment area comprised two adjacent districts, one of entirely private housing and the other of predominately council-built, rented accommodation. Many of the children's parents, from both districts, worked in the car plant or associated industries.

The socio-economic mix was fairly evenly divided between those termed manual and non-manual classes in the Registrar General's Classification of Occupations (1970) - but only a very small number of parents fell into socio-economic Groups One and Five.

The school had some 350 children of ages varying from seven to eleven years on the roll. The sexes were evenly divided within the school. Entry into the first year was from four feeder schools. The year groups consisted of between 70 and 110 pupils, with the actual number of staff allocated to the year depending on organisational factors.

At the time of these tests the first and third years were divided into three classes, and the second and fourth years into four classes.

The allocation of children to classes was normally

made after informal discussion between staff members and teachers from the feeder schools. Class groups were altered if necessary from year to year to take into account changing patterns of organisation. Class groupings, were never, however, based on criteria of academic prowess, or levels of test scores.

The samples for the study were taken from the complete register of the age ranges 7.0 - 7.11 years, 8.0 - 8.11 years, 9.0 - 9.11 years and 10.0 - 10.11 years. The allocation of subjects to the cells in the design is described later, in the Procedure section. None of the subjects in the cell groups failed to complete the tests.

Materials.

The tests were designed to show whether the subjects understood the affirmative and negative comparative forms of unmarked and marked spatial adjectives. The adjectives employed, and their forms are shown in **Tables 2 and 3.**

Table 2.

Words used for the tests of comprehension of two dimensional spatial adjectives in their comparative forms.

	UNMARKED.	MARKED.
Affirmative.	Wider.	narrower.
	thicker.	thinner
	fatter.	skinnier.
	deeper.	shallower.
Negative.	not wider	not narrower
	not thicker	not thinner
	not fatter	not skinnier
	not deeper	not shallower.

Table 3.

Words used for the tests of comprehension of one dimensional spatial adjectives in their comparative forms.

	UNMARKED.	MARKED.
Affirmative	longer	shorter
	higher	lower
	taller	shorter
	farther	nearer
Negative.	not longer	not shorter
	not higher	not lower
	not taller	not shorter
	not farther	not nearer

The tests were derived from previous studies of similar nature. Their construction took into account factors which emerged from these sources. It was noted in the previous chapter that the comprehension of spatial adjectives involves understanding the implicit standard against which the adjective is measured, either in a positive or negative direction. In testing children's ability to use the secondary reference point it was necessary to offer them a clear standard against which to judge the affirmative and negative comparative forms. De Villiers and de Villiers (1974) found that in tasks using the words here/there, this/that and my/your, a three year old showed comprehension if a clear physical reference was given, but if not, then children of six were likely to be perplexed. (Bryant 1974), reviewing studies of the child's ability to make inferences, noted that if children of six or seven years were given a direct comparative task they were quite able to cope, but "if a child has to seek out a measure, detach it from its surroundings and apply it before making an inference, he is usually at a loss" (p.57).

Ehri (1976) used sets of illustrations in her study of the comprehension of big and little. Each child was presented with a series of four cards, each showing five pictures of objects, identical except for size. In addition a cut out figure, "Patty", equal in size to the middle sized picture, was supplied. The children had to indicate, for example, "The jar which is bigger than Patty." The present writer could see no reason for using a standard figure of a different kind to the picture on the card, for

it might have been a distracting influence. In the tests employed for this study the middle sized standards were of the same nature as the other objects in the test.

Very young children have been shown to have a perceptual preference for choosing objects of greatest extent (Farnham-Diggory and Barman 1968). The tendency is strong at three years of age but relatively weak at five years of age (Townsend and Erb 1975). With subjects aged eight it is likely that this tendency will have disappeared, and also that when given a term such as tall, for example, they will be able to extract the right dimension around which to organise their comparison. Thus whereas in testing with terms of overall size such as bigger-smaller, it is necessary to co-vary all the dimensions of the objects simultaneously (Bartlett 1975), in testing other spatial adjectives only the dimension actually being referred to is varied, and the other dimensions are kept constant.

Previous work has been more or less equally divided between the presentation of pictures of objects, and actual objects, to the subjects. Donaldson and Wales (1970) used both and recorded considerably higher scores for bigger, wee-er on three dimensional objects as opposed to two dimensional pictures. However their test with two dimensional sketches of rectangles did not co-vary in all dimensions, and this will certainly have caused "conflict", and hence possible discrepancies in the results. The present study used objects because of the dimensional feature involved in the argument for a perceptual base to the

acquisition of spatial adjectives as proposed in the previous chapter. Reducing a three-dimensional object to a two dimensional representation might influence the results. The tests employed by Bartlett (1975) and Clark E.V.(1972) only allowed the child choice of response from two alternatives. This was not appropriate in the present tests because even if a child, having been shown the standard by which to judge, made the correct choice, for example, of a taller object, it would not be clear whether the subject was simply interpreting the task as one of choosing the superlative sized object. This type of confusion was noted by Donaldson and Wales (1970), who sought two answers from subjects who had been asked to pick pictures of objects "bigger" than a standard. They suggested that the subject's handling of the comparative morpheme might be semantically analogous to the handling of the superlative, consistent with the model proposed by Clark H. (1970, 1973) indicating that initially children interpret comparative adjectives as nominal forms denoting extremes of extent. Statistically their data did not support the supposition.

In order to avoid the possibility, however, the tests in this study used five items. Two were of greater extent along the target dimension than the standard, and two were of lesser extent on the same dimension. This followed the pattern of Ehri (1976) and avoided the necessity of changing the standard stimuli as Donaldson and Wales (1970) had had to do when using only four items.

The objects used with the one-dimensional spatial

adjectives were:-

tall, short - men, masts.

high, low, - flags, cards on a wall.

long, short - lines, pencils.

far, near. - blocks on a table, model horses.

The objects used with the two dimensional words were:-

wide, narrow - strips of paper, model roads.

thick, thin. - pipes, books.

fat, skinny - model people, rolls of plasticine.

deep, shallow - water in beakers, holes bored into a piece of wood.

These objects were chosen by the experimenter, and their appropriateness as referents for the particular adjectives discussed in order to ensure their suitability for the study. Representation of them can be seen in Appendix IX.

By a process of randomisation, the position of each object in each test was determined. The standard object in each test was included in this process, because placing it in the central position for each test might have caused children to assume that both objects referred to by the affirmative comparative form of the adjective would be on the opposite side of the standard object to those referred to by the negative comparative form of the adjective. Each set of five objects was used for only one pair of adjectives but for both of the forms of the words. For example, masts were used to test understanding of both taller , not taller , and shorter , not shorter.

The objects were placed in random order, with the standard being clearly indicated to the subjects. The questions were put in the form "Point to the masts which are taller than that one." If the child made only one response this was noted, together with information showing which object was indicated. Then a further question was asked "Is that the only mast which is taller than that one?" The second question was used to make certain that the child was not simply responding to the tallest object. For each pair of words two sets of objects were used, thus questions referring to tall and short were used in relation to a set of five masts and a set of five toy men. Since each of the four words was used with two objects, and there were two correct answers for each question, each child could attain a maximum score of sixteen marks.

The questions were asked in a random order because if the two questions using the same word were always asked consecutively, a practice effect could have influenced the results.

The Reading Test (Burt Rearranged) was used to obtain Reading Age Scores. The procedure used was in accordance with the recommended practice for the test.

Procedure.

Permission to carry out the study was obtained from the Headmaster of the school, and from the local authority. The Pilot Study was conducted during a Summer Term. It is described at the end of this chapter. As a result of the first section of the Pilot Study a decision was made about the age groups to be used for the testing of the first two hypotheses. A further section of the Pilot Study was used to decide which age group should be used to test Hypothesis 3. This determined the number of subjects allocated to each cell for the main tests.

The pilot tests showed that the most satisfactory year groups to use were those containing children aged 7.0 - 7.11 years, 8.0 - 8.11 years and 9.0 - 9.11 years. To test Hypothesis Three eight cells of children were needed for comparative purposes within one year group, in addition to those used for the Pilot Study. The biggest year group of the three mentioned above was the 8.0 - 8.11 year age group, which could be divided into eight cells of ten subjects each, and still leave children over to substitute for children leaving the school, or having to be eliminated from the experiment for any other reason. Consequently, it was decided that each cell in the design should contain ten subjects.

After eliminating the children used in the Pilot Study the remaining children in the age groups 7.0 - 7.11 years, 8.0 - 8.11 years and 9.0 - 9.11 years were numbered. Forty children were selected by use of a table of random numbers

from each of the age groups 7.0 - 7.11 years and 9.0 - 9.11 years. Eighty children were selected by the same procedure from the 8.0 - 8.11 years age group. The children from each age range were allocated at random into groups of ten, the groups being subsequently allocated, again at random, to each cell, in the design. The four groups of ten remaining from the age group 8.0 - 8.11 years were used to test Hypothesis Three. They were randomly allocated to the four cells in the design, and were tested on one dimensional spatial adjectives.

Testing took place during the Autumn Term, with reading tests being completed before testing of spatial adjectives. The tests were conducted in a small, empty classroom during school hours. The researcher, being a teacher in the school, was familiar to all the children. The child being tested sat at a table with the researcher. The appropriate set of five objects, masts for example, were put out in a row in front of the child. Care was taken to ensure that the standard object was placed in the pre-selected random position in the row. The questions were put in a random order, and were of the form "Point to the masts which are taller than that one." The researcher pointed to the standard. If the child made only one response this was noted and a further question was asked. "Is that the only mast which is taller than that one?" the standard again being indicated. If the child answered in the affirmative then the next set of objects was put out, e.g. cylindrical tubes, and the process repeated using the

appropriate word - in this case "longer." If the child replied that it was not the only mast which was taller than the standard, he was asked to point to any other mast taller than the standard. The children were not rushed in making their responses, but were given encouragement when appropriate, albeit not being allowed any indication by the tester of whether their answers were the correct ones. On completion of the tests the subjects were thanked and sent back to their classrooms.

The collected data was analysed using the S.P.S.S. procedure, "ANOVA", which allowed the relationships between the mean scores of the subjects and the variables sex, marking factor and age group to be examined.

Pilot Study.

The pilot study took place in the term before the main study, which was in fact in the previous academic year. The study was mounted in order to ascertain with which year groups in the primary school it would be most appropriate to carry out the main experiment in order that the hypotheses in the main study could be satisfactorily tested.

Hypothesis One predicted that mastery of the secondary reference system would occur as a developmental process.

Previous experiments carried out in this field had been concerned with children aged up to eight years of age, and the work of Ehri (1976) had concluded with the remark that "even by age eight, mastery of this reference point system as it is represented in language has not yet been achieved." (p. 379).

The author of this study needed some evidence of the age by which children in primary school had reached an understanding of the system. Although it seemed reasonable, given that three consecutive age groups were to be tested, to assume that the fourth year children, aged 10.0 to 10.11 years, would have understanding of spatial adjectives, and consequently to test the three year groups aged between 7 and 10 years, it would have been an intuitive decision, albeit based on several years experience of teaching these age groups.

Thus it seemed that a pilot study should be mounted with one group of children from each of the age ranges of the junior school. Four groups of ten children were selected at random, one from each of the age groups 7.0 - 7.11 years, 8.0 - 8.11 years, 9.0 - 9.11 years and 10.0 - 10.11 years. The subjects were given the tests on the two dimensional adjectives, with the two younger groups being tested on the marked words, and the older groups on unmarked words. The 7.0 - 7.11 year old children and the 9.0 - 9.11 year old children were tested on the negative comparative forms, and the other groups on the affirmative comparative forms.

The different forms of spatial adjectives were tested with these particular groups because the affirmative comparative form of the unmarked words is the least complex form, and the oldest children ought to have scored higher in the tests of this form than any of the other groups. Consequently, if a ceiling effect was going to occur in the results, it would become apparent in this section of the results of the Pilot Study. By the same reasoning, the most complex form, i.e. the negative comparative form of the marked words, was tested with the youngest age group of children to determine whether this was going to be an area of particularly low scoring. The other forms of comparative adjectives, i.e. the affirmative form of the marked words, and the negative form of the unmarked words, were allocated at random to the two other age groups. The reason for including these forms in the Pilot Study was that the children involved also helped in the clarification of test procedures. From their comments exact procedures

of testing were drawn up so that the tests could be repeated exactly with each subject in the main experiment. Any problem of unclear, or ambiguous questions, was consequently eliminated.

The full results of these tests can be seen in Table 4.

Table 4.

Mean scores from the Pilot Study of children tested for comprehension of two dimensional spatial adjectives in their comparative forms.

Age Group.	Form of Comparative Adjective Tested.	Unmarked or Marked.	Mean score.	S.D.	Mean Age.	No.
10.0 to 10.11.	Affirmative.	Unmarked.	15.2.	1.32.	10.11.	10.
9.0 to 9.11.	Negative	Unmarked.	14.7	1.90.	9.10.	10.
8.0 to 8.11.	Affirmative.	Marked.	9.6.	4.98.	8.9.	10.
7.0 to 7.11	Negative	Marked.	7.0.	5.19.	7.10.	10.

Details of the scores of individual children on the tests can be seen in Appendix I. The groups with mean scores of 9.6 and 7.0 out of 16 were not achieving full comprehension of the forms of adjectives on which they were tested, whereas the oldest age group were near to complete understanding of the unmarked terms in their affirmative comparative forms. Although when full testing was due to take place, the average chronological age of the respective groups was likely to be some six months lower than that of the pilot groups, it was decided in the main experiment to test the age ranges 7 to 7.11 years, 8 to 8.11 years and 9 to 9.11 years, because the mean scores of the children

in the age range 10 to 10.11 years seemed likely to be high enough to cause difficulties when drawing conclusions from a statistical analysis.

The results of the first section of the pilot study were used to assist in planning that part of the Pilot Study relating to the testing of the third hypothesis. One dimensional adjectives are less complex than two dimensional adjectives and consequently one would expect children to score higher on tests of one dimensional adjectives. The results in **Table 4** illustrated that tests of <u>one</u> dimensional adjectives with children aged 9 - 10.11 would probably give scores near to ceiling level. In the two other age groups there was, in the following academic year, to be a great discrepancy in numbers of children (7.0 - 7.11 years, N = 70) (8.0 - 8.11 years N = 110). Since the testing of Hypothesis Three required eight cells, and ten children had already been used for the first section of the Pilot Study, the most practical age group to test was clearly that of children aged 8.0 - 8.11 years, for using the younger group would reduce the number of children in each cell of the main tests to below ten, and leave few over to use as substitutes should the need arise. Therefore, it was decided to randomly select a further ten children from the age group 8.0 - 8.11 years, and test them on the least complex form of the unmarked one dimensional adjectives, in order to determine whether this age group could be used to test Hypothesis Three. The results are shown in **Table 5.**

Table 5.

Mean scores from the Pilot Study of children tested for comprehension of one dimensional spatial adjectives in their comparative forms.

Age Group.	Form of Comparative Adjective Tested.	Unmarked or Marked.	Mean Scores.	S.D.	Mean Age.	No.
8.0 - 8.11.	Affirmative	Unmarked	14.0.	1.88	8.11	10.

The mean score of 14.0 was near to the ceiling level for statistical analysis, but after discussion relating to the difficulties associated with using the younger age group for this part of the study, and thus reducing each cell in the study to only eight subjects, it was determined to test Hypothesis 3 using the age group 8.0 - 8.11 years.

There were 25 males and 25 females in the pilot tests. The mean scores of these groups were males 11.2, females 11.3, on two dimensional adjectives, and males 13.3 and females 15.0 on one dimensional adjectives.

One alteration to the test procedure was made as a result of the pilot tests. When testing "far" and "near" the row of objects was, in the main tests, set out "end on" to the subject, rather than across the line of vision, because of confusion which arose amongst subjects during the pilot tests. This confusion may have been due to the difficulties which young children have in seeing the world from any other view than their own (Turner 1975). In asking children to point to objects set out across their line of vision, when responding to the words far and near, one is requiring them to see the objects from an "end on" position.

To ensure that the possibility of confusion was eliminated from this test, the subjects were placed, for the main tests, in that "end on" position. For the other tests, however, the subject and experimenter faced each other across the table, and the objects were placed on a line across their field of vision.

On completion of the Pilot Study the main experiment was undertaken.

RESULTS.

The scores obtained by individual subjects on the tests of comprehension of spatial adjectives, together with their Reading Ages, are recorded in Appendix II.

The mean scores of the subjects in the cells are tabulated in **Tables 6 and 7.** below. **Table** 7 is formed by averaging the scores of children tested on the affirmative and negative forms of the spatial adjectives.

Table 6.

Mean scores of subjects tested for comprehension of affirmative and negative comparative forms of spatial adjectives.

			UNMARKED.		MARKED.	
	Age Group.	Dimen-sions.	Affirmative.	Negative.	Affirmative.	Negative.
A.	7.0-7.11.	2.	M = 7.6. S.D = 6.5. N = 10.	M = 7.3. S.D = 4.9. N = 10	M = 7.0. S.D = 5.5. N = 10.	M = 6.6. S.D = 5.1. N = 10.
B.	8.0-8.11.	2.	M = 12.5. S.D = 3.5. N = 10.	M = 10.4. S.D = 3.9. N = 10.	M = 8.3. S.D = 5.6. N = 10.	M = 7.9. S.D = 5.1. N = 10.
C.	9.0-9.11.	2.	M = 13.7. S.D = 3.5. N = 10.	M = 11.8. S.D = 2.7. N = 10.	M = 13.0. S.D = 2.5. N = 10.	M = 11.6. S.D = 2.7. N = 10.
D.	8.0-8.11.	1.	M = 14.2. S.D = 1.8. N = 10	M = 13.6. S.D = 3.1. N = 10	M = 12.0. S.D = 2.2. N = 10	M = 12.3. S.D = 3.9. N = 10.

Table 7.

Mean scores of subjects tested for comprehension of unmarked and marked spatial adjectives in their comparative forms.

	Age Group.	Dimensions.	Unmarked.	Marked.
A.	7.0 - 7.11.	2.	M = 7.5. S.D = 5.5. N = 20.	M = 6.8. S.D = 5.1. N = 20.
B.	8.0 - 8.11.	2.	M = 11.5. S.D = 4.2. N = 20.	M = 8.1. S.D = 5.2. N = 20.
C.	9.0 - 9.11.	2.	M = 12.3. S.D = 3.2. N = 20.	M = 12.3 S.D = 2.6. N = 20.
D.	8.0 - 8.11.	1.	M = 13.9. S.D = 3.4. N = 20.	M = 12.2 S.D = 3.1. N = 20.

Graphical representations of the mean scores, Figures 1 and 2, show that the mean scores on each form of adjective tested increase with age, although the rate of increase, shown by the slope of the lines, is not uniform. Whereas unmarked terms are acquired comparatively rapidly between 7.5 and 8.5 years, the marked forms appear to be acquired later.

Figure 1

Graph to show comprehension of the affirmative and negative comparative forms of two dimensional spatial adjectives.

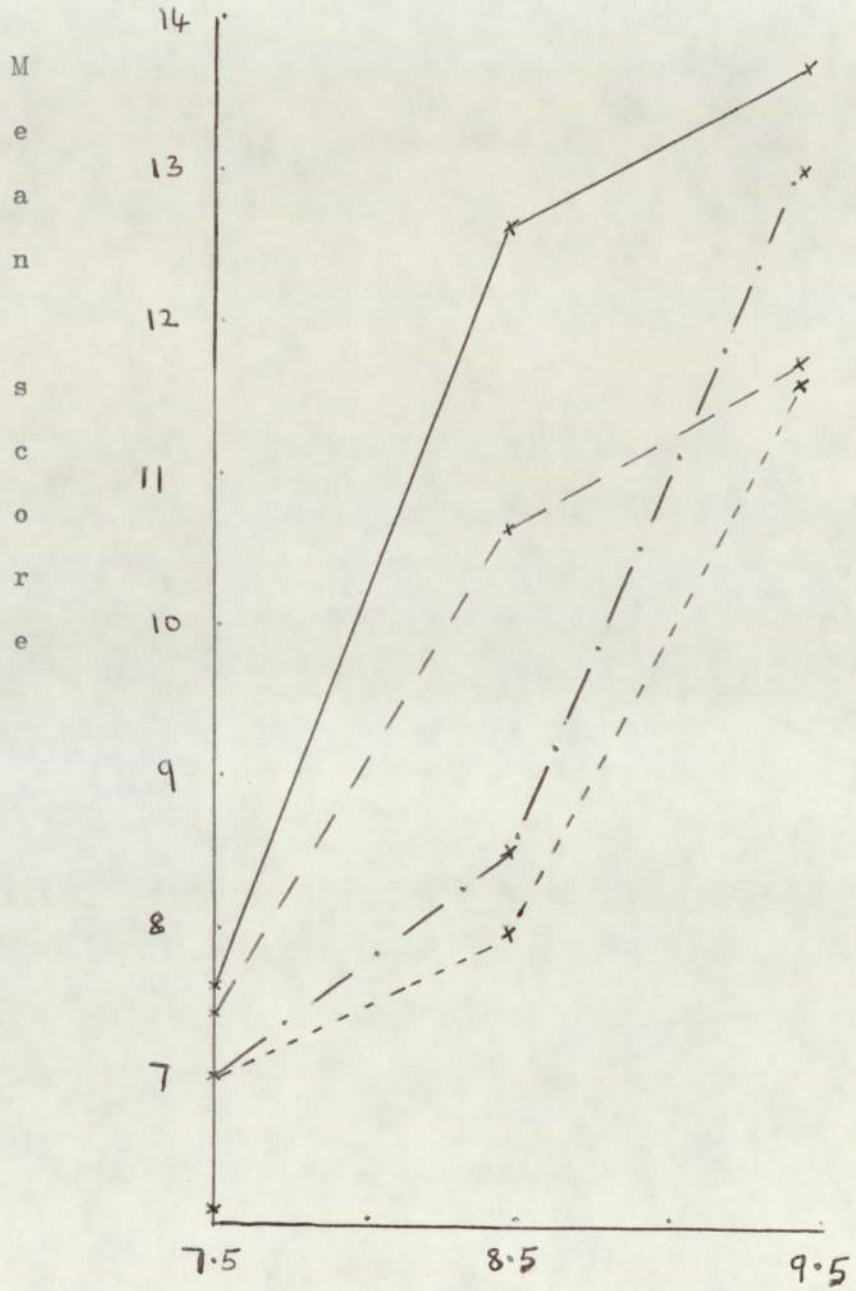
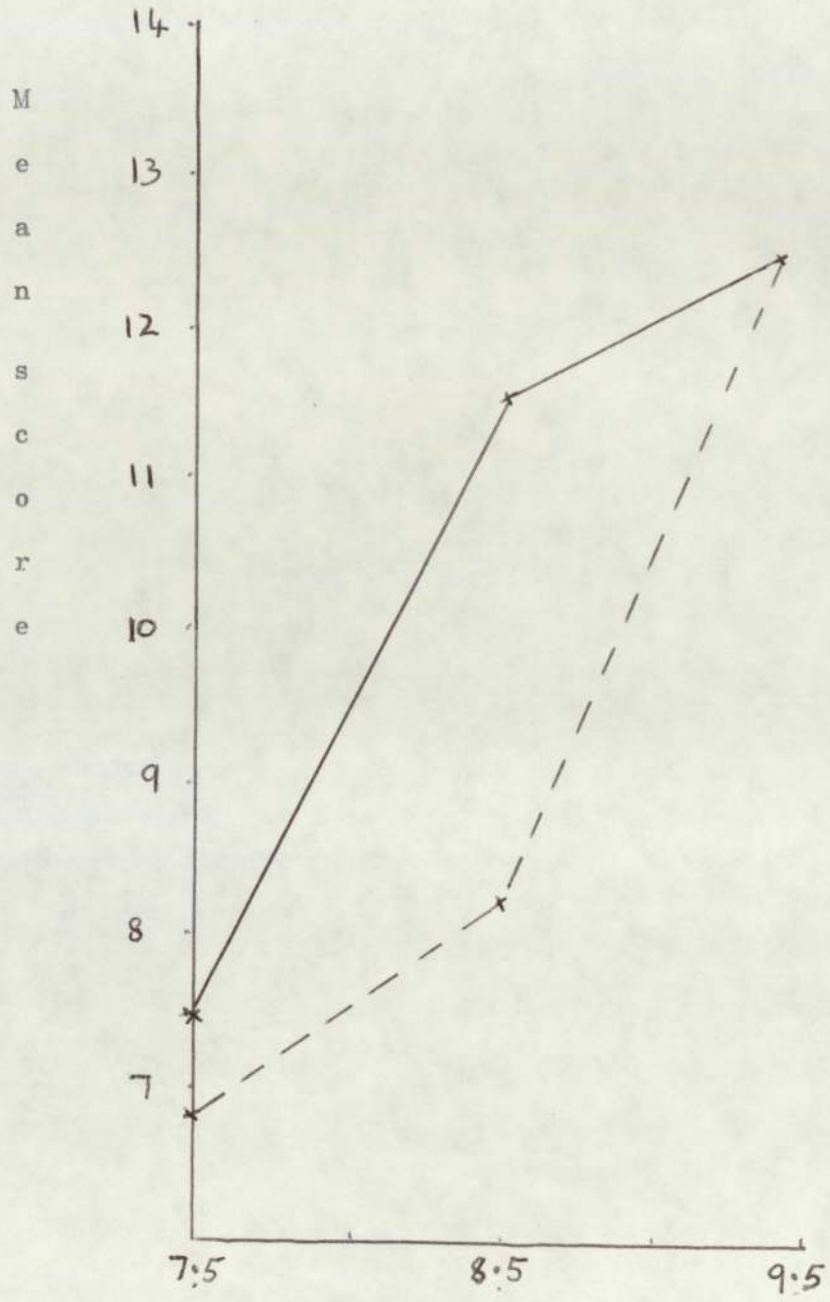


Figure 2

Graph to show comprehension of the comparative form of unmarked and marked two dimensional spatial adjectives.



In order to determine whether sex is a significant factor in performance on the tests, the mean score for each sex is calculated. The mean score for the 77 boys is 10.7 and for the 83 girls is 10.3. An Analysis of Variance of the mean scores in **Table 6.** with score as the dependent variable and year, sex and marking factor as the independent variables shows that sex is not a significant explanatory factor $\underline{F}$ (1) = 0.016, $\underline{p}$ = 0.898 (See **Table 8.**), but in subsequent analyses of the data sex is kept as an independent variable, thus enabling its effect to be taken into account. The same analysis shows no significant interaction effects.

Table 8.

Analysis of Variance to show the effects of year, sex and marking factor on the comprehension of spatial adjectives in their comparative forms.

SOURCE OF VARIATION.	SUM OF SQUARES.	DF.	MEAN SQUARE.	F.	SIGN. OF F.
MAIN EFFECTS.	1055.820.	7.	150.831.	9.198.	.001.
YEAR	912.137.	3.	304.046.	18.542.	.001.
SEX	.270.	1.	.270.	.016.	.898.
MC.	143.250.	3.	47.750.	2.912.	.037.
2-WAY INTERACTIONS.	168.289.	15.	11.219.	.684.	.796.
YEAR SEX	19.795.	3.	6.598.	.402.	.752.
YEAR MC	99.107.	9.	11.012.	.672.	.733.
SEX MC	49.703.	3.	16.568.	1.010.	.390.
EXPLAINED	1538.652.	31.	49.634.	3.027.	.001.
RESIDUAL	2098.948.	128.	16.398.		
TOTAL	3637.600.	159.	22.878.		

N = 160.

Only ten subjects are used in each cell of the Design, which makes it possible that, even though they were chosen by random selection, some of the cells contain unrepresentative samples of subjects. An Analysis of Variance, with reading age as the dependant variable, and sex and marking factor as independent variables, shows that no significant differences exist between the mean reading ages of children from the

cells within any year group. $\underline{F}$ (3) = 0.643, $\underline{p}$ = 0.589 (see Appendix IV). Consequently it is reasonable to assume that the cells do contain representative samples of subjects.

Hypothesis 1 states that the forms of the two dimensional adjectives being tested are acquired by children as a developmental process between the ages of seven and ten years.

Figures 1 and 2 show that the mean scores on each form of adjective tested increase with age. Statistical evidence supporting the hypothesis is derived from an Analysis of Variance of the mean scores in Table 6. The analysis shown in Figure 11 is fully detailed in Appendix V. The letters A and C are used for the purposes of data analysis to represent the year groups 7.0 - 7.11 and 9.0 - 9.11 years respectively. B and D represent those children from the age group 8.0 - 8.11 years tested on two and one dimensional adjectives respectively.

Table 9.

Analysis of Variance to show the effect of age on the comprehension of comparative forms of two dimensional spatial adjectives.

Independent Variables.	Dep. Var.	No. of cases.	Main sources of variation.	Sum of squares.	D F.	Mean Square.	F.	Sign. of F.
Year(A,B,C)	Score	120.	Year.	582.004	2	291.002	15.284	.001.
Sex. Marking Factor			Res.	1827.352	96	19.040		

Age is a significant contributing factor in the variance of the mean scores $\underline{F}$ (2) = 15.284, $\underline{p} < 0.001$. Further support for the hypothesis is derived from the Analysis of Variance in Table 10 which demonstrates that age is a significant source

of variation when the mean scores of children tested on unmarked terms are compared, and also when the mean scores of children tested on marked terms are compared F (2) = 7.747, $p < 0.001$ and F (2) = 9.285, $p < 0.001$ respectively.

Table 10

Analyses of Variance to show the effect of age on the comprehension of the comparative forms of unmarked and marked two dimensional spatial adjectives.

Indep. Variables.	Dep. Variables.	Term.	No. of cases.	Main sources of variation.	Sum of squares.	D. F.	Mean Square	F.	Sign. of F.
Year (ABC) Sex	Score.	Unmarked	60	Year	296.599	2	148.300	7.747	.001.
				Res.	1033.672	54	19.142		
Year (ABC) Sex	Score	Marked.	60	Year	365.178	2	182.589	9.285	.001.
				Res.	1061.867	54	19.664		

The complete Analyses of Variance tables are in Appendix V. Analyses of Variance to discover exactly where these differences occur reveal that significant differences exist between the mean scores of children from the years A and B, the first and second years, tested on unmarked terms, F (1) = 6.473 $p < 0.05$. The values of F for those tested on the affirmative and negative forms of the unmarked adjectives are F (1) = 3.168, $p < 0.094$ and F (1) = 5.076, $p < 0.039$ respectively. Between the second and third year groups, B and C, however, significant differences occur where the children had been tested on the marked spatial adjectives F (1) = 12.471 $p < 0.001$. The analyses reveal that the differences are significant between the mean scores of children who had been tested on the affirmative comparative forms of the marked terms. F (1) = 11.049 $p < 0.01$. Details of the analyses are shown in **Table 11** and the full tables can be found in Appendix VI.

Table 11.

Analyses of Variance to show the effect of age on the comprehension of unmarked and marked two dimensional spatial adjectives and of their affirmative and negative comparative forms.

Indep. Variables.	Dep. Variables.	Term.	Form	No. of cases.	Main sources of variation.	Sum of squares.	D F	Mean Square.	F	Sign. of F.
Year (AB) Sex	Score	Unmarked		40	Year Res	150.684 38.056	1 36	150.684 23.279	6.473	.015
Year (AB) Sex	Score	Unmarked	Aff.	20	Year Res	101.682 513.500	1 16	101.692 32.094	3.168	.094
Year (AB) Sex	Score	Unmarked	Neg.	20	Year Res	84.045 264.929	1 16	34.045 16.558	5.076	.039
Year (AB) Sex	Score	Marked		40	Year Res	6.400 936.667	1 36	6.400 26.019	.246	.623
Year (AB) Sex	Score	Marked	Aff.	20	Year Res	.458 343.690	1 16	.458 21.481	. .021	.886
Year (AB) Sex	Score	Marked	Neg.	20	Year Res	5.812 445.633	1 16	5.812 27.852	.209	.654

(continued overleaf)

Table 11. (Cont'd.).

Analyses of Variance to show the effect of age on the comprehension of unmarked and marked two dimensional spatial adjectives and of their affirmative and negative comparative forms.

Indep. Variables.	Dep. Variables.	Term.	Form.	No. of cases.	Main sources of variation.	Sum of squares.	D F	Mean Square.	F	Sign. of F.
Year (BC) Sex	Score	Unmarked		40	Year Res.	16.900 493.172	1 36	16.900 13.699	1.234	.274
Year (BC) Sex	Score	Unmarked	Aff.	20	Year Res.	1.950 227.000	1 16	1.950 14.188	.137	.716
Year (BC) Sex	Score	Unmarked	Neg.	20	Year Res.	5.393 189.429	1 16	5.393 11.839	.455	.509
Year (BC) Sex	Score	Marked		40	Year Res.	216.585 625.200	1 36	216.585 17.367	12.471	.001
Year (BC) Sex	Score	Marked	Aff.	20	Year Res.	150.835 218.433	1 16	150.835 13.652	11.049	.004
Year (BC) Sex	Score	Marked	Neg.	20	Year Res.	72.782 280.833	1 16	72.782 17.552	4.147	.059

These analyses indicate that the children in this study acquire comprehension of unmarked spatial adjectives between the ages of 7.0 and 8.11, whereas comprehension of the marked adjectives is acquired between 8.0 and 9.11 years. This pattern of acquisition is clearly evident in Figures 1. and 2.

The second hypothesis postulates that unmarked spatial adjectives are acquired before marked spatial adjectives, with significant differences occurring between the mean scores of the groups taking tests on unmarked words and the mean scores of the groups taking the tests on marked words constituting evidence to support acceptance of the hypothesis.

Initial evidence is derived from an Analysis of Variance of the scores in Table 6. The results are given in summary form in Table 12. and the full Analysis of Variance table can be found in Table 8.

Table 12.

Analysis of Variance to show the effect of the marking factor on the comprehension of spatial adjectives in their comparative forms.

Independent Variables.	Dep. Var.	No. of cases	Main sources of vari ation	Sum of squares	D F	Mean Square	F	Sign. of F.
Marking F. Sex Year(A,B,C,D)	Score.	160	M.Factor.	143.250	3	47.750	2.912	.037
			Res.	2098.948	128	16.398		

The "marking factor" is a significant source of variation in the mean scores, F (3) = 2.912, p <0.05, but the term "marking factor" in the data is the term used to refer to the division of the data into the four categories of adjectives tested. Thus the significant variation is not necessarily between the mean scores of children tested on unmarked and marked terms. However, it appears from the mean scores in

Tables 6 and 7. that if significant differences exist within a year group between the mean scores of those children tested on unmarked terms, and those tested on marked terms, they are to be found in the 8.0 - 8.11 age groups, labelled B and D.

A $\underline{t}$ test reveals that significant differences are present, in that particular age group, both between the mean scores of children tested on unmarked and marked one dimensional spatial adjectives ($\underline{t}$ (38) = 2.29 $p < 0.05$) and between the mean scores of children tested on unmarked and marked two dimensional spatial adjectives ($\underline{t}$ (38) = 2.26, $\underline{p} < 0.05$).

Analyses of Variance comparing the mean scores of the groups tested on the same forms of the unmarked and marked terms within each year, e.g. unmarked affirmative with marked affirmative, show that no significant differences exist between the mean scores of children tested on different forms of the unmarked and marked terms in the age groups 7.0 - 7.11 years, and 9.0 - 9.11 years.

The significant difference within the 8.0 - 8.11 year age groups exists between the mean scores of children tested on the affirmative comparative form of one dimensional unmarked and marked terms F (1) = 5.254, $\underline{p} < 0.05$. For the equivalent groups tested on two dimensional terms the value of F (1) = 3.612, $\underline{p} < 0.076$. Details of the analyses are set out in **Table 13.**. Full tables can be found in Appendix VII.

Table 13.

Analyses of Variance to show the effect of "Marking" on the comprehension of comparative forms of spatial adjectives wihin each year group.

Age Group.	Indep. Variables.	Dep. Variables.	Form.	No. of cases.	Source of variation.	Sum of Squares.	D F	Mean Square.	F.	Sign. of F.
7.0 to 7.11 A	Marking Sex.	Score.	Aff.	20	Marking.	3.601	1	3.601	.106	.749
					Res.	543.857	16	33.991		
	Marking Sex	Score	Neg.	20	Marking	1.197	1	1.197	.052	.822
					Res.	368.300	16	23.019		
8.0 to 8.11 B	Marking Sex	Score	Aff.	20	Marking	70.727	1	70.727.	3.612	.076
						313.333	16	19.583.		
	Marking Sex	Score	Neg.	20	Marking	29.387	1	29.387	1.374	.258
					Res	342.262	16	21.391		
9.0 to 9.11 C	Marking Sex	Score	Aff.	20	Marking	4.651	1	4.651	.563	.464
					Res	132.100	16	8.256		
	Marking Sex	Score	Neg.	20	Marking	.200	1	.200	.025	.876
					Res	128.000	16	8.000		
8.0 to 8.11 D	Marking Sex	Score	Aff.	20	Marking	22.882	1	22.882	5.254	.036
					Res.	69.679	16	4.355		
	Marking Sex	Score	Neg.	20	Marking	8.450	1	8.450	.671	.425
					Res.	201.417	16	12.589		

This evidence partially supports acceptance of Hypothesis 2. Additional support is given by the Analyses of Variance in **Table 14.** If age is a significant factor in the variation of mean scores of children tested on unmarked terms before it becomes a significant factor in the variation of mean scores of children tested on marked terms, then an order of acquisition of unmarked and marked terms is indicated. The full Analyses of Variance tables are shown in Appendix VI.

Table 14.

Analyses of Variance to show the effect of age on the order of acquisition of spatial adjectives.

Indep. Variables	Dep. Variables	Term.	No. of cases	Source of variation	Sum of squares	D F	Mean Square	F	Sign. of F.
Year (AB) Sex	Score	Unmarked.	40	Year	150.684	1	150.684	6.473.	.015
				Res	838.056	36	23.279		
Year (AB) Sex	Score	Marked	40	Year	6.400	1	6.400	.246.	.623
				Res	936.667	36	26.019		
Year (BC) Sex	Score	Unmarked	40	Year	16.900	1	16.900	1.234	.274
				Res	493.172	36	13.699		
Year (BC) Sex	Score	Marked	40	Year	216.585	1	216.585	12.471	.001
				Res	625.200	36	17.367		

The results show that there is a significant difference between the mean scores of the children aged 7.0 - 7.11 years and those aged 8.0 - 8.11 years when tested on unmarked adjectives ($F(1) = 6.473$ $p < 0.05$). This does not occur with these types of spatial adjectives when the scores of the second and third age range children are compared.

However, when comparing the mean scores of the age groups tested on the forms of marked adjectives, significant differences occur only between the age groups 8.0 - 8.11 years and 9.0 - 9.11 years. (F (1) = 12.471, $p < 0.001$). Thus the acquisition of comprehension of unmarked terms appears to occur between the ages of 7.0 and 8.11 years, whereas, for the marked terms it appears to occur between the ages of 8.0 and 9.11 years, as shown graphically in Figure 1.

Hypothesis Three, which was tested within the 8.0 - 8.11 year old age group, states that the comparative forms of one dimensional spatial adjectives are acquired before the equivalent forms of two dimensional spatial adjectives. Significant differences occurring between the mean scores of groups of children tested on the adjectives of one and two dimensions constitutes evidence in support of the third hypothesis. An initial Analysis of Variance of the data in Table 6 appears in Table 15. The full table is in Table 7.

Table 15.

Analysis of Variance to show the effect of the dimensional feature of spatial adjectives on the comprehension of their comparative forms.

Indep. Variables.	Dep. Variables.	No. of cases.	Main source of variation.	Sum of squares.	D F.	Mean square.	F.	Sign of F.
Year (ABCD) Sex Marking	Score	160.	Year.	912.137.	3.	304.046.	18.542.	.001.
			Res.	2098.948.	128.	16.398.		

Since for the purposes of data analysis, the children from the same age group i.e. 8.0 - 8.11 years, who were tested on one dimensional and two dimensional adjectives were labelled as year groups D and B respectively, the appearance of year as a main source of variation $\underline{F}$ (3) = 18.542, $\underline{p} < 0.001$ in **Table 15.** indicates the need for a further analysis to see whether significant differences are present between the two particular groups B and D. This analysis, in **Table 16.**, shows that the dimension of the adjective is a main source of variation in the mean scores $\underline{F}$ (1) = 14.914, $\underline{p} < 0.001$.

Table 16.

Analysis of Variance to show the effect of the dimensional feature of spatial adjectives on the comprehension of their comparative forms within the 8.0 - 8.11 age group.

Indep. Variables.	Dep. Variables.	No. of cases.	Main source of variation.	Sum of squares.	D F.	Mean square.	F.	Sign of F.
Dims.	Score	80.	Dim.	245.000.	1.	245.000.	14.914.	.001.
Sex.			Res.	1248.461.	76.	16.427.		

Further analyses to ascertain exactly where the significant variations occur, show, (Figure 3., **Table 17**) that they are only present between the mean scores of groups tested on the affirmative and negative comparative forms of the marked terms, $\underline{F}$ (1) = 9.388, $\underline{p} < 0.01$ and $\underline{F}$ (1) = 5.292, $\underline{p} < 0.05$ respectively. Full Analyses of Variance tables for **Tables 16 and 17** are in Appendix VIII.

These analyses, related to Hypothesis 3, give support to its acceptance, and consequently to the notion that the comparative forms of one dimensional spatial adjectives are acquired before the comparative forms of two dimensional spatial adjectives.

Figure 3.

Comprehension of the affirmative and negative comparative forms of one and two dimensional spatial adjectives.

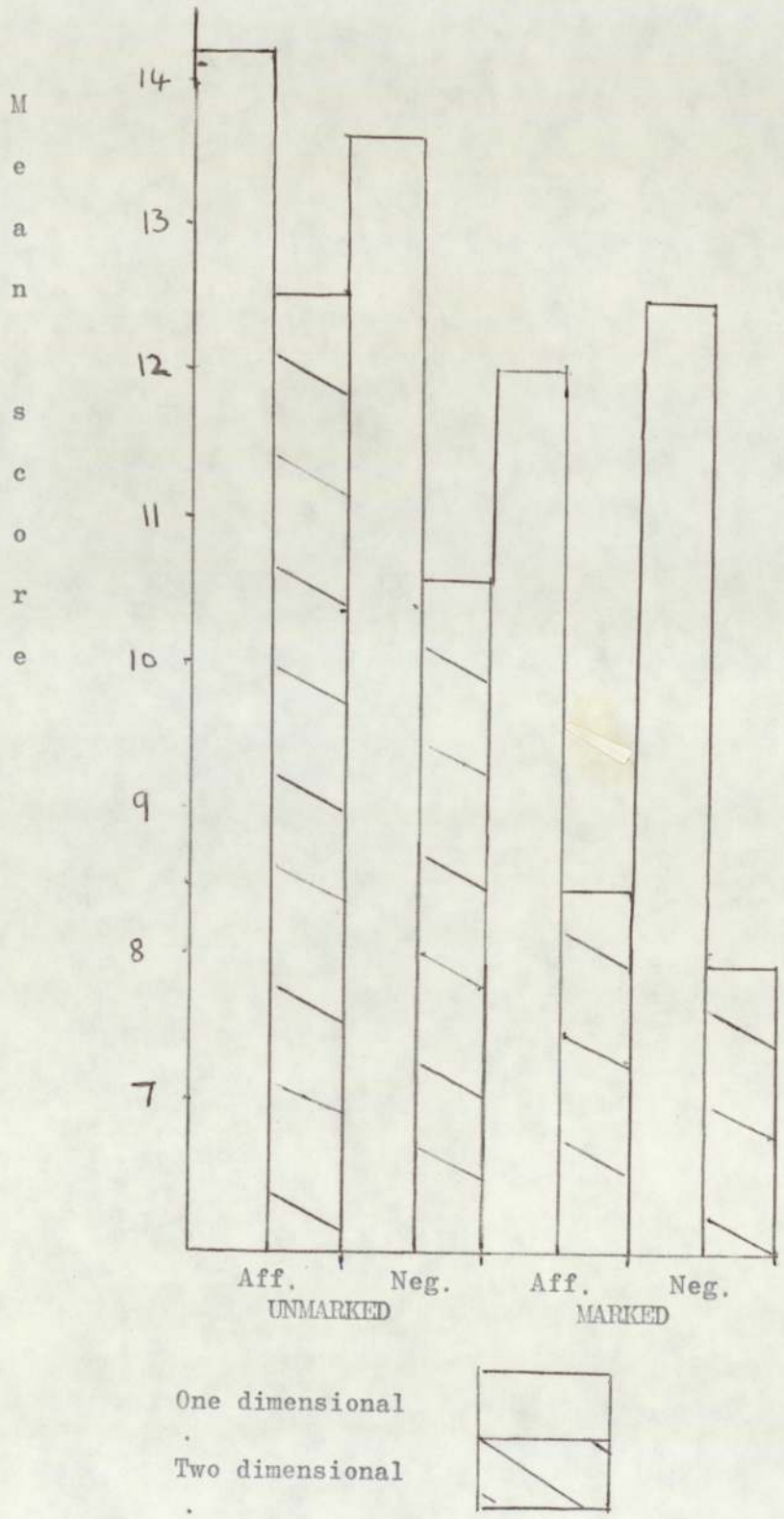


Table 17.

Analyses of Variance to show the effect of the dimensional feature on the comprehension of unmarked and marked spatial adjectives in their affirmative and negative comparative forms.

Indep. Variables.	Dep. Variables.	Term.	Form.	No. of cases	Source of variation.	Sum of squares.	D F.	Mean square.	F.	Sign. of F.
Dimension. Sex	Score.	Unmarked.	Aff.	20.	Dim.	7.260.	1.	7.260.	.699.	.415.
					Res.	166.083.	16.	10.380.		
Dimension. Sex	Score.	Unmarked.	Neg.	20.	Dim.	48.110.	1.	48.110.	3.873.	.067.
					Res.	198.762.	16.	12.423.		
Dimension. Sex	Score.	Marked.	Aff.	20.	Dim.	127.279.	1.	127.279.	9.388.	.007.
					Res.	216.929.	16.	13.558.		
Dimension. Sex	Score.	Marked.	Neg.	20.	Dim.	114.075.	1.	114.075.	5.292.	.035.
					Res.	344.917.	16.	21.557.		

D I S C U S S I O N.

The results of this study justify the acceptance of the first hypothesis. Children in the first, second and third years of the junior school do not have a complete understanding of the meaning of spatial adjectives. Their understanding increases during these years, as demonstrated by the fact that age is a significant contributory factor in the variation of mean scores of children tested on all forms of the terms. Comparing the mean scores from the first age range with those from the second age range, there is significant difference between the mean scores of the cell groups tested on the unmarked terms, but not between the mean scores of cell groups tested on marked terms. Comparing the cell groups from the second age range with the cell groups from the third age range, there is significant difference between the mean scores of the cell groups tested on the marked terms, but not between the mean scores of the cell groups tested on unmarked terms. Thus for the children in this study it is apparent that understanding of the unmarked terms develops significantly during their seventh year, whilst understanding of the marked terms develops during the subsequent year. There is, however, no significant difference between the mean scores of the second and third age groups tested on the negative comparative forms of the marked terms. Even the children of mean age 9.5 years achieved a mean score of only 11.6 marks on this test. The reason for this may be that the development of understanding of the secondary reference point interacts with the ability of children to understand negative sentences. Scores on the affirmative comparative forms of terms are higher

than scores on the negative comparative forms of the terms, but this trend clearly does not show conclusively that negative forms are more difficult to comprehend than affirmative forms. If, as was discussed in Chapter 2 of this study, comprehension does result from the application of a number of processes or rules (Clark E. 1974), with the processing of a negative requiring an extra rule to be applied, then comprehension of negative statements will be acquired later by children than comprehension of affirmative statements. In order to use the extra rule, however, children must first be able to understand affirmative statements. Thus in the tests in this study, the subjects, before being able to comprehend the negative comparative form of spatial adjectives, must be able to understand the affirmative form, which entails an understanding of the use of the secondary reference point. The children in this study applied the extra rule well enough to attain similar scores for the negative and affirmative comparative forms, although the latter is somewhat lower where the mean score on the affirmative form is significantly different from the mean score obtained by the equivalent cell group from the younger age group. Thus where there is significant difference between the mean scores of the second and third age groups when tested on the affirmative form of the marked terms, there is 1.4 points difference between the mean scores of cell groups tested on the affirmative and negative comparative forms of the marked terms within the third age range. It may be that children have the ability to apply the extra rule

required for comprehension of negative forms, but that where understanding of the role of the secondary reference point has only recently been acquired, they have difficulty in using the knowledge correctly. The understanding of the role of the secondary reference point may consequently be seen as a factor in the occurrence of the lower mean scores attained by children tested on the negative comparative forms of spatial adjectives. The interaction of both these factors may explain why no significant development of understanding has occurred of the negative comparative forms of the marked terms between the second and third age groups.

Although the tests for Hypothesis 1. were used only in relation to so called two dimensional spatial adjectives, other experimental evidence (Clark E. 1972, Ehri 1975) suggests that such developmental progress also occurs in the achievement of full understanding of other spatial adjectives.

The results of this study only partially support the acceptance of Hypothesis 2, that the unmarked words are learned earlier than the marked words. In the age groups 7.0 - 7.11 years and 9.0 - 9.11 years there is no significant difference between the levels of comprehension of unmarked and marked words. However, in the age group 8.0 - 8.11 years there are significant differences, both within the groups tested on one dimensional and two dimensional spatial adjectives. The results give a further comparison, which supports Hypothesis 2. They show that significant progress is made in acquiring comprehension of the unmarked words between the ages of 7.0 years and 8.11 years, but that significant progress in acquiring comprehension of the marked words occurs between ages 8.0 years and 9.11 years.

Though there are no significant differences between the mean scores of groups tested on unmarked and marked terms within the first or third age groups, the mean scores of those tested on the unmarked terms is in every case higher than the mean scores of those tested on the marked terms. Thus the trend is in the direction predicted by the hypothesis. These results may be accounted for by the recurrence, as problems with the secondary reference point are being overcome, of difficulties which originate in the perceptual discrepancy between the child's ability to perceive positive as opposed to negative distance relative to the secondary reference point along a dimension.

Perhaps the child in learning to understand spatial adjectives has to reconcile two types of knowledge. Previous perceptual preferences may cause confusion as he begins to apply knowledge of linguistic constraints to developing concepts - in this instance, the concept of relations. In attempting to explain cognitive development from a linguistic standpoint both syntactic and semantic theories have contributions to offer. Linguistic form can indicate meaning by the use of grammatical additions, the order of words, and the function of words, but although conceptual development may progress without full knowledge of the appropriate syntax, the reverse cannot apply. For instance, an understanding of the future tense is required if hypothetical statements are to be understood, e.g. "If it is cold, I will wear a jersey." The grammar of this construction in English is complicated and does not appear until the early school years. In Russian

the grammar is elementary, yet the form still does not appear until the underlying cognitive processes develop. This may be an indication of universal cognitive processes (Slobin 1966, Cromer 1974).

If children do have such universal processes of cognitive development, any variation in the time span between mastery of expressions of certain concepts will be a function of the complexity of the language form, and should give clues to the nature of the processes of acquisition. Slobin (1973), found universals across different languages and suggested operating principles which affect the process of acquisition, for instance, that the child pays attention to the suffixes rather than the prefixes of words. In English the "s", which denotes the plural form, comes at the end of the word. This leads to the plural form in English being learned early, because there is a good fit between the operating principle and the linguistic form.

However, the syntactic element of language must not be overemphasised, for often a listener requires only semantic information to discern meaning, (Greene 1974), (Smith C. 1970), with syntactic form being used to clarify meaning where necessary. A processing model of language comprehension, like that of Clark H. (1974) in which difficulties of processing and acquisition are taken to be functions of the number of rules which have to be applied in order to attain comprehension, assume that conceptual systems are fully consolidated before the learning of appropriate language begins (Tanz 1980). If this is so, then the results of the tests used in this

experiment to assess language comprehension, would only demonstrate that different linguistic forms were of differing degrees of complexity, and that the understanding of language was mediated by facts related to the structure of language, and not related directly to perceptual complexity. In this particular experiment, the implication would be that the concept of relations was completely developed, and subsequently as full comprehension of spatial adjectives was being acquired, the order of acquisition would reflect the linguistic complexity of those particular terms.

Clark H. (1969) derived his criteria of linguistic complexity from Bierwisch's (1967) suggestion that sentences have varying degrees of "normality" depending upon how many outside conditions have to be met in order to make them acceptable. Thus whereas the sentence "The table is twice as long as the bench", can be designated as "normal", the sentence "The table is half as short as the bench" is "not normal". These two conditions were designated respectively as positive and negative, by Bierwisch, but on purely linguistic grounds.

Within his hypothesis relating to P and L space the linguistic justifications that Clark H. (1969) gave for the unmarked - marked distinctions between spatial adjectives, which he hypothesised, would dictate the order of their acquisition, corresponded with the positive - negative distinctions of Bierwisch. First Clark noted that unmarked adjectives name the dimension, i.e. long - length. Second, only unmarked terms can be used in measure phrases of the type "One metre long", for one does not say "One metre short."

Third, the unmarked terms make no presuppositions about a measurement. Thus although "How tall is Tom?" does not pre-suppose that Tom is tall, "How short is Ben?" pre-supposes that Ben is short.

Experimental evidence, as noted in Chapter 2, does not give conclusive support to an order of acquisition of spatial adjectives predicted by the marking theory proposed by Clark H. This casts doubt on the proposition that the concept of relations is completely developed before children begin to be able to comprehend spatial adjectives. It seems more likely that children initially acquire words like long and short separately. Ehri (1976) suggested that the order of acquisition of the 'marked' adjectives depends on the lexical history of the adjectives in question. Thus "short", "low" and "skinny" appear as synonyms of "little" and are attached to the dimensional concepts, i.e. length, height and fatness, as they emerge. The result of Townsend's investigation in 1975 showed only isolated instances of the overextension of the meaning of unmarked spatial adjectives to encompass the meaning of the marked term, as had been suggested by Clark E. (1970). This led him to conclude that children respond randomly to the meaning of an adjective, until they are able to respond correctly. If the words "long" and "short" are acquired separately as synonyms for "big" and "small", (Clark E. 1972), and these adjectives themselves have very different histories of acquisition arising from variations in children's previous contexual experiences, initially the linguistic discriminator may be overridden (Donaldson 1978, Clark H. 1976) and there will be no apparent difference between

the children's understanding of the unmarked and marked forms.

The results of the tests in this study correspond with those discussed, in not giving unequivocable support to the "marking theory." The fact that there are no significant differences between the mean scores of the groups of children tested on unmarked and marked forms of spatial adjectives within the lowest age group supports the theory that these children respond at random to the meaning of the words, which are at this age taken to apply to separate dimensions.

Significant differences do occur, both in the tests on one dimensional and two dimensional spatial adjectives, between the mean scores of children tested on unmarked and marked words within the age group with mean age 8.5 years. At about this age, according to Piaget (Gruber and Veneche 1977), the concept of relations is beginning to be acquired. An understanding of relations requires the ability both to invoke a reference point against which to compare the size of objects along one dimension, and to use one object to provide such a reference point in order to make a comparison with another object. This understanding enables children to realise, for instance, that one object is long compared with another which is short, and that it is long compared with a contexually determined criterion of length. An understanding of the concept of relations, and the ability to use a secondary reference point which it entails, also enables children to understand the comparative forms of spatial adjectives.

The discrepancies which became apparent between the scores on tests of unmarked and marked terms at this age may thus be

the consequence of attempts to map developing knowledge of linguistic constraints onto developing conceptual knowledge. Clark H. (1974) argued that a model of language acquisition in which the acquisition of spatial terms was governed directly by perceptual complexity should only be considered as applicable in the special circumstances which occur when children begin to learn spatial terminology before having a fully consolidated system of conceptual space. Such circumstances may be present in this instance, for if the children at this age are beginning to understand the concept of relations, they are moving from the perceptually dominated period, designated by Piaget as the Pre-Operational stage of learning, to the stage of Concrete - Operations.

In relation to Hypothesis Two the perceptually positive nature of the forwards and upwards directions may account for the significant differences between the mean scores of children tested on unmarked and marked terms in this second age group. For full comprehension, children must know that words like taller refer to a measurement in a positive direction from the secondary reference point, whereas, words like shorter refer to a negative measurement from the secondary reference point. Consequently, as understanding of the concept of relations develops, linguistic conventions are applied. Although unmarked and marked terms are initially learned separately, full understanding of the unmarked terms will be reached prior to full understanding of marked terms. The lack of significant difference between the mean scores of the cell groups tested on unmarked and marked terms in the third age group shows that by

this stage children have learned to understand the marked terms as well as they can understand the unmarked terms.

The results of this study support the acceptance of Hypothesis 3. Children achieve understanding of spatial adjectives which require only one dimensional referents before they achieve understanding of spatial adjectives which require two dimensional referents. Thus the affirmative and negative comparative forms of tall, short, high, low, long, short, far and near are understood before the same forms of wide, narrow, thick, thin, deep, shallow, fat and skinny.

Clark's (1973) hypothesis about the alignment of P and L Space stated that the acquisition of the meaning of spatial adjectives could be characterised as consisting of a dimensional feature and a polarity feature, of which the dimensional feature is acquired first. In this study, both the unmarked and marked groups from the second age range tested as one dimensional spatial adjective forms, e.g. not taller, shorter, not shorter, scored significantly higher than the groups being tested on the same form of two dimensional spatial adjectives. These results correspond with those obtained by Clark E. (1972) and Eilers et al (1974). In view of the fact that the subjects of this present study had a mean age of 8.5 years, whilst those of the other two studies were approximately six years of age, it seems justifiable to generalise the discussion to encompass children in the intervening age groups and suggest that there is strong evidence that spatial adjectives which need reference to only one dimension i.e. tall-short,

high-low, long-short, and far-near are learned before those requiring reference to two dimensions, i.e. deep-shallow, wide-narrow, fat-skinny, and thick-thin.

In the discussion related to Hypothesis 2, it is argued that the results of this study give support to the notion that underlying perceptual factors are responsible for the order of acquisition of spatial adjectives. The underlying perceptual factor responsible for the order of acquisition predicted by Hypothesis 3 may be the salience of the vertical dimension in human perception. The fact that children are able to understand the comparative and negative forms of one dimensional spatial adjectives must reinforce the conclusion that it is the difference in the dimensional feature which causes the difference in levels of understanding.

It may be argued that the order of acquisition of the two groups is due to the different frequencies of occurrence of the words in adult language. The more often a word is heard, the earlier it will be understood by the child. The table in Appendix III is taken from Kucera and Francis (1967). It illustrates the fact that the frequencies of occurrence of tall-short, high-low, long-short, wide-narrow, thick-thin, and deep-shallow, are indeed consistent with the predictions of a perceptually based hypothesis. However, where, as in the experiments of Clark E. (1972), the task involved the substitution of stimulus words by their opposites, those words used incorrectly as substitutes still preserved the dimensional component of meaning held in common with the original terms. A frequency hypothesis could not account for this feature and consequently it is possible to argue that the discrepancy in the frequency count occurs ultimately for psychological reasons.

Brown (1973), examining the frequency of use of morphemes by parents, and the order of acquisition by their children of the same morphemes, found no relationship. Herriot (1970), summarising tachistoscopic experiments in which the recognition times for frequently used words was shorter than the recognition times for less frequently used words, noted that the correlation was probably due to the shorter length and greater meaningfulness of frequently used words, and certainly not due to frequency of experience. Such frequency, according to Tanz (1980) should be considered as a reflection of the interplay of syntactic, conceptual and pragmatic factors in language acquisition.

Evidence which supports a theory that the order of acquisition of spatial adjectives has origins in the earliest perceptions of children has a relevance to the school curriculum and to the materials which teachers use in their work which will be discussed in detail in the Conclusion of this study. However, one immediate and apparently obvious implication is that in teaching the "language of mathematics", teachers should include work designed to assist the development of understanding of the affirmative and negative comparative forms of the spatial adjectives, and that this work should continue throughout the primary school. Careful consideration, however, must be given to the problem of whether teaching the language will necessarily be of value to the teacher in enhancing the conceptual development of the child.

The Russian psychologist, Vygotsky (1962) considered

language to have a starting point separate from the thought processes, with the two activities coming to overlap at an early age, when thought becomes verbal and speech internalised. Developing this suggestion Luria and Yudovitch (1971), worked with twins who, although having no mental impairment, had evolved no communication system other than that which they used between themselves. After separating them and using a specific language programme with one child, the experimenters concluded that communication with an adult was a critical factor in the development of the thought processes. The vehicle of this communication was language.

Jerome Bruner (1974) proposed that a relationship exists between perception, conceptual development, language learning and problem solving. All are active processes containing elements of intention and of matching incoming sensory information with prior experience. The degree of match determines the resultant activity, and the subject infers rules or principles from specific cases before applying them to more general instances.

Bruner envisaged conceptual development as having three stages by which a child represents the world, the enactive, iconic and symbolic modes. The transition from the iconic imagery of concepts to the symbolic representations of concepts occurs during the early school years. Symbolic representation, in its linguistic form, is the most advanced way of representing the world, and is able to help in the child's conceptual development. Such symbolisation skills can be encouraged by the use of the two initial modes of representation (Sonstroen 1966).

Thus for Bruner, school is a place where these skills ought to be learned by methods of instruction related to the mode of representation used by the child, and conceptualisation developed through the employment of the other modes in the learning process. Put simply, talking and writing about their own experiences will speed the conceptual development of children.

Whereas Bruner and Luria and Yudovitch concluded that "teaching the language" appropriately would aid conceptual development, Sinclair-de-Zwart (1966) reached the opposite conclusion from her attempts to teach pre-operational stage children the language used by those at the operational stage. She found that a group of non-conservers, after being taught the comparative terms used by conservers, did not make significant progress on conservation tests. The lack of success of this attempt may have meant that language was not of prime significance in conceptual development, or that the particular language used was inappropriate. Bruner (1974) has suggested that if identity is the essential ingredient of conservation then the teaching of "sameness" would have been more appropriate to aid conservation tasks.

Piaget saw cognitive development as a restructuring and modification of a previously acquired network of concepts, established by the interaction of objects and people in the environment, (Gruber and Veneche 1977). Language was for Piaget a tool of developing cognitive processes. A child's awareness of himself as an agent acting upon the environment is related to the general use of grammatical functions expressing agent-action, action-object relations (Sinclair-de-

Zwart 1973). Although the discovery of meaning and the learning of the correct linguistic terms interact, language is not seen as an integral part of cognitive growth. However, if thinking, in Piagetian terms, results from operational intelligence, which begins at approximately seven years of age, language precedes it by several years (Turner 1975). In the early stages, language is symbolic and as such can only stand for what is already known, but subsequently language which gives the possibility of transcending the here and now, is appropriate as a vehicle for formal thought, which is concerned with the hypothetical and possible, rather than the actual. Herriot (1970) concluded that language and behaviour must be related before the child reaches the Pre-operational stage, but that this fact need not be seen as a contradiction of Piaget's position. Piaget was concerned with language used as a symbol system for representation, rather than as a register of behaviour, or an indicator of perceptual universals.

It is argued in Chapter Two that words like "taller" can only be interpreted with reference to their context and that difficulties of understanding may be due to complexity of the language structure, and the stage of development of the child's cognitive apparatus (Donaldson and Wales 1970). The children are attempting to map developing language on to developing cognitive levels and just as Smith F. (1973) and Clark M. (1976) suggest is the case with developing reading skills, the child's interpretation of incoming information derives from his knowledge of language, his assessment of

the language producers intent, and his interpretation of the situation. Though adults may give language priority over context, children probably do the reverse (Donaldson 1978).

Contexual understanding may be acquired from action schema, derived from external experience, and from features of the language. Hence different experiences may lead to different concepts, or to knowledge of a concept which is suited only to specific situations. The acquisition of concepts, and the transfer from the Pre-operational stage to the Concrete-operational stage at 7 - 8 years may be particularly influenced by language, for it is a feature of the Pre-operational stage that perceptual features rather than functional attributes dominate performance at problem solving (Greene 1974).

As the child progresses to the concrete operational stage of thought he learns not only to handle logical operations on the combination of classes, but also on the relations within the same class, (Williams and Shuard 1976), processes which are communicated by spatial adjectives, and may be confused if the child has difficulty in making a good fit between his developing cognition and his ability to comprehend the appropriate linguistic forms. It may be that the very requirements of communication enforce changes in the child's language, which subsequently assist his cognitive development. Teaching which takes account of the interrelation of cognitive and linguistic development and the relevance of contexual experience to both, ought to assist conceptual development.

In the conclusion of this study, the implications of this discussion will be applied to the task of the teacher who is seeking to assist children to understand the concept of relations and the language related to it.

C O N C L U S I O N.

The previous discussion of the results of the tests which support acceptance of Hypothesis 1 conclude that the child's ability to understand and use the secondary reference point in some spatial adjectives is still developing between the ages of 7 and 10 years. Consequently it is suggested that the teaching of language related to particular concepts can aid conceptual development, provided that the teacher takes into account conceptual and linguistic interaction.

The attainment of understanding of spatial adjectives is a process which begins in the pre-school and continues through the infant and junior levels of primary education. The area of conceptual development referred to by spatial adjectives is that of the logical addition of relations between objects belonging to the same class - one of the basic processes of mathematical and logical thinking (Williams and Shuard 1976). So basic, indeed, that Bruner (1974) thought that possibly we ought to concentrate in the early school years on "a series of exercises in manipulating, classifying and ordering objects in ways that highlight basic operations of logical addition, multiplication, inclusion, serial ordering and the like" (p. 420). The concept of relations underlies the ability to carry out any form of measurement.

Teachers of young children use apparatus of varying degrees of sophistication to aid conceptual development. To teach the concept of relations practical aids are essential. One of the earliest relations recognised by the child is "bigger than" and "smaller than". A child of less than two years of age can, after many trials and errors, put a smaller box into a larger one and a cube through a slot into a box. It will, however,

be some years before he is able to recall the procedures and repeat them without having to resort to further periods of trial and error. He is learning by "discovery", or by a hypothetical mode of learning, as opposed to being taught in an expository fashion by the teacher. In order to continue in this fashion the lower infant school child should be given plenty of opportunity to explore the possibilities of both everyday objects, in which size and shape are significant, and mathematical shapes which have constructional interest, and can be used for representational building. By play experience, and teacher-child interaction through language, the child can be introduced to mathematically structured apparatus. Basic apparatus such as blocks of identical shape, but different size, can be employed for pattern making, by placing them alongside each other to give comparisons of length. Unifix blocks, which are plastic cubes each representing one unit, can be pressed together to make rods. Rods of the Stern apparatus cannot be divided, but are scored around so that the units can be seen which make up the rod. Cuisenaire rods have smooth surfaces, but different lengths of rod have their own particular colours. For example, the green rod is six times as long as the white rod, and three times as long as the red. Using such apparatus a child is able to build sequences of lengths, and will come to appreciate the need for all the rods to be placed on the same level surface to attain a true comparison. Thus the child becomes able to re-arrange objects into sequences according to the criterion of size, and is beginning to transfer from the perceptually

dominated, intuitive, Pre-Operational stage, to the stage of Concrete-Operations. At this stage, when faced with problems of conservation, children take into account heights and base areas, and their relationship to volume. They accomplish tasks which demand reversibility in thinking. They proceed through sequences of actions physically, then repeat them mentally and reverse them if necessary in order to return to the starting point. Next, children, wanting perhaps to boast of their achievement in building a bigger snowman, or growing a taller sunflower than their friends, find a moveable tool to use as a comparative object. Initially a body part is likely to be employed, for example, a hand or a foot. Comparisons of distance between two objects pose special problems for the child at this stage - for in reality the distance between, for example, two houses, is not marked by a physical, visible, line. Children need plenty of experience using arbitrary units to make comparative measurements. When the measure is seen to fall short of, or go beyond the target distance, the relevance of a reference point becomes evident.

Comparisons are still being made with the objects present and available to the children. Such "discovery" learning will not occur automatically without appropriate intervention by the teacher. If "discovery via hypothesising" is to be a successful mode of learning, then the assumptions of teacher and taught must correspond, and the former must enable the latter to operate cognitively at the "cummulative-constructionism" end of Bruner's (1974) dimension of cognitive activity, rather than at the "episodic-empiricism" end of the

scale. The child should use a strategy of conservative focussing in order to organise incoming information by its regularity and relatedness and to analyse it for underlying transformational elements which can be used in relation to information which may be received subsequently - he must "go beyond the information given."

A good example of the potency of teacher intervention was shown by George Miller (1956) in an experiment designed to explore the memory processes. One group of children was simply told to memorise pairs of words. Another group was told to remember the pairs by use of their own choice of a mediating word or idea. The third group was actually told which mediating words or ideas to employ. In subsequent memory tests the second group, who had been given a clue to a method of helping their memories, but had to construct it for themselves, scored higher than either of the other groups.

Thus appropriate teacher intervention is not confined to the presentation of structure apparatus, but in addition the teacher must help the child to pose the sort of questions which, when answered, will lead to meaningful learning. Questions which, moreover, will emanate from an enquirer who knows already the sort of things which will count as an answer (O'Connor 1957) and, in the case of the development of theoretical concepts, will allow abstract ideas to be derived from particular instances.

The very vehicle of this intervention is words, the use of which is "governed by the public rules in terms of which we are taught" (Dearden 1968, p.114). The language rules

concerning the secondary reference point of spatial adjectives are inseparable from the development of concepts of relations. The limits of the child's language mean the limits of the child's world (Wittgenstein 1921). Hence, structured learning, organised with regard to the developmental processes involved, can, by instruction and questioning, using appropriate language, lead a child from free imaginative activities to the point at which comparisons of the required nature become meaningful.

The research presented in this study indicates that the teaching of the concept of relations and, consequently, of the language related to it, should continue throughout the infant and junior classes of primary schools. The present author would do this even when the teaching of formal measurement is well advanced. The Mathematics Schemes discussed in Chapter One conclude their specific work on the language of relations when the formal teaching of measurement is begun. This is usually in the books intended for use by children of 7 - 8 years of age.

In the previous chapter the discussion relating to Hypothesis 2 suggests that the discrepancy in understanding between unmarked and marked terms is not present in the first age range because of the variety of routes by which children attain understanding of spatial adjectives.

The reason for the discrepancy between the mean scores of the children tested on the unmarked and marked words in the 8 to 8.11 year old age group may be the development at that age of the concept of relations, and the fact that the children, faced

with mapping developing knowledge of language on to a newly forming concept, are caused particular difficulties in comprehending the marked terms. When in doubt they may revert to their preference for the perceptually salient positive direction, which, when applied to the secondary reference point, leads to the erroneous choice of the unmarked term. A child's ability to comprehend terms which refer to measurement in a negative direction relative to the reference point may be enhanced by the teaching, not only of marked terms in equal concentration to unmarked terms, but also of the affirmative and negative comparative forms of the terms.

In a literacy scheme for 7 - 8 year old children titled "Read, Write and Remember" by Constance Milburn (1975), marked and unmarked terms are concentrated upon equally, as indeed they are in the Reading Scheme for infant children "One, Two, Three and Away" by Sheila K. McCullagh (1972). Most mathematics schemes discussed in Chapter One follow suit, except for the Fletcher Maths Scheme which does not refer to all of the marked terms. However, although unmarked and marked words appeared to receive equal attention there were few concentrated attempts to teach comparative forms, especially of the negative variety.

Hypothesis 3 is supported by the experimental data. If one dimensional spatial adjectives are understood before the two dimensional terms, then it would seem appropriate for teachers of the younger age groups to pay particular attention to the former. When the children can demonstrably understand and correctly use the different forms of one dimensional spatial adjectives, then is the time to concentrate on the attainment

of the understanding of the more complex terms.

At present infant school schemes of work apparently do not take this factor into account. The language programme in "Talk Reform" (Gahagan and Gahagan 1970) does not specifically include spatial adjectives, whereas an American programme (Bereiter and Engelmann 1966) makes the ability to understand and apply polar opposites a minimum goal of language development. The spatial adjectives listed are long-short, big-little, fat-skinny and tall-short. Exercises devised to aid learning of these words involve practices in classifying objects according to their salient dimension, and in answering yes/no questions designed to teach children that if an object is not long, then it is short. In a book entitled "Opposites" published by Hamlyn (1974) the order of introduction of spatial adjectives is big-little, fat-thin, high-low, near-far and finally tall-short. Clearly, although antonyms, being the subject of the book, are evident, there is no semblance of order based on dimensional features, for if these words were ordered by degree of complexity as related to the dimensional criteria the order would be big-little, tall-short, high-low, near-far and fat-thin. Ordering of similar haphazard nature occurs also in the Mathematic Schemes examined in the Introduction to this study.

When formulating school curricula, therefore, it would seem appropriate to ensure that teachers are aware that

(1) teaching the language of the concept of relations may assist understanding of that concept.

Consequently if spatial adjectives are implicitly

assumed by the teacher to have unitary meaning, and are hence taught as having unitary meaning, the acquisition of understanding of the concept of relations may be hindered.

(2) the concept of relations, and the language related to it, need to be understood by children if the teaching of measurement is to succeed.

(3) comparative and negative comparative forms of spatial adjectives should receive considerable attention in language programmes, reading schemes and mathematics schemes.

(4) marked words need as much attention as unmarked words.

(5) in the early stages, if one dimensional spatial adjectives receive more attention than their two dimensional counterparts, correct comprehension of the one dimensional spatial adjectives can be employed as an aid to comprehension of the comparative forms of two dimensional spatial adjectives.

(6) the process of acquisition of the language and the concept of relations is not completed until late in the junior school.

Clearly some of the teaching of mathematical concepts and the language which is an integral part of those concepts, is based on false assumptions about the child's level of understanding, and on inadequate notions about the complexity of the relationship between the perceptual mechanisms and the linguistic restraints which make up the meaning of words.

These factors can be investigated, and taken into account by teachers in primary schools.

Although this study has been concerned with children between seven and ten years of age, and the acquisition of understanding of spatial adjectives, it must not be supposed that such assumptions are necessarily limited to this particular part of the mathematics curriculum, or even to the primary age group of students.

Clark H. (1973) extended his theory that the alignment of P and L space indicated underlying perceptual mechanisms, to predict that where spatial adjectives are also used in relation to time e.g. long, short, near, far, they will, because of the more salient nature of the spatial dimension, first be understood in their spatial roles. Navon D. (1978), however, proposed that because of the way humans conceive attributes, there exists a psychological hierarchy of two levels, where time is the primary level and space the secondary level. It ought to be possible, by using a somewhat similar experimental method to the one described here, to ascertain which of these viewpoints is most likely to be correct. The results could have relevance to the order in which concepts related to time and space are taught and also to the use of language by the teacher, and to the integration of these sections of the mathematics curricula.

At secondary level, the Bullock Report (1975) stimulated Michael Marland (1976) to note in the preface of a Working Party Report that there was no doubt that a great deal of learning occurred via language, because access to ideas, knowledge, and

explanations was largely through words. The Working Party had been set up to consider a language policy across the curriculum. One of its recommendations was that each subject department should consider the teaching of meaning of words specific to that subject, and of words given specific meaning within that subject. A later paper, "The Understanding of Non-technical Words in Science" (Cassels and Johnstone 1978) showed that in both England and Australia significant proportions of students did not understand commonly used non-technical words.

It is evident, then, that in aspects of our school curriculum, problems may arise between teachers and taught through lack of appropriate knowledge about the development of the understanding of concepts, and the language related to them. In primary schools underlying perceptual mechanisms may influence this development. The mechanisms, and the levels of understanding reached by children, can be illuminated by the study of language acquisition. Teachers ought to consider linguistic and conceptual factors when making their choice of textbooks and teaching methods, so that in their work they are able to give maximum assistance to the development of understanding by their pupils.

APPENDICES.

Appendix I.

PILOT TEST SCORES.

Comprehension scores on negative comparative forms of two dimensional marked spatial adjectives for the first year group.

Subject.	Sex.	C.A.	Score.
1	F	7.10	0
2	M	7.5	16
3	M	7.5	0
4	F	7.6	10
5	F	8.1	6
6	F	7.9	6
7	M	8.3	7
8	F	8.6	5
9	M	8.2	6
10	F	8.0	14

N = 10 Mean C.A. = 7.10

Mean score = 7.0

S.D. = 5.19

Comprehension scores on affirmative comparative forms of marked two dimensional spatial adjectives for the second year group.

Subject.	Sex.	C.A.	Score.
1	F	8.10	12
2	M	8.5	14
3	F	9.1	12
4	M	9.3	12
5	F	8.10	16
6	M	8.10	12
7	F	8.9	8
8	M	8.3	6
9	M	8.6	0
10	F	8.5	4

N = 10 Mean C.A. = 8.9

Mean score = 9.6

S.D. = 4.98

Comprehension scores on affirmative comparative forms of unmarked one dimensional spatial adjectives for the second year group.

Subject.	Sex.	C.A.	Score.
1	M	9.0	16
2	F	8.9	16
3	M	8.10	15
4	M	8.10	14
5	F	9.5	13
6	M	9.4	12
7	F	8.10	16
8	M	9.0	12
9	M	9.0	11
10	F	8.6	15

N = 10 Mean C.A. = 8.11

Mean score = 14.0

S.D. = 1.88

Comprehension scores on negative comparative forms of unmarked two dimensional spatial adjectives for the third year group.

Subject.	Sex.	C.A.	Score.
1	F	9.10	16
2	M	9.4	16
3	M	10.0	16
4	M	10.2	16
5	M	9.8	12
6	F	9.6	16
7	M	10.2	16
8	F	9.6	15
9	F	9.10	12
10	F	10.0	12

N = 10. Mean C.A. = 9.10

Mean score = 14.7

S.D. = 1.90.

Comprehension scores on affirmative comparative forms of unmarked two dimensional spatial adjectives for the fourth year group.

Subject.	Sex.	C.A.	Score.
1	M	11.1	16
2	F	11.4	16
3	M	11.0	15
4	F	11.2	15
5	F	10.9	14
6	M	10.6	16
7	F	10.7	12
8	M	10.9	15
9	F	11.0	16
10	M	10.10	14

N = 10 Mean C.A. = 10.11

Mean score = 15.2

S.D. = 1.32

Appendix II

MAIN EXPERIMENT SCORES AND READING AGES.

Comprehension scores on comparative forms of unmarked and marked two dimensional spatial adjectives for the age group 7.0 - 7.11 years.

Unmarked affirmative.

Subject.	Sex.	C.A.	Score.	R.A.
001	M	7.4	16	7.6
002	F	7.7	14	7.11
003	M	7.2	0	7.0
004	F	7.10	0	6.6
005	F	7.4	0	5.4
006	M	7.9	8	7.8
007	F	7.2	14	10.2
008	F	7.4	12	6.9
009	F	7.7	2	7.11
010	M	7.4	10	7.0

N = 10 Mean R.A. = 7.5

Mean score = 7.6. Mean C.A. = 7.5

S.D. = 6.51

Unmarked negative.

Subject.	Sex.	C.A.	Score.	R.A.
011	M	7.3	10	6.9
012	M	7.2	13	8.0
013	M	7.2	9	7.6
014	F	7.5	6	7.0
015	M	7.10	13	8.4
016	M	7.8	11	9.10
017	F	7.10	8	8.1
018	F	7.6	2	8.8
019	M	7.5	1	7.5
020	F	7.3	0	7.1

N = 10 Mean R.A. = 7.10

Mean score = 7.3 Mean C.A. = 7.5

S.D. = 4.86

Marked affirmative.

Subject.	Sex.	C.A.	Score.	R.A.
021	F	7.2	10	8.1
022	F	7.8	10	7.9
023	M	7.4	0	7.1
024	F	7.1	6	7.2
025	F	7.6	0	7.7
026	M	7.6	14	7.9
027	F	7.8	10	7.4
028	F	7.10	14	7.0
029	M	7.9	0	7.1
030	M	7.10	6	7.8

N = 10 Mean R.A.=7.7

Mean score = 7.0 Mean C.A.=7.5

S.D. = 5.51

Marked negative.

Subject.	Sex.	C.A.	Score.	R.A.
031	M	7.3	12	7.6
032	F	7.9	10	8.6
033	F	7.11	4	7.5
034	F	7.7	9	9.2
035	M	7.3	1	7.1
036	F	7.4	0	6.10
037	M	7.4	0	7.10
038	M	7.4	11	9.0
039	F	7.6	13	7.6
040	M	7.2	6	7.0

N = 10 Mean R.A. = 7.9

Mean score = 6.6. Mean C.A. = 7.5

S.D. = 5.07

Comprehension scores on comparative forms of unmarked and marked two dimensional spatial adjectives for the age group 8.0 - 8.11 years.

Unmarked affirmative.

Subject.	Sex.	C.A.	Score.	R.A.
041	M	8.6	4	9.9
042	M	8.8	16	8.8
043	M	8.0	14	8.0
044	F	8.4	14	7.5
045	M	8.7	16	7.9
046	M	8.2	11	7.7
047	F	8.10	15	8.8
048	M	8.5	7	7.2
049	M	8.1	15	11.0
050	M	8.8	13	8.7

N = 10 Mean R.A. = 8.5

Mean score = 12.5 Mean C.A. = 8.5

S.D. = 3.52

Unmarked negative.

Subject.	Sex.	C.A.	Score.	R.A.
051	F	8.8	11	7.11
052	M	8.1	8	8.8
053	M	8.2	16	9.0
054	F	8.3	10	10.2
055	F	8.9	14	7.2
056	F	8.5	10	10.7
057	F	8.10	8	8.10
058	M	8.6	12	9.4
059	F	8.3	2	8.11
060	F	8.2	13	7.7

N = 10 Mean R.A. = 8.10

Mean score = 10.4 Mean C.A. = 8.5

S.D. = 3.89

Marked affirmative.

Subject.	Sex.	C.A.	Score.	R.A.
061	M	8.10	14	8.4
062	M	8.3	6	9.7
063	F	8.10	0	7.7
064	F	8.11	5	8.7
065	F	8.8	8	7.2
066	M	8.8	16	9.10
067	F	8.6	12	9.10
068	F	6.0	14	8.4
069	M	8.4	8	8.11
070	F	8.3	0	7.8

N = 10 Mean R.A. = 8.7

Mean score = 8.3 Mean C.A. = 8.6

S.D. = 5.61

Marked negative.

Subject.	Sex.	C.A.	Score.	R.A.
071	M	8.9	2	7.1
072	F	6.9	8	7.8
073	F	8.9	8	8.0
074	F	6.6	15	9.5
075	F	8.6	14	9.3
076	M	8.8	12	9.1
077	M	8.0	8	8.7
078	M	8.3	2	7.4
079	F	8.8	0	9.1
080	F	8.2	10	10.0

N = 10 Mean R.A. = 8.7

Mean score = 7.9 Mean C.A. = 8.6

S.D. = 5.17

Comprehension scores on comparative forms of unmarked and marked two dimensional spatial adjectives for the age group 9.0 - 9.11 years.

Unmarked affirmative.

Subject.	Sex.	C.A.	Score.	R.A.
081	M	9.0	14	8.1
082	F	9.6	16	7.6
083	F	9.8	15	11.3
084	F	9.4	15	9.8
085	M	9.10	14	11.5
086	M	9.10	4	11.10
087	M	9.0	15	10.9
088	F	9.0	16	10.1
089	M	9.9	13	8.9
090	M	9.8	15	8.9

N = 10
Mean score = 13.7
S.D. = 3.53

Mean R.A. = 9.10
Mean C.A. = 9.5

Unmarked negative.

Subject.	Sex.	C.A.	Score.	R.A.
091	M	9.8	10	13.3
092	F	9.6	13	11.10
093	F	9.6	13	8.2
094	M	9.5	14	10.10
095	M	9.8	10	12.3
096	F	8.9	6	9.2
097	F	9.0	14	9.0
098	M	9.4	15	7.10
099	M	9.2	13	12.4
100	F	9.4	10	6.10

N = 10
Mean score = 11.8
S.D. = 2.67

Mean R.A. = 10.1
Mean C.A. = 9.5

Marked affirmative.

Subject.	Sex.	C.A.	Score.	R.A.
101	M	9.6	13	8.10
102	F	9.1	13	13.0
103	M	9.5	13	11.7
104	F	9.10	16	9.11
105	F	9.10	15	7.11
106	M	9.1	14	8.6
107	M	9.3	7	12.11
108	M	9.4	12	11.4
109	F	9.5	12	10.6
110	F	9.7	15	7.11

N = 10 Mean R.A. = 10.3

Mean score = 13.0 Mean C.A. = 9.5

S.D. = 2.49

Marked negative.

Subject.	Sex.	C.A.	Score.	R.A.
111	M	9.7	10	8.10
112	F	9.5	14	11.8
113	F	9.3	14	11.11
114	M	9.0	11	10.10
115	M	9.1	10	10.4
116	F	9.0	6	8.5
117	F	9.1	13	11.4
118	M	9.9	14	8.4
119	M	9.4	14	8.8
120	F	9.5	10	10.1

N = 10 Mean R.A. = 10.3

Mean score = 11.6 Mean C.A. = 9.5

S.D. = 2.67

Comprehension scores on comparative forms of unmarked and marked one dimensional spatial adjectives for the age group 8.0 - 8.11 years.

Unmarked affirmative.

Subject.	Sex.	C.A.	Score.	R.A.
121	F	8.0	16	8.10
122	M	8.1	16	9.3
123	M	8.1	14	8.3
124	F	8.2	14	7.5
125	F	8.5	14	7.6
126	F	8.7	10	8.2
127	F	8.7	15	10.1
128	M	8.6	14	8.1
129	F	8.11	16	9.1
130	M	8.10	13	8.6

N = 10 Mean R.A. = 8.6

Mean score=14.2 Mean C.A. = 8.5

S.D. = 3.8

Unmarked negative.

Subject.	Sex.	C.A.	Score.	R.A.
131	M	8.3	14	9.6
132	M	8.2	16	7.5
133	M	8.11	6	8.4
134	M	8.2	16	8.6
135	F	8.8	16	10.6
136	M	8.8	12	8.4
137	F	8.9	14	7.7
138	F	8.4	16	9.9
139	M	8.8	12	7.1
140	F	8.2	14	7.6

N = 10 Mean R.A.=8.5

Mean score = 13.6 Mean C.A.=8.6

S.D. = 3.1

Marked affirmative.

Subject.	Sex.	C.A.	Score.	R.A.
141	F	8.2	12	8.5
142	M	8.7	14	6.11
143	M	8.3	12	8.2
144	F	8.9	12	9.8
145	M	8.3	12	8.5
146	F	8.7	8	8.2
147	F	8.5	13	10.0
148	F	8.8	11	7.10
149	F	8.7	10	9.8
150	F	8.7	16	8.6

N = 10 Mean R.A. = 8.7

Mean score = 12.0 Mean C.A. = 8.6

S.D. = 2.2

Marked negative.

Subject.	Sex.	C.A.	Score.	R.A.
151	F	8.4	14	8.9
152	M	8.0	15	9.1
153	M	8.1	16	10.10
154	M	8.5	10	11.4
155	M	8.11	12	6.8
156	F	8.6	11	8.2
157	M	8.8	3	8.3
158	M	8.4	14	9.8
159	F	8.3	16	11.9
160	F	8.5	12	6.8

N = 10 Mean R.A. = 9.1

Mean score = 12.3 Mean C.A. = 8.5

S.D. = 3.9

Appendix III.

Geometric mean frequencies of pairs of dimensional terms.

Big - small	(545) *
Tall - short	(108)
High - low	(294)
Long - short	(400)
Wide - narrow	(89)
Thick - thin	(78)
Deep - shallow	(39)

From Kucera and Francis (1967).

* This figure was calculated using frequencies of big, small and little.

Appendix IV.

Analysis of Variance to show the effect of the marking factor and sex on Reading Age.

ANOVA - R. Age by Sex, Marking Factor (1,4).

Source of Variation.	Sum of Squares.	DF.	Mean Square	F.	Sign. of F.
MAIN EFFECTS	805.673	4	201.418	.603	.661
MC	643.690	3	214.563	.643	.589
SEX	197.398	1	197.398	.591	.443
EXPLAINED	1651.951	7	235.993	.707	.666
RESIDUAL	50734.424	152	333.779		
TOTAL	52386.375	159	329.474		

N = 160

Appendix V.

Analysis of Variance to show the effects of year, sex and marking factor on the comprehension of comparative forms of two dimensional spatial adjectives.

ANOVA - Score by Year (A, B, C) Sex, Marking Factor (1,4).

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS.	700.678	6	116.780	6.133	.001
YEAR	582.004	2	291.002	15.284	.001
SEX	.186	1	.186	.010	.921
MC	111.893	3	37.298	1.959	.125
EXPLAINED	1158.073	23	50.351	2.644	.001
RESIDUAL	1827.852	96	19.040		
TOTAL	2985.925	119	25.092		

N = 120

Analyses of Variance to show the effect of age on the comprehension of the comparative forms of unmarked and marked two dimensional spatial adjectives.

ANOVA - Score by Year (A, B, C) , Sex for unmarked terms.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	330.199	3	110.066	5.750	.002
YEAR	296.599	2	148.300	7.747	.001
SEX	24.999	1	24.999	1.306	.258
EXPLAINED	369.178	5	73.836	3.857	.005
RESIDUAL	1033.672	54	19.142		
TOTAL	1402.850	59	23.777		

N = 60

ANOVA - Score by Year (A, B, C), Sex for marked terms.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	371.175	3	123.725	6.292	.001
YEAR	365.178	2	182.589	9.285	.001
SEX	17.975	1	17.975	.914	.343
EXPLAINED	439.533	5	87.907	4.470	.002
RESIDUAL	1061.867	54	19.664		
TOTAL	1501.400	59	25.447		

N = 60

Analyses of Variance to show the effect of age on the comprehension of unmarked and marked two dimensional spatial adjectives and of their affirmative and negative comparative forms.

ANOVA - Score by Year (A, B), Sex for unmarked terms.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	211.106	2	105.553	4.534	.018
YEAR	150.684	1	150.684	6.473	.015
SEX	51.106	1	51.106	2.195	.147
EXPLAINED	221.844	3	73.948	3.177	.036
RESIDUAL	838.056	36	23.279		
TOTAL	1059.900	39	27.177		

N = 40

ANOVA - Score by Year (A, B), Sex for marked terms.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	19.467	2	9.733	.374	.691
YEAR	6.400	1	6.400	.246	.623
SEX	13.067	1	13.067	.502	.483
EXPLAINED	87.733	3	29.244	1.124	.352
RESIDUAL	936.667	36	26.019		
TOTAL	1024.400	39	26.267		

N = 40

ANOVA - Score by Year (A, B), Sex for the unmarked affirmative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	120.090	2	60.045	1.871	.186
YEAR	101.682	1	101.682	3.168	.094
SEX	.040	1	.040	.001	.972
EXPLAINED	135.450	3	45.150	1.407	.277
RESIDUAL	513.500	16	32.094		
TOTAL	648.950	19	34.155		

N = 20

ANOVA - Score by Year (A, B), Sex for the unmarked negative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	120.050	2	60.025	3.625	.050
YEAR	84.045	1	84.045	5.076	.039
SEX	72.000	1	72.000	4.348	.053
EXPLAINED	131.621	3	43.874	2.650.	.084
RESIDUAL	264.929	16	16.558		
TOTAL	396.550	19	20.871		

N = 20

ANOVA - Score by Year (A, B), Sex for marked affirmative form.

Source of Variation.	Sum of squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	.459	2	.229	.011	.989
YEAR	.458	1	.458	.021	.886
SEX	.009	1	.009	.000	.984
EXPLAINED	198.860	3	66.287	3.086	.057
RESIDUAL	343.690	16	21.481		
TOTAL	542.550	19	28.555		

N = 20

ANOVA - Score by Year (A,B), Sex for marked negative forms.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	31.381	2	15.690	.563	.580
YEAR	5.812	1	5.812	.209	.654
SEX	22.931	1	22.931	.823	.378
EXPLAINED	36.117	3	12.039	.432	.733
RESIDUAL	445.633	16	27.852		
TOTAL	481.750	19	25.355		

N = 20

ANOVA - Score by Year (B, C), Sex for unmarked terms.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	17.692	2	8.846	.646	.530
YEAR	16.900	1	16.900	1.234	.274
SEX	.792	1	.792	.058	.811
EXPLAINED	26.428	3	8.809	.643	.592
RESIDUAL	493.172	36	13.699		
TOTAL	519.600	39	13.323		

N = 40

ANOVA - Score by Year (B, C), Sex for marked terms.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	221.394	2	110.697	5.374	.004
YEAR	216.585	1	216.585	12.471	.001
SEX	.494	1	.494	.028	.867
EXPLAINED	236.700	3	78.900	4.543	.008
RESIDUAL	625.200	36	17.367		
TOTAL	861.900	39	22.100		

N = 40

ANOVA - Score by Year (B, C), Sex for unmarked affirmative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	38.560	2	19.280	1.359	.285
YEAR	1.950	1	1.950	.137	.716
SEX	31.360	1	31.360	2.210	.157
EXPLAINED	38.800	3	12.933	.912	.457
RESIDUAL	227.000	16	14.188		
TOTAL	265.800	19	13.989		

N = 20

ANOVA - Score by Year (B, C), Sex for unmarked negative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	23.026	2	11.513	.972	.399
YEAR	5.393	1	5.393	.455	.509
SEX	13.226	1	13.226	1.117	.306
EXPLAINED	24.371	3	8.124	.686	.573
RESIDUAL	189.429	16	11.839		
TOTAL	213.800	19	11.253		

N = 20

ANOVA - Score by Year (B, C), Sex for marked affirmative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	178.254	2	89.127	6.528	.008
YEAR	150.835	1	150.835	11.049	.004
SEX	15.804	1	15.804	1.158	.298
EXPLAINED	268.117	3	89.372	6.546	.004
RESIDUAL	218.433	16	13.652		
TOTAL	486.550	19	25.608		

N = 20

ANOVA - Score by Year (B, C), Sex for marked negative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	77.340	2	38.670	2.203	.143
YEAR	72.782	1	72.782	4.147	.059
SEX	8.890	1	8.890	.506	.487
EXPLAINED	92.917	3	30.972	1.765	.194
RESIDUAL	280.833	16	17.552		
TOTAL	373.750	19	19.671		

N = 20

Appendix VII.

Analyses of Variance to show the effect of "Marking" on the comprehension of comparative forms of two dimensional spatial adjectives within the 7.0 - 7.11 age group.

ANOVA - Score by Marking, Sex for the affirmative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	23.683	2	11.841	.514	.607
MC	1.197	1	1.197	.052	.822
SEX	21.233	1	21.233	.922	.351
EXPLAINED	78.650	3	26.217	1.139	.363
RESIDUAL	368.300	16	23.019		
TOTAL	446.950	19	23.524		

N = 20

ANOVA - Score by Marking, Sex for the negative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	30.680	2	15.340	.451	.645
MC	3.601	1	3.601	.106	.749
SEX	28.880	1	28.880	.850	.370
EXPLAINED	114.343	3	38.114	1.121	.370
RESIDUAL	543.857	16	33.991		
TOTAL	658.200	19	34.642		

N = 20

Analyses of Variance to show the effect of "Marking" on the comprehension of the comparative forms of two dimensional spatial adjectives within the 8.0 - 8.11 age group.

ANOVA - Score by Marking, Sex for the affirmative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	164.360	2	82.180	4.196	.034
MC	70.727	1	70.727	3.612	.076
SEX	29.160	1	29.160	1.489	.240
EXPLAINED	236.467	3	78.822	4.025	.026
RESIDUAL	313.333	16	19.583		
TOTAL	549.800	19	28.937		

N = 20

ANOVA - Score by Marking, Sex for the negative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	32.992	2	16.496	.771	.479
MC	29.387	1	29.387	1.374	.258
SEX	1.742	1	1.742	.081	.779
EXPLAINED	66.288	3	22.096	1.033	.405
RESIDUAL	342.262	16	21.391		
TOTAL	408.550	19	21.503		

N = 20

Analyses of Variance to show the effect of "Marking" on the comprehension of the comparative forms of two dimensional spatial adjectives within the 9.0 - 9.11 age group.

ANOVA - Score by Marking, Sex for the affirmative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	38.009	2	19.005	2.302	.132
MC	4.651	1	4.651	.563	.464
SEX	35.559	1	35.559	4.307	.054
EXPLAINED	38.450	3	12.817	1.552	.240
RESIDUAL	132.100	16	8.256		
TOTAL	170.550	19	8.976		

N = 20

ANOVA - Score by Marking, Sex for the negative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	3.400	2	1.700	.213	.811
MC	.200	1	.200	.025	.876
SEX	3.200	1	3.200	.400	.536
EXPLAINED	4.200	3	1.400	.175	.912
RESIDUAL	128.000	16	8.000		
TOTAL	132.200	19	6.958		

N = 20

Analyses of Variance to show the effect of "Marking" on the comprehension of the comparative forms of one dimensional spatial adjectives within the 8.0 - 8.11 age group.

ANOVA - Score by Marking, Sex for the affirmative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	25.276	2	12.638	2.902	.004
MC	22.882	1	22.882	5.254	.036
SEX	1.076	1	1.076	.247	.626
EXPLAINED	26.121	3	8.707	1.999	.155
RESIDUAL	69.679	16	4.355		
TOTAL	95.800	19	5.042		

N = 20

ANOVA - Score by Marking, Sex for the negative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	26.858	2	13.429	1.067	.367
MC	8.450	1	8.450	.671	.425
SEX	18.408	1	18.408	1.462	.244
EXPLAINED	27.533	3	9.178	.729	.550
RESIDUAL	201.417	16	12.589		
TOTAL	228.950	19	12.050		

N = 20

Appendix VIII.

Analyses of Variance to show the effect of the dimensional feature of spatial adjectives on the comprehension of their comparative forms within the 8,0 to 8,11 age group.

ANOVA - Score by Year (B, D) Sex.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign of F.
MAIN EFFECTS	252.895.	2.	126.447.	7.697.	.001.
YEAR	245.000.	1.	245.000.	14.914.	.001.
SEX	7.895.	1.	7.895.	.481.	.490.
EXPLAINED	285.489.	3.	95.163.	5.793.	.001.
RESIDUAL	1248.461.	76.	16.427.		
TOTAL	1533.950.	79.	19.417.		

N = 80.

ANOVA - Score by Year (B, D), Sex for the unmarked affirmative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign of F.
MAIN EFFECTS.	18.060.	2.	9.030.	.870.	.438.
YEAR	7.260.	1.	7.260.	.699.	.415.
SEX	3.610.	1.	3.610.	.348.	.564.
EXPLAINED	24.467.	3.	8.156.	.786.	.519.
RESIDUAL	166.083.	16.	10.380.		
TOTAL	190.550.	19.	10.029.		

N = 20

ANOVA - Score by Year (B, D), Sex for the unmarked negative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign. of F.
MAIN EFFECTS	51.342.	2.	25.671.	2.066.	.159.
YEAR	48.110.	1.	48.110.	3.873.	.067.
SEX	.142.	1.	.142.	.011.	.916.
EXPLAINED	75.238.	3.	25.079.	2.019.	.152.
RESIDUAL	198.762.	16.	12.423.		
TOTAL	274.000.	19.	14.421.		

N = 20.

ANOVA - Score by Year (B, D), Sex for the marked affirmative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign of F.
MAIN EFFECTS	173.170.	2.	86.585.	6.386.	.009.
YEAR	127.279.	1.	127.279.	9.388.	.007.
SEX	62.720.	1.	62.720.	4.626.	.047.
EXPLAINED	203.621.	3.	67.874.	5.006.	.012.
RESIDUAL	216.929.	16.	13.558.		
TOTAL	420.550.	19.	22.134.		

N = 20.

ANOVA - Score by Year (B, D), Sex for the marked negative form.

Source of Variation.	Sum of Squares.	DF.	Mean Square.	F.	Sign of F.
MAIN EFFECTS	123.875.	2.	61.938.	2.873.	.086.
YEAR	114.075.	1.	114.075.	5.292.	.035.
SEX	27.075.	1.	27.075.	1.256.	.279.
EXPLAINED	126.883.	3.	42.294.	1.962.	.160.
RESIDUAL	344.917.	16.	21.557.		
TOTAL	471.800.	19.	24.832.		

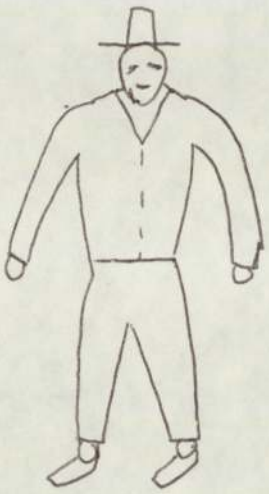
N = 20

Appendix IX

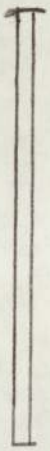
Objects used to test comprehension of the comparative forms of spatial adjectives. (Five of each were used).

tall-short

model men



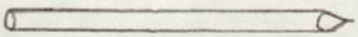
masts



long-short

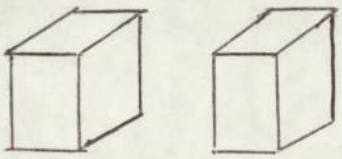
lines

pencils

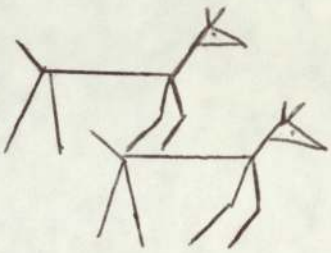


far-near

blocks on a table

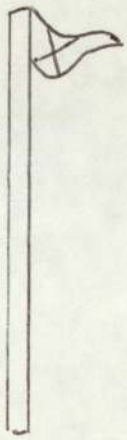


horses

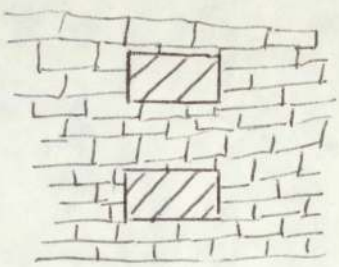


high-low

flags



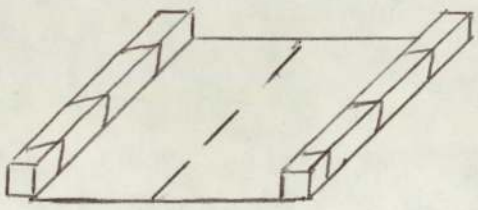
cards on a wall



wide-narrow

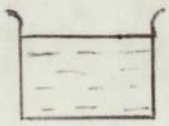
strips of paper

model roads

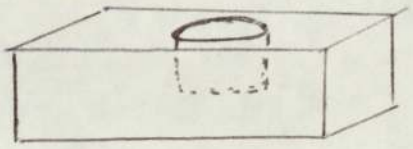


deep-shallow

beakers of water

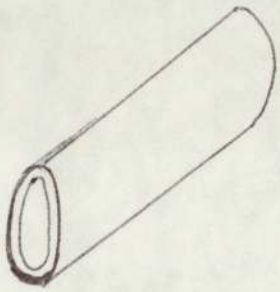


holes in wood

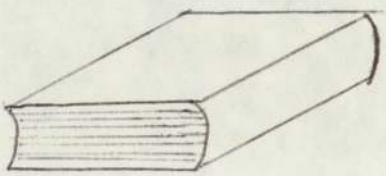


thick-thin

pipes

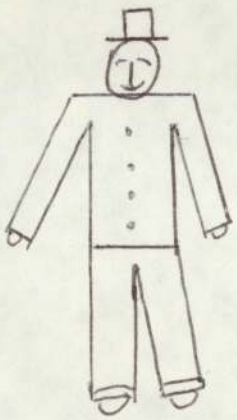


books

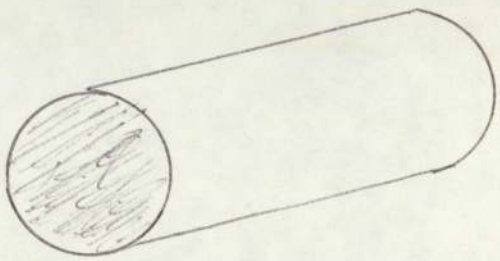


fat-skinny

model men



rolls of plasticine



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