THE ONTOGENETIC DEVELOPMENT OF LEXICAL REFERENCE

Patrick David Griffiths

Ph.D. University of Edinburgh 1976

Declaration

I hereby declare that this thesis is my own original composition. The empirical child language material used in this thesis was collected in collaboration with my colleagues on a research project entitled "Linguistic development of young children", between 1970 and 1974. The project was directed by Professor John Lyons, in the Department of Linguistics, University of Edinburgh. I participated in and contributed to all stages of the planning and execution of the project, including the selection of children. In particular, I helped devise the questionnaires used, I conceived the idea of using a microphone mixer to record a running commentary on the non-linguistic background to the children's conversations and I took a major part in the recording and transcription of tapes.

P. D. Griffiths

York, 30th September, 1976.

Acknowledgements

My mother's kindly and enlightened introductory course in English, which I had the pleasure of taking in early childhood, was the foundation of this thesis. More recently I have contracted intellectual debts to the people from whom I learnt linguistics: Martin Atkinson, Michael Garman, John Lyons, Tony Traill and Roger Wales. That what I learnt coincides only partly, and perhaps imperfectly, with their teachings is no fault of theirs. Discussions with many other people during the course of five years spent in Department of Linguistics, University of Edinburgh, were of great benefit to me too. I am further indebted to John Lyons for extremely tolerant and helpful supervision. The help came in the form of insightful advice on drafts of this work and a general concern for my academic and personal welfare. His tolerance will reveal itself patently in the strongly psychological slant of parts of the text. He also allowed me to proceed at my own ill-organized pace. Had he shown less forbearance in this matter there would undoubtedly have been qualitative improvements in many parts of the text, but I should probably have given up the enterprise before completion.

I am grateful to the Social Science Research Council for supporting the research project (Grant No. HR 1019) which employed me and provided me with the means of gathering the empirical data reported here. This corpus of annotated child speech was assembled in collaboration with Martin Atkinson, Renira Huxley, Alison Macrae, Pauline Ford, Alwyn Cooper and Janet Griffiths. I enjoyed their company as well as the

fruits of their labour. The children whose speech was recorded and their parents, who facilitated the process and assisted in it, deserve my special gratitude.

I am thankful to Mrs. Cathy James for typing the bulk of the thesis. She did so with great speed and efficiency.

Tamsin and Jane generously granted me the time for the last lap by accepting postponement of a promised attempt at the Pennine Way and by making other allowances for my preoccupation. My love and thanks go to Janet for typing most of the draft, the appendix, references and sundry afterthoughts; also for checking vocabulary tallies, but mainly for being constantly supportive and forgiving over the past month.

Index

Abstract

A theory is presented according to which language users are held to employ detailed videotape-like memory traces of prototype objects in association with their lexemes for the purpose of mediating the application of lexemes.

The theory is advanced by pointing to flaws in rival conceptions, which are for this purpose amalgamated under the label "theory of criterial attributes". In an extensive discussion of psychological issues the theory of prototypes is shown to be plausible in terms of what is known of human mental structures and operations. A longitudinal study (up to the age of 2½ years) of concrete nominals in the vocabularies of three young children is also offered in support of this view. The following properties of the children's words and usage are noted: accuracy, diversity within denotation classes (including the dispensability of even functional and contextual factors which at other times appear to be crucial in the application of the same word), vacillation in the selection of a name for an object and caution in extending denotation classes. The children's lexical structures are also examined.

1.0 Statement of bias

In this thesis I aim to develop and defend an account of the intension - the basis for appropriate application - of nominals. In choosing between alternative theories or parts of theories the touchstone to which I shall most frequently have recourse will be 'psychological plausibility'. In those places where I feel that the most optimism is warranted the phrase will be apt to be supplanted by 'psychological reality'. This concern, that linguistic theories should be compatible with what is known of the capabilities of the human organism, arises out of my assumption that no science can remain significant if it shirks ontological questions for too long; that is, if no attempt is made to find out whether or not the hypothetical entities and relationships resorted to in the explanation of certain phenomena are, in fact, instantiated as the 'real-life' underpinnings of those phenomena. Metatheoretical assumptions are not open to proof but they can be argued for. This one is vigorously advanced by Harré (1961) in a general work on the philosophy of science and is implicit in Fodor's (1968) analysis of explanation in psychology. I feel under no obligation, in the present work, to trespass on the domain of philosophers of science by attempting to justify my bias, having declared it.

1.1 Outline of the problem

Weinreich (1962, p.42) says: "It is apparently a biological fact that human beings are capable of deriving intensional definitions

from instances ("perceiving universals"): not only lexicographers, but all children do it, and they do it well." To the extent that one believes communication to be, by and large, successful this conclusion is inescapable. One of the prerequisites for successful communication is that the denotation class of any given lexeme - the set of entities to which tokens of the phonological type/s related to that lexeme, in utterances, may refer - should be approximately coincidental across users of a language. And it is inconceivable, for the majority of lexemes in a language, that, in acquiring their language, people could be taught, separately, (by ostensive definition) the pairing between lexeme and entity for all the members of each lexeme's denotation class.

Of course, it can be argued that many lexemes are of a kind whose use could not be taught through ostensive definition. I shall avoid this issue by restricting myself to a consideration of only those lexemes whose denotation classes consist of (relatively) concrete entities. That is to say, I shall be concerned mainly with nuclear members of the class of nominals [Cf. Lyons (1966).]. The empirical basis of this study consists of observations on the uses to which three young children put the nominals in their vocabularies. Tracy (1893) tabulated the vocabularies of twenty-one children, up to the age of about two years, and found that 60% of the total number of words could be classed as nouns and that fewer than 1% of these were abstract nouns. It would seem, therefore, that in spite of the restricted nature of the study I shall nonetheless be dealing with a significant part of the children's vocabularies.

To return to Weinreich's claim, what is the nature of the intensional definitions of lexemes which people derive from instances of their use? I am interested in the intensional definitions which people actually employ in making, probably unconscious, decisions about the application of words in the process of speaking; not in definitions which they might be able to verbalize for, say, the purpose of philosophical analysis or linguistic description. One answer to this question is a group of widespread, old and popular notions which I shall call, collectively, "the theory of criterial attributes". A version of this theory will be described in §1.2 and thereafter much of the thesis will be devoted to presenting arguments and evidence against it and in favour of an alternative (also old), to be sketched in §1.3, which I shall call the "theory of prototypes". §1.4 offers some psychological data in support of my suggestions. The issue is related to the philosophical problem of universals and in §1.5 I propose, briefly, to try to show how the theories outlined in §1.2 and §1.3 fit in with the philosophical frameworks, conceptualism, nominalism and realism, which have arisen in connection with philosophical discussions of universals. In §2 I present an account of the growth of the vocabularies of three young children as an empirical test of my hypotheses.

1.2 The theory of criterial attributes

This theory is fairly baldly advanced by Bloomfield (1935, p.141):

> ... it is clear that we must discriminate between non-distinctive features of the situation, such as the size,

> shape, color, and so on of any one particular apple, and the distinctive, or linguistic meaning (the semantic features) which are common to all the situations that call forth the utterance of the linguistic form, such as the features which are common to all the objects of which English-speaking people use the word apple.

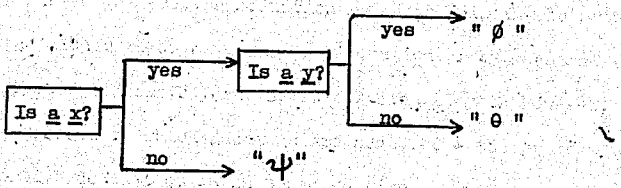
Bloomfield acknowledged that the internal state (disposition) of a given speaker, on a particular occasion, might be such that the external features which distinctively characterize an apple fail to 'call forth' the word apple from him and that people talk of apples when none are present. However, I am not concerned with whatever it is that evokes utterances; so this problem is irrelevant here. Bloomfield also believed (p.145) that " ... the linguist cannot define meanings, but must appeal for this to students of other sciences or to common knowledge .... ", presumably for a list of the distinctive features which are common to the members of the denotation class of each lexeme. The specification of the meanings of the majority of our words may well be an encyclopaedic task beyond the scope of theoretical linguistics but it is certainly linguistics which must provide an account of the nature of lexical entries. Now, I know of no linguist who holds the view that lexical entries consist, for each lexeme, simply, of a list of the entities which (could possibly) fall into its denotation class. Everyone seems to believe that some kind of generalization is necessary to describe the denotation classes. The theory of criterial attributes, and I take this to be Bloomfield's view, holds that the generalization which links the members of a denotation class is that they all possess each member of a determinate set of attributes and that the presence of these attributes is a criterion for the applicability of the lexeme by which the class is denoted. That is,

the criterial attributes are separately necessary and jointly sufficient conditions governing the application of a lexeme.

Harrison (1972) in the course of a critique of the explanatory value of the notion of ostensive definition - definition by a combination of naming and pointing - suggests what we may take as a necessary modification to the version of the theory of criterial attributes given above. One of the things ostensive definition has been invoked to explain is (p.58) " ... how we learn to apply names correctly to their proper objects." He holds that proponents of ostensive definition claim, in effect, that the learner need use only the following rule: a given word W is to be applied to any object which resembles the members of the series of paradigm objects by reference to which W is defined in all, and only, those respects in which they resemble one another. In fact, Harrison states this rule for the case where W is any "basic word" - a word which cannot be defined in terms of other words. However, he proceeds to an examination of the possibility of employing it in the definition of "nonbasic general terms" like crocodile, table and book and it is an observation of his in this connection which is of interest to me here.

He points (p.61) out that strict application of the rule will result in the learner " ... taking as species-determining minor variations which merely happened to be constant in the specimens which figured in the paradigm series by reference to which the word was defined for him." If the rule is relaxed (p.62) by requiring only "a rough general resemblance" the learner may end up applying

the word too widely. Harrison proposes, as an alternative, that what the learner is doing is building up taxonomic schemata of the following kind (p.65):



In this scheme, a is a specimen, x and y are taxonomic characters and ϕ, θ, ψ are species names. " ... all that the user of it has to do is to decide whether or not a specimen possesses certain well-defined taxonomic characters: for any case of the possession or nonpossession of these characters the schema yields (determines) a name." (p.66). "Provided he can recognize all the relevant taxonomic characters ..., no one need ever have provided him with an ostensive definition of any species name ...." (p.64f.).

He claims that we cannot (p.66) simply trace a path from left to right through a taxonomic schema to " ... determine a complex property whose predication will, in effect, be a sufficient and necessary condition for the application of the name in question .... And ... devise in each case some paradigm series which will single out just this property." The reason we cannot is that some of the sub-properties are of the form not-x. "Why should the learner suppose that it is the absence of some element from the paradigm series - some property which all its members lack - which is critical for the application of ψ? And if he is somehow or other aware of this, why should he fix on x

as the crucial lack, rather than on one of the infinitely many other properties which all members of the paradigm series resemble each other in lacking?" (p.67). This certainly is a problem for the most elementary kind of ostensive definition in which pointing is not supplemented either through verbal specification or by means of conventions more elaborate than the rule stated above. However, if we ignore the process by which meanings are acquired - the process in which ostensive definition is supposed to figure - and focus on the question of what is acquired, then there seems to be nothing preventing us from tracing paths from end to end through taxonomic schemata in order to determine a conjunction of attributes which are criterial for the application of a lexeme. The only difference, according to this way of looking at them, between Harrison's proposals and Bloomfield's views is that Harrison is prepared to recognize as criterial the absence of particular attributes. Given the existence of words such as poll 'animal (of a limited set of species) without horns' it seems that the theory of criterial attributes should be allowed to specify either the presence or absence of particular attributes as the criteria governing the application of lexemes.

I have taken the term criterial attributes from Brown (1958). The version of the theory which he propounds differs in certain respects from what I have thus far adumbrated as the theory of criterial attributes. His basic position is similar to Bloomfield's: (p.8) "Any sort of recurrence in the non-linguistic world can become the referent of a name and all such recurrences will be categories because recurrences are never identical in every detail. Recurrence

always means the duplication of certain essential features in a shifting context of non-essentials." However, he goes on to say (p.10) that "Aristotle's distinction between essential and accidental attributes is a kind of ideal logic of categories that is not very well suited to the psychology of categorizing behavior." And that, therefore, (p.10f.) "It will be useful to replace that dichotomy with a continuum ... we shall speak of the relative 'criteriality' of an attribute for a category. When some value of an attribute is used as a basis for inferring the category membership of an object then that attribute is to some degree criterial for the categorization. To the degree that an attribute can change in value without affecting categorizing judgements, it is not criterial for the categories in question." Incidentally, although Brown defines an attribute (p.10) as " ... any dimension on which objects and events can differ" he generally speaks of attributes as if they were values along dimensions. For instance (p.51) he refers to " ... such familiar attributes as the color red, the form of the circle, the tactile experience of hardness." I have been treating attributes as values along dimensions.

If Brown is prepared to consider assigning numerical weights to the criteriality of each of a list of attributes which define a lexeme and to believe that in each determination of the applicability of a given lexeme the same weightings are resorted to, then his ideas are merely a sophisticated version of what I am calling the theory of criterial attributes. If, on the other hand, he means only that people take account of the attributes of objects in deciding what they should be called his position is much harder to refute and the use of the

term criterial is, then, gratuitously misleading (insofar as it suggests the use of fixed standards). Unfortunately, Brown does little to resolve this dilemma. It is worth noting though that he says (p.14) "Probably our favourite kind of category is that in which the members all have some attribute that is never found outside the category. We prefer this kind of category because it puts least strain on the memory; from a single attribute one can infer category membership with perfect confidence." [He is talking of human beings in general.]. Brown recognizes categories defined by a disjunction of attributes but I will defer discussion of these to §1.5 where they will be considered in connection with Wittgenstein's notion of 'family resemblance'. Functional attributes which Brown (p.14f.) says " ... are uses that can be made of members of a category" will also not be discussed here. They are dealt with in §2, the empirical part of this thesis.

1.2.1 Componential Analysis

Componential analysis is a method of describing semantic structures by factoring the 'meanings' of lexemes into semantic components (markers or distinctive features). For dealing with individual lexemes, as distinct from the meanings of sentences, this is probably the predominant type of semantic analysis in linguistics today. Componential analysts usually address themselves primarily to trying to understand and describe the semantic structure of the vocabulary, or parts of the vocabulary, of a language. For instance, Katz and Fodor (1963, p.187) state that: " ... the semantic markers

assigned to a lexical item in a dictionary entry are intended to reflect whatever systematic semantic relations hold between that item and the rest of the vocabulary of the language." The kind of meaning characterized in this way is the sense of lexemes. Lyons (1968, p.427) defines " ... the sense of a word ..." as " ... its place in a system of relationships which it contracts with other words in the vocabulary." He then points out that " ... since sense is to be defined in terms of relationships which hold between vocabulary-items, it carried with it no presuppositions about the existence of objects and properties outside the vocabulary of the language in question." In this section I shall review some componential analyses with a view to showing that their authors, despite concentrating their attention on vocabulary structure, seem to have assumed that they were describing not only the sense of lexical items but also the criteria according to which entities are classified by language users into the denotation/classes of different lexemes.

Some of classic componential analyses have been attempts by linguists and anthropologists to describe the semantic structure of systems of kinship terms. One such is Goodenough's (1956) study which presents both a theoretical discussion of the method and exemplification of its use in an analysis of Trukese kinship terms. Goodenough (p.215) describes componential analysis in general terms as: "A method based on determining the consistent difference between the possible denotata or other contextual aspects of linguistic forms ...." He says (p.208): "The components of signification ... are the formal criteria by which we differentiate one thing from another." For Goodenough these criteria

are not just ones which may be used, they are necessary conditions (p.195): " ... the significatum of a linguistic form is composed of those abstracted contextual elements with which it is in perfect association, without which it cannot properly occur." That he is anxious to deal with psychologically real criteria is shown by the following excerpt (p.195):

> The problem of determining what a linguistic form signifies is very well illustrated by kinship terms. In essence it is this: what do I have to know about A and B in order to say that A is B's cousin? Clearly, people have certain criteria in mind by which they make the judgment that A is or is not B's cousin. What the expression his cousin signifies is the particular set of criteria by which this judgment is made.

This is thus a theory of the kind I am calling a criterial attributes theory. However, it should be stressed that the body of the paper comprises an account of the structure of Trukese kinship vocabulary. Goodenough shows of the kinship lexemes " ... that we can group them in various ways according to their denotata." (p.201). Thus, although Lyons [cited above] notes that sense does not presuppose objects and properties existing outside the vocabulary, it seems that sense can be approached through a consideration of denotation classes.

Lounsbury (1956) presents an analysis along similar lines, of Pawnee kinship terms. He says (p.167): "There are two ways of defining a class: by naming the members of the class, or by stating the defining features of the class, that is to say, the necessary and sufficient conditions for membership in the class." And:

> In the case of our Pawnee kin classes we have begun with definitions of the first variety. These reveal one aspect of the structure of the system, namely

> the specific segmentation of the semantic field. They do not show, however, the underlying principles of organization. These will be shown only if we can proceed from the definitions-by-naming in such a way as to arrive at definitions in terms of distinctive semantic features, and further, if we can formulate the semantic structure of the whole set.

Again, the underlying principles being sought are the ones which Pawnee speakers might be supposed actually to have used. Thus Lounsbury says (p.173) of two lists of kin-types - a purportedly universal notation used by anthropologists to characterize members of the denotation classes of kinship terms - which are denoted by tiwátsiriks, 'uncle': "If the Pawnee included these types in the same class with the preceding types, we must assume that there was some feature of similarity which all of these types shared."

Wallace and Atkins (1960) is a careful theoretical discussion of the application of componential analysis to kinship vocabularies. It is illustrated by an analysis of the semantic structure of a subset of American English kin terms. They quote with approval (p.75) Goodenough's plea for psychologically real definitions of kin terms; in particular, part of a passage [quoted above] which claims that people "have certain criteria in mind by which they make the judgment that A is or is not B's cousin." In general, Wallace and Atkins seem to subscribe to the theory of criterial attributes. One of their cautions though suggests a slightly weaker version of the theory. They observe (p.68):

> ... the definition of the universe of denotata and the choice of dimensions must be determined in part by the task of discrimination imposed by the list of terms originally selected. Thus the meaning of a term will be in part dependent on the size and composition of the particular list of terms being defined.

but they conclude: "This fact does not diminish the value of componential analysis as a method but suggests that the signification of a kinship term be defined as those semantic features which are in fact used to distinguish the kin-type designatum of the term from the kin-type designata of the other terms in a given set of terms." The dependence of the sense of a lexeme on the size and nature of the vocabulary in which it occurs, either naturally or for purposes of analysis, is obvious. That Wallace and Atkins should comment on it is significant: their doing so seems to confirm that they believed that the tradition of componential analysis of systems of kinship terms, on which their paper is a commentary, was concerned both with semantic structure and with (p.67) the " ... statement of various necessary and sufficient conditions for a kin-type to belong to the class of kin-types denoted by a term."

Romney and D'Andrade (1964) review the componential analyses discussed above and present their own analysis of American English kin terms. They present evidence from a number of psychological studies to support their claim that their own analysis reflects "individual cognitive structures" more nearly than do various rival analyses. The psychological techniques used were: an examination of clustering in free listing, the semantic differential, and the scaling of 'similarity in meaning' on the basis of people's judgments of the kin term "most different in meaning" in each of a series of triads of terms presented to them. None of these methods was likely to directly reveal anything about the application of kin terms to objects, and the clustering and scaling studies are clearly concerned with structure. However, Romney

and D'Andrade conclude (p.168) that: "In the psychological lexicon, it would seem that the sememes [= semantic components] of kin terms function as discriminative stimuli for individuals." They then put forward the hypothesis (p.168) that:

> ... a discriminative stimulus is most efficiently learned when a subject is repeatedly presented with events which differ or contrast in one particular feature and in which the subject's responses to the contrastive stimuli are differentially reinforced. What both the individuals who use the native system and the analyst do is learn the set of contrasts which signal a difference .... Thus both the analyst and the native speaker learn that only females are aunts and only males are uncles.

It is not clear whether they believe that all the 'discriminative stimuli' are necessary for the application of a lexeme (They suggest, for instance, (p.169) that both the analyst and the native speaker " ... may face equivocal contrasts ....") but in general it appears that they subscribe to what I am calling the theory of criterial attributes.

1.2.2 Structural Semantics

The theory of criterial attributes is concerned with the basis for the application of lexemes and the demarcation of their denotation classes. And so too is the theory of prototypes with which I propose to confront it. Will it be reasonable to deem whichever of the two theories it is that emerges least scathed from the debate the best currently available approach to semantics? Are there any extant theories which are likely to be immune from strictures which arise out of the debate? Of course, these questions assume an acquaintance with

arguments which have not yet been presented. However, one might perhaps suspect that a purely structural theory of semantics, such as the one described by Lyons (1968), would, in virtue of not being founded on denotation, remain unaffected. I propose therefore to anticipate the sequel to the extent of briefly considering this possibility.

Wallace and Atkins (1960), in the paper referred to above, suggest that in the analysis of a given lexicon one will sometimes encounter lexemes which can be defined either as products of semantic components or (p.74) "... as relative products of the primitive terms of that lexicon." They also hold that, in at least some instances, definitions of the latter type will more nearly reflect the cognitive systems of native speakers. Bendix (1966) presents componential analyses of three sets of verbs, drawn from English, Hindi and Japanese, which are purely structural. That is, he was concerned solely with distinguishing each of the verbs under consideration from each of the others, and not with conditions governing their application. Weinreich (1966) argues that the semantic components which enter into the meaning of a lexeme are interrelated in the same ways as are the lexemes which comprise sentences. He points out that this would account for the ability of competent native speakers to provide verbal definitions for words. These studies seem to point to the possibility of providing adequate semantic descriptions of lexemes wholly in terms of the very language from which the lexemes under analysis themselves come. If this were possible then problems involving the intension of lexemes could justifiably be ignored by semanticists and relegated to pragmatics or psychology.

There are grounds, however, for believing a priori that such an enterprise is impossible. Many philosophers have argued that it is necessary to recognize a class of 'basic words' which derive their semantic value from their relationship to extralinguistic entities. For instance, Kotarbinska (1960, p.1) puts the argument as follows: "Some names can be defined by some other names, those other names in turn by still other ones, but sooner or later we reach the primitive (elementary, basic) names such as "acid", "hard", "red", etc." These 'names' she says have to be defined ostensively. Lyons (1968, p.433f.) discusses this issue in connection with the problem gaining entry to the semantic structure of a language other than one's own. He suggests that one enters a new system through the area of cultural overlap. However, with regard to the analogous problem of securing a foothold in one's first language he is apparently (p.410) resigned to "... the inevitable 'circularity' of semantics ...." This is because of (p.409) "... the difficulty of explaining the meaning of any word without using others to limit and make more explicit the 'scope' of 'ostension' (it suggests that it may be impossible to determine, and perhaps also to know, the meaning of one word without also knowing the meaning of others to which it is 'related' ...." The difficulty is real enough (See, for example, Lewis' (1963) account of the acquisition of the word mama) but everyone who acquires his first language in the normal fashion demonstrates the possibility of gaining a foothold in the system without the help of words. Of course, the meaning(s) of one's first word(s) will be only the grossest approximations to adult meanings, even where correspondences between adult and child forms

can be found [Cf. Greenfield (1973) and Halliday (1975).]. I do not doubt that these meanings subsequently undergo refinements which depend upon access to a language, as other words are taken into the vocabulary.

Harrison (1972), whose proposed 'taxonomic schemata' were described above, says that provided the user of a taxonomic schema can recognize all the relevant taxonomic characters he need never have had any of the species names which the schema determines defined for him by ostension. This may be true but it seems to me that the notion of ostensively defined 'basic words' arose out of precisely the sort of problem glossed over in Harrison's proviso. I conclude that he has not demonstrated the dispensability of 'basic words'.

Much the same can be said of structural theories of semantics which though expressed as componential analyses claim that the components are not words of the object language but are 'atomic concepts', as in Katz and Fodor's (1963) theory, or [Bierwisch (1970, p.181)] " ... psychological conditions according to which human beings process their physical and social environment." Thus Anderson (1968, p.397) says in his discussion of Katz and Fodor's semantic components:

> ... a primitive like Human is not as primitive as it may seem to be. We must talk about the primitives of semantics using words, and the words we use have parts of speech attached to them. Given the fact that human is an adjective and the range of occurrence which adjectives have in the phrase structure, a speaker of English extracts exactly the same information from 'Human' that he would extract from 'N is human'.

Either we understand the components in terms of the object language names given to them and then we are still faced with the problem of explaining how we entered the structure of the object language in the first place. Or we can stave off the reckoning one step by using a foreign natural language as the semantic metalanguage. Or, if it is insisted that the metalanguage is not a natural one, we face the even more perplexing problem of explaining how we came to an understanding of 'Semantic Markerese', as Lewis (1972) has dubbed systems of this kind. It seems that an account of the intension of at least some lexemes is a necessary part of any complete semantic description of a vocabulary.

Another way of stating the problem facing a purely structural description is as follows [De Mauro (1967, p.33)] ; "Linguistic forms are defined according to the relationship which binds them ... But how can the relationships be defined without having defined the relata?" De Mauro also points out (p.34f.) that: "Even the smallest differences in the vocabularies of two people ... would force us to conclude that the two spoke different languages and that even the words that they apparently had in common were in reality only homophonic, having different values because they occured in two different sets of relationships." and this would render the fact of communication mysterious.

1.2.3 Preliminary critique of the theory of criterial attributes

Linguists have occasionally expressed doubts concerning the

plausibility of the theory of criterial attributes. For instance, Nida (1951, p.9) says that the difficulty with the "common denominator" approach to the specification of meaning " ... is that in a series of contexts a word may have practically no common denominator, and yet the series exhibits obvious relationships." He appears to favour, instead, defining a lexeme in terms of an aggregate of the features discernible in those situations in which its forms are appropriately used.

Burling (1964) casts doubt on the likelihood of determining, for a given set of lexemes, those attributes which are actually the ones relevant to native speakers in making the necessary distinctions. He shows that for any given set of only four lexemes, even restricting oneself to binary components, there are a priori 124 theoretically possible discrete, non-redundant componential analyses. (A 'discrete' analysis is one which distinguishes each lexeme from all the others in the set. A 'non-redundant' analysis is one from which no component can be eliminated without breaking down the distinction between at least one pair of lexemes in the set.) He also claims that there is no reason, other than economy, for disallowing redundant analyses. Lyons (1968, p.478) is similarly pessimistic about the possibility of determining the cognitively real criterial attributes used by people in deciding the applicability of a lexeme. And Bolinger (1965, p.573) summarizes Katz and Fodor's proposals as amounting to: " ... the selection of a few markers out of a vast sea of intuitions." He goes on to say: "Native speakers need no drastic reduction." Macnamara (1971) is of the same opinion. He says (p.371f.):

> ... the problems of what information is stored in connection with a word, such as chair, are the problems of what information is stored in connection with the percept 'chair'. This surely includes a vast array of associated features which may indeed be very like a list. Probably some of these features are very abstract, representing functions and purposes of chairs; these may even be the defining attributes. But no features are particularly favored in performance; depending on the context, any feature or set of features may be salient, while others, including the defining ones, may play no part.

Before proceeding to a presentation of the theory of prototypes, which I believe circumvents some of these problems, I should like to indicate some of my own reasons for dissatisfaction with the theory of criterial attributes. Many of these arise from the study of vocabulary development in children. I propose therefore to adumbrate Clark's (1973, 1974) discussion of vocabulary growth - it is one of the most interesting and ambitious recent essays on this topic - with a view to establishing that it is founded squarely on the theory of criterial attributes and in order to show, with the aid of a few examples drawn mainly from my own observations, the inadequacies of this theory in accounting for lexical development.

1.2.3.1 Clark's 'semantic feature hypothesis' and some grounds for disquiet

Tracy (1893) notes that the daughter of Hippolyte Taine - a pioneer psychologist - who learnt the form bébé in connection with a picture of the infant Jesus subsequently used bébé to refer to pictures of all kinds (instead of to babies) and comments (p.115): "Children who are able to use a few words at this age [second six months of life], show by their use of them how inadequately defined is their

meaning." Clark (1973) has collated a large number of such examples of 'inadequately defined' words drawn from 19th and 20th century diary studies of the early stages in the acquisition of a variety of languages. She found that many of the children's errors - in adult terms - of word usage were cases of the child's word having a wider denotation class than that of a corresponding adult form. Such errors she calls overextension. One of her examples is of a child who used fly first to refer to a fly and then afterwards to refer to specks of dirt, dust, small insects, his own toes, crumbs of bread and a toad. She reports that the phenomenon of overextension is noticeable for up to a year in the development of any one child and that this period generally falls within the age range 1;1 to 2;6 [Here and in the remainder of this thesis ages are expressed as: number of years, semi-colon, number of months.]. She surmises that striking overextensions cease when the child has had sufficient negative feedback regarding the incorrect application of words to encourage caution, and has also learnt how to ask 'what's that' questions.

To account for the existence of the phenomenon of overextension Clark proposes the following hypothesis (1973, p.72):

> ... the child will begin by identifying the meaning of a word with only one or two features rather than with the whole combination of meaning components or features ... that are used criterially by the adult. The acquisition of semantic knowledge, then, will consist of adding more features of meaning to the lexical entry of the word until the child's combination of features in the entry for that word corresponds to the adult's.

Overextensions are held to derive from these early incomplete semantic specifications because (1973, p.72): "The child will use those one or

two features criterially in deciding when to apply the word and when not."

On the question of what kinds of semantic components are used by young children Clark says, firstly, (1973, p.75) that "The Semantic Feature Hypothesis would predict it is the more general semantic features that will be acquired earliest." The import of "more general" is not clearly stated but it seems to mean 'used in the semantic specification of a larger number of lexemes'. Secondly, she assumes that the first semantic features are likely to be based on directly perceptible salient physical characteristics of the denotata. This second assumption is simply an appeal to reason: there must be (1974, p.109) " ... some correspondence between the adult and child perceptual features and ... it is this correspondence that allows communication in the first place when the child begins to use words with some consistency." It is justified by showing that the examples of overextension uncovered in her survey of the diary studies are amenable to classification under the headings "overextensions related to movement/shape/size [cf. the fly example quoted above] /sound /taste/texture". In addition Clark quotes two instances of 'overextended' action verbs but those are of no concern here. Kirkpatrick (1891), who also compared the vocabularies of several children, came to a similar conclusion (p.175): "Any word which can be associated with a distinct, sensible experience can readily be learned, but abstract terms are not found in children's vocabularies."

Kirkpatrick (1891, p.175) conjectures that: "A child who calls

a goat a 'dog' may lack in clearness of conception of the characteristics of dogs, or in his powers of discrimination, or only in experience." A part of Clark's 1974 paper tends to refute suggestions such as Kirkpatrick's second one: she reviews some studies of infant development [e.g., Bond (1972)] to establish that (p.113) " ... the child has already developed a number of perceptual skills even before the age of 6 months ...." It is perhaps worth remarking that Bond's (1972, p.225) conclusion was even stronger: " ... there seems to be no evidence to date which necessitates rejection of the prevailing view that the perception of the infant is qualitatively similar to that of the adult." The following observations of the psychologist Perez (1889, p.180) provide further support for this view:

> I knew a child of two months old who could clearly distinguish a person from an animal, or from a piece of furniture; but he used to smile indiscriminately at the first comer, and would seek the breast of any woman who took him in her arms. But at three months he could so well distinguish his nurse from his mother that if, when his mother was holding him, his nurse took another child on her lap, or he saw her being embraced by anyone, he would at once show his jealousy by frowns and tears. At this age he also clearly distinguished a cat from a dog, the former having scratched him more than once, whereas the latter overwhelmed him daily with caresses; the moment the dog appeared he always showed great delight. One month had thus sufficed to fix clearly in his mind a large number of individual conceptions.

I accept that it is unlikely that by the age at which children first begin to use words meaningfully - that is, at about one year old, taking McCarthy's (1954) statistics as probably the most authoritative available - they have any difficulty in perceiving any relevant physical properties of objects. However, I believe that another way in which Clark seeks to support her semantic feature hypothesis with a prop borrowed from the literature on perceptual development is more

dubious. This is the parallel which she claims (1973, p.102f.) may exist between time-course of object perception in infancy (as described in Gibson's (1969), partly speculative, account) and her own view that the meanings of young children's words are represented in terms of a limited number of criterial perceptual attributes.

Gibson (1969, p.357) holds that " ... development of object perception begins with the discovery of distinctive features, progressing to grasping of higher order structure in the object." By "the discovery of distinctive features" she appears to mean no more than that studies of the direction of gaze reveal that (p.368): "The newborn infant attends, visually, to high-contrast spots, edges, and corners within his view; but he does this in a way that has been referred to as obligatory or compulsory." [1] Gibson's main evidence comes from investigations of infants' responses towards faces and face-like objects, which she summarizes as follows (p.368):

> Differentiation of features of the face object begins with the eyes. Then the eyes in a given setting become important; and later the mouth, especially when it is moving. Mouth-widening movements are particularly attractive. A realistic head is discriminated from unrealistic dummies by five months or so.

Note, with regard to Clark's hypothesis, that this progression from 'attention-to-features' to interest in what adults might regard as objects takes place six months or more before the period to which the semantic feature hypothesis is applicable. Note also that Gibson does

---

1 See Sackett (1963) for a straightforward explanation of this phenomenon in terms of the specialization of peripheral sense receptors for certain kinds of stimulation.

not offer any evidence that eyes, mouth, etc. are distinctive or criterial features mediating the recognition of objects as faces; the 'features' might, for the infant, be objects in their own right.

Clark (1973, p.77) says that: "By considering the actual categories that result from an overextension, one should be able to infer which features the child has used criterially." I shall now describe an attempt I made to follow this suggestion. I believe that the results cast doubt on the validity of Clark's hypothesis. One of the children whose linguistic development I observed - I shall call him P. [§2.] - at 2;5⅔, when shown a roughly drawn circle with two radial lines from the centre to the perimeter, and asked "What's that?" replied "That is a clock". Clock was a word he had previously used often to name clocks and pictures of clocks. For instance, three months earlier at 2;2⅔, he had said "clock" spontaneously on finding, in a book, a full-page, full-frontal, coloured picture of an alarm clock. I guessed from P's response to the drawing that the presence of hands might be criterial to his identification of clocks. The circular outline could be dismissed as non-criterial because he had several times called a circle which he had just drawn "circle", only a few minutes before he called the circle with hands "a clock". To test my guess I presented him one week later (age: 2;6) with a compass-drawn circle around the inside of which I had written the numbers 1 to 12 as they appear on a clock face. In response to this picture he said "tick tock tick tock", which I regarded as adequate identification of it as a clock. I then showed him a circle of the same size and he

responded "O for ink". P's spelling is not at issue here, but this response confirmed my belief that a circle alone would not evoke "clock" from him. Since the numbered but handless clock had a small dot in the centre and the handed but unnumbered one also had a dot there, I next showed P a circle of the same size as the 'O for ink' one but with a dot to mark the centre and he called it "orange" - a word which he also applied a few minutes later to a realistic coloured picture of two halves of an orange on a plate. What perceptual attribute or attributes enabled P to decide when to use the word clock? It was not merely the presence of something more complicated than a dot within a circular outline because immediately after P had identified the dotted circle as an orange he showed that he recognized a rough circle with two eyes drawn inside it as a face by calling it "lady".

Similar negative conclusions are suggested by Major's (1906) observations on his son's naming of 'divided pictures'. Major cut a picture of a kitten's head in two just above the eyes and cut a picture of a shoe " ... in two at the instep leaving the 'upper' in one piece and the foot and heel in the other ...." (p.266). He then presented the halves separately to his son, R, and asked him to name them. Major began to use this procedure shortly after R was one and a half years old and continued, using these and other 'divided pictures', until the end of the third year. He states (p.260):

> It is perhaps unnecessary to tabulate the answers which the child gave since they were uniform throughout, and can be stated in a paragraph.
>
> (1) The two parts of the picture of the kitten

were always recognized and named as kă, tăt, or kittie. Once one piece was referred to as "bloke kiddie". (broken kittie). (2) The two halves of the shoe were named as "shoe" or "shoos" every time.

Major's demonstration seems to me to run counter to Clark's hypothesis because one might expect that if, for example, the perceptual attributes of a sole were criterial to the recognition of a shoe only one of the half pictures would have been recognized. A proponent of Clark's view could of course claim that recognition must have been based on a feature or features which spread across the line along which the pictures were sectioned. Colour would be a good example of such a perceptual feature, but Clark (1973, p.83) says of her classification of overextensions found in diary studies: "Although the overextensions are clearly based on perceived features of different objects, there is one surprising omission among these features: the attribute of color does not appear criterially at all." Now, Goodman (1966, p.199) has pointed out that there is an important difference between colour and some of the other visual properties which do enter Clark's classificatory scheme (size and shape):-

> And whereas a comprehensive concrete individual may still be uniform in color or place or time in that all concrete phenomenal parts of it have the same color or place or time, no individual can be uniformly square or of a given size in that every concrete phenomenal part of it is square or of that size.

The "surprising omission" of colour is perhaps an indication therefore that children categorize according to overall configuration rather than in terms of criterial features.

There is a speculation of Clark's (1973, p.86) which might seem to offer an explanation of P's naming of clocks:

> Since overextensions are rarely reported once a domain has been restricted, one might propose that by this stage, the child has analysed and coded particular configurations of perceptual features, and it is now the configurations of features that are used criterially in deciding on appropriate instances. However, the use of a configuration rather than isolated features does not necessarily mean that the lexical entry for a particular word is complete, but simply that the child has by now coded what appear to be the relevant set of attributes used to identify a certain set of objects or events. These perceptually based configurations are often represented in a shorthand form of notation as something like +Canine or +Bovine in the adult lexicon.

Taking a 'configuration of perceptual features' to mean a wholistic 'picture' of a (generic) member of a category, Clark appears here to be proposing something akin to the theory of prototypes, which I shall set forth in §1.3. Perhaps P had an internal 'picture' of a clock and applied the term clock to any percept which matched this 'picture' more closely than it did others in his mental gallery. I believe this to be a roughly correct account. But Clark says the configuration would be used "criterially". For criterial use of attributes to have the role she requires of it in explaining overextensions, it must be assumed that partial matches between perceptual input and internal configurations would not be criterial. "Criterially" is therefore gratuitous and would prevent this speculation of Clark's from being a basis for explaining P's use of clock but, unwanted as this qualification is, it is central to Clark's thesis. Clark's position here is of course trivially correct if it amounts to saying that a necessary and sufficient condition for being a clock is having the (configurational perceptual) property of being a clock [Cf. Putnam (1970, p.140).].

The failure of 'criterially used configurations' to explain P's behaviour is *a fortiori* evident if *configuration* is equated to *set*, as Clark appears to do above.

One might argue that P identified a circle as a clock if it contained *either* numbers or hands, and *mutatis mutandis* for Major's child. However, in her exposition of the semantic feature hypothesis Clark makes no provision for disjunctive composition in the meanings of children's words. To admit disjuncts would rob her hypothesis of much of its elegance. I shall argue in §1.5 that the theory of prototypes offers a better account of cases which appear to call for a disjunction of semantic components.

It might be claimed that the case cited above is not really to the point because P was not indulging in 'overextension' with his word *clock* any more than an adult would. Perhaps there is something special about overextensions. Perhaps Clark's hypothesis will hold only when a child is clearly willing to apply a lexeme to a wider denotation class than adults are for their corresponding form. I would therefore like to present a case of this kind. Another child I studied, J, first used *nose* when he was 1;10$\frac{2}{3}$, according to a questionnaire completed by his mother at weekly intervals. He used it in connection with people's noses. At 2;0 she again noted this use. When he was 2;0$\frac{1}{2}$ his mother reported that he used *nose* for paper tissues as well as his nose. At 2;0$\frac{2}{3}$ he used *nose* of his own nose, in my presence, and at 2;1$\frac{3}{4}$ his mother reported that he applied the term to a handkerchief. When J was 2;2$\frac{2}{3}$, I observed the following, travelling in a car driven by J's

mother: He requested of his mother a tissue from a box out of sight under the dashboard by stretching his hand in that direction and saying "nose". Immediately afterwards he replied "nose" to my questions, "What's this?" as I touched my own nose, touched his nose, held up another paper tissue and showed him my handkerchief. At 2;1, J had pointed at his own posterior, saying "there", in response to my request "Show me your nose. Where's your nose?" I submit that it would be perverse to seek to explain these uses of nose in terms of a small number of criterial perceptual attributes present in each member of J's denotation class for this word.

Further doubt is cast upon Clark's position by attested cases of what might be called underextension. A child using too few criterial features in deciding on the applicability of a lexeme will thereby encompass a denotation class larger than the adult one. A child who demonstrably has too small a denotation class for a lexeme may, in many cases, be assumed to be using too detailed an intensional definition for the lexeme; (in the phraseology of the theory of criterial attributes:) to be using more features criterially than adults do for that lexeme. There are reports of this kind to be found in the child language literature. For instance, Stross (1973), who investigated the acquisition of botanical terminology by Tzeltal children, states (p.124): "A two and a half year old girl was observed to correctly identify a pahčiak' tree growing next to the house in which she lived. Later it was found that she could correctly identify only this one specimen; she called others wamal or te?." [The latter two words are glossed as 'herb' and 'tree', respectively.]

Stross suggests that the location of this particular tree may have been (part of) the basis on which the child applied pahčiak'. It might therefore be argued that the child had a briefer-than-adult componential definition: NEXT TO HOME (& TREE). But equally, it seems to me, one could claim that this child was using a very detailed specification of her tree. Also, it is by no means obvious that NEXT TO HOME is a simple perceptual property.

Reich (1976) reports that his son, at the age of 8 months, would crawl to his mother, the bed etc. when asked "Where's Mummy/the bed/...?" In response to "Where's the shoes?" he would always crawl to his mother's cupboard and play with her shoes there. He would even crawl around a pair of his mother's shoes placed near him in order to reach the ones in the cupboard. Placed near the open door of his father's adjacent cupboard, he would ignore the array of shoes which it contained and crawl along to play with the shoes in his mother's cupboard as before. After successive intervals of approximately two weeks the following became additional goals towards which the child would crawl, upon being asked "Where's the shoes?": (1) shoes in h[illegible]her's cupboard, (2) shoes lying on the floor, (3) shoes being worn by someone. These observations led Reich (p.120) to what seems to me to be a justified conclusion: "It appears that the very first word meanings are formed by associating a sequence of sounds with essentially everything that is perceptually and functionally salient about the objects or actions in the environment that co-occur with that word."

There is some evidence too that lexical development in older

children sometimes involves a broadening of denotation classes rather than a Clarkian process of adding criterial features to lexical entries to narrow down to the adult denotation classes. In a systematic study Saltz et al (1972) found support for the view that (p.1192): " ... a child's early notions about a concept tend to be restricted to the attributes characteristic of his first few examples of the concept. Only with difficulty does the child learn to accept the fact that certain attributes, even though they were present in his first encounters with a given concept, are really irrelevant to the concept ...." They tested 24 children in each of the age ranges 5 - 6 years, 8 - 9 years and 11 - 12 years. Each child was required to work through a pack of coloured pictures of familiar objects, indicating whether or not each picture represented an instance of a given 'concept'. Each child did this six times, once for each of the 'concepts': food, animals, transportation, clothes, toys, furniture [Transportation had to be defined for most of the younger children; as "something that can take you from one place to another". The school bus was cited as an example to help them understand the definition.]. Children in the youngest group consistently included significantly fewer items under each of these labels than did the older children. In an examination of those pictures which had been selected as instances of each label by 75% or more of the entire sample of children, it was found that a significantly smaller proportion of the selection of instances for each 'concept' was drawn from this 'core' set by the younger children than by the older children. For every category the 8 - 9 year olds had a higher proportion of 'core' responses than the 5 - 6 year olds. In the case of five of the six categories 11 - 12 year olds drew a

higher proportion of their selections from the 'core' than did the 8 - 9 year olds; these two groups were tied on this measure for transportation. The developmental pattern implied by the results of this cross-sectional study is thus a progression from narrow idiosyncratic categories to broader socially-shared categories. I admit that equating the categories used in this experiment to denotation classes is not simply a matter of terminological substitution, salva veritate. However, it would be surprising if these results were not symptomatic of lexical development.

Given that many, perhaps most, perceptible properties of objects are gradable, the theory of criterial attributes leads naturally to a particular way of employing ostensive definition pedagogically. I shall conclude this section by explaining that remark and appealing to the reader's intuition for a judgement that the method involved is not a natural one for a parent to use. [See Farwell's (1973) review of studies of the characteristics of adult utterances addressed to young children for some evidence that ostensive definition is a central parental activity.] Kotarbinska (1960) offers the following analysis of ostensive definition: Given a standard object, A, then $\forall x$ (x is N $\equiv$ x is such as A in the respect R and in the degree D). Other examplars than A are shown in order to establish the degree, D, to which variation is tolerated for instances of N.

> ... from the point of view of the principle of effectiveness it is, of course, better to demonstrate as positive exemplars (standards) those of the designata of the given term which are, in the given respect, less similar to each other than those which are more similar to each other. (p.15)

Thus if one believed that what a child had to discover in learning the application of a lexeme were the criterial limits of the various attributes of members of the denotation class of that lexeme, it would be best to use, in ostensive definition, exemplars which fell just inside the fringes of the category. I do not believe that parents do this and the makers of children's picture books certainly seem to choose central rather than peripheral members of categories for their illustrations - consider the differential likelihood of finding either an igloo or a suburban bungalow under "H is for house".

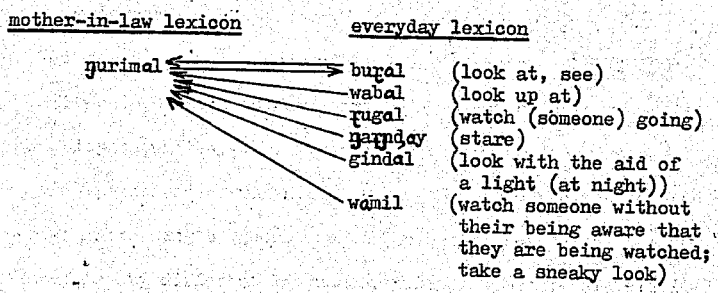
"As far as negative examples (standards) are concerned, it is better to specify as such examples which are not designata of the term "N", but which, in the given respect, are more similar to the standard designata than those which are less similar to them ...." (Kotarbinska, 1960, p.15). Thus, in order to delimit the boundary accurately, the child should be exposed to negative examples which lie just outside of the denotation class. One might for instance display a bat in flight as an instance of something which is not a bird; a strategy bound to lead to confusion in children, I submit. A strategy, though, which works well in models which instantiate the theory of criterial attributes, such as Winston's (1973) computer programme for naming toy block structures. As he says (p.3) " ... one must show the machine not just examples of concepts, but ... something which is close to being an example, but fails to be admissible by way of one or a few crucial deficiencies."

1.3 The theory of prototypes

In this section I shall expound a theory according to which the intension of a lexeme is a fairly detailed conceptual representation of a central member (or members) of its denotation class. First I need to justify the recognition of hierarchies within denotation classes.

1.3.1 Central and peripheral meanings

Bloomfield (1935, p.149) in a discussion of polysemous lexemes such as eye - 'oculus', eye of a needle, etc. - says: "The remarkable thing about these variant meanings is our assurance and our agreement in viewing one of the meanings as normal (or central) and the others as marginal (metaphoric or transferred)." Dixon's (1971, 1972) studies of Dyirbal (an Australian language) provide a neat illustration of the differential centrality of the various meanings of lexemes. Until about 1930 each speaker of Dyirbal had two lexicons: one for use in everyday speech and another for use in the presence of certain taboo relatives ('mother-in-law language'). The correspondence between the 'mother-in-law' lexicon and the 'everyday' lexicon is one-to-many. Some older Dyirbalŋan still remember their taboo lexicon and Dixon was able to establish many correspondences of the following kind, where items at the heads of the arrows are offered as equivalents of the items at the shaft ends.



The important point is that, although ɲurimal was given as the taboo equivalent of each of the words in the righthand column, only bural was offered as an everyday equivalent of ɲurimal and informants had to be prompted to concede that the other words were also equivalent to it. Furthermore, when informants were asked for specific taboo translations of the set of everyday words - translations which would reveal their differences in meaning - they retained ɲurimal as the correspondant of bural but modified it syntactically in various ways to render the other meanings. Dixon's primary interest in this data is that it allows him to distinguish a class of nuclear verbs (viz. bural) from the others, in the everyday lexicon. However, focusing on the 'mother-in-law' lexicon, this type of correspondence makes Bloomfield's intuition patent. I should point out that Dixon says that his nuclear/non-nuclear distinction is not in general appropriate to the nouns of Dyirbal, although I do not understand the significance of this claim.

Bloomfield's examples and the verbs from the 'mother-in-law' lexicon of Dyirbal are instances of what is usually taken to be polysemy - multiple but related meanings for single forms. However, a fair amount of evidence now points to there being a hierarchy even

among the members of parts of denotation classes denoted by (in traditional terms) single senses of lexemes. Berlin & Kay (1969) showed a 320-chip Munsell colour chart [in which the colours - all were maximally saturated - are arranged in a regular progression of wavelength - perceived as variation in hue - along one dimension and in order of increasing brightness on the other orthogonal axis] to speakers of twenty different languages. They had previously elicited the set of 'basic colour terms' for each language [For a definition of basic colour term, see the original text.] and they asked each informant to do two things: (1) To mark the boundaries of the area of the chart to which each basic colour term could be applied. (2) To indicate the best, or most typical, exemplar of each of their basic colour terms. The first task proved to be a difficult one and speakers of different languages varied widely in their estimates of where the boundaries should be drawn. Even speakers of the same language allocated the chips differently among their basic colour terms. And, when people were re-tested after an interval of three weeks they often did not end up with the same denotation classes as they had the first time. However, informants found the second task easy and their judgements were reliable (that is, they usually chose the same chips on the second testing). There was a high measure of agreement between speakers of the same language. And even speakers of different languages, if they had a basic colour term for a given area of the chart, tended to chose chips from the same small subregion of that area as best instances.

So, although there is room for argument about which colours

may reasonably be, for example, called green, there is general agreement on what is the best green for English and it is the same as the best green for any language having a term applicable to that general area of the colour chart. I shall call these best instances prototype colours in what follows [Berlin & Kay call them focal colours.] Eleanor Heider/Hosch has subsequently extended and confirmed Berlin & Kay's finding in a number of ways. She has shown (Heider, 1972), for 11 languages, that results equivalent to Berlin & Kay's are obtained when variation along the dimension of saturation is taken into account. In the same paper she demonstrated that, for speakers of 23 different languages, the prototype colours are more codable than colours elsewhere on the chart, in the sense that the names applied to them are shorter and in that they are named more quickly. Heider (1971) also reports some experiments which show that the prototype colours have a special status even for children as young as three years old. She presented three-year olds with linear arrays varying in either brightness or saturation, each containing one of Berlin & Kay's prototype colours, and then, putting her hands over her eyes, invited the subjects to choose any colour they wanted "to show me". The children chose prototype colours significantly more often than they would have been expected to do if chance alone had determined their choices. With four-year old children she found that they could select colours from linear arrays, varying in either brightness or hue, to match given samples more accurately when the samples were prototype colours than when they were not. In addition, errors made in matching colours which were close to prototypes significantly more often involved the choice of a colour even nearer to the prototype than they

did a colour on the other side of the sample, in abstract colour space. In a third experiment she presented three- and four-year old children with hue-varying arrays containing prototype colours and asked them "Which is the X one?", where X was each of the eight basic chromatic colour terms Berlin & Kay had elicited from English speakers. If a child 'knew' the colour term involved then the colour pointed to was significantly more likely to be a prototype than a non-prototype colour. ['Knowing' a given colour term was operationally defined as pointing to a colour which at least 50% of a group of adults, in a pilot test, had agreed "could be called" by that term.]

Heider/Rosch has also shown that Berlin & Kay's prototype colours are psychologically salient for speakers of a language which contains only two basic colour terms. The language is Dani, which is spoken in West Irian, and its two basic colour terms are mili, which may be roughly translated as "dark", and mola, which is approximately equivalent to "light". In Heider (1972) she reports that monolingual speakers of Dani were significantly more accurate in choosing, from an array of Munsell chips, a colour which they had held in memory for 30 seconds if it was a prototype colour than if it was not.

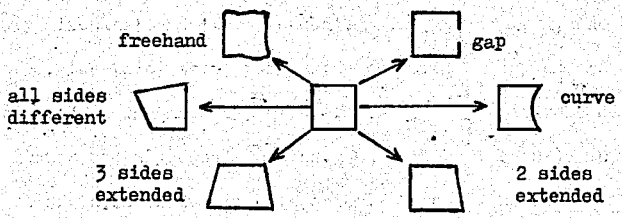
Rosch (1973a, b) also investigated the learnability of different kinds of linguistically encoded colour categories by monolingual speakers of Dani. Each category consisted of three chips, either of the same hue and of adjacent Munsell levels of brightness, or of the same brightness and next-but-one neighbours in hue on the Munsell colour chart. Both 'natural' categories, in which a Berlin & Kay

prototype was the central colour, and 'unnatural' categories were used. There were two kinds of 'unnatural' category: ones which did not contain a prototype colour at all and ones which contained a prototype colour as a peripheral member. Eight three-item categories were constructed for each of these six types $[\{\text{brightness varying, hue varying}\} \times \{\text{natural, unnatural}_1\text{, unnatural}_2\}]$. The experimental subjects were then taught to apply the same name to the three members of each category. Each subject learnt to do this for the eight categories of only one of the types. 63 of the 68 subjects completed the task successfully and demonstrated that they had learnt a categorization (and not merely a set of specific pairings of names and particular colours) by correctly naming new colours which were perceptually close to members of each of the categories they had learnt. Categories with prototype colours as their central members - the 'natural' ones - were learnt with significantly fewer errors than any of the four types of 'unnatural' categories. The hue-varying categories which lacked prototype colours were the most difficult of all to learn; as shown by the large number of errors made in learning them and by the fact that 3 of the 5 subjects who failed in the task were trying to learn categories of this type. The importance of the prototype colours is also manifested in the data on the learning of the names of individual colour chips: within the unnatural categories it was <u>not</u> the case that their central members were easier to learn to name but, within categories of the four types which contained prototype colours, either peripherally or centrally, significantly fewer errors were made in learning the names of the prototypes.

The fact that the same colours behave as prototypes for children who are still acquiring colour vocabulary and for people whose language has only two basic colour terms (as well as for speakers of many different languages) suggests that they are prototypes because of specific universal biological characteristics of human colour vision. This suggestion is reinforced by Heider & Olivier's (1972) multi-dimensional scaling analysis of the abstract colour-naming and colour-memory spaces of a group of monolingual Dani speakers and a group of speakers of American English. They used a computer technique to translate degree of similarity between colours into relative distance. Similarity in memory was assessed by noting confusions which occurred when subjects were asked to point out on a colour chart a colour which they had been shown earlier. Similarity in naming was measured by asking subjects to name each of the colours on a chart and recording the number of times each pair of colours was given the same name. It was found that the analogical distances between all the possible pairs could best be accommodated in roughly cylindrical figures, which look like a colour chart wrapped around the brightness axis. The 'cylinder' representing Dani similarity between the colours in terms of the names given to them is very differently shaped from the one arrived at for American English. This is hardly surprising given the considerable differences between the two colour vocabularies. However, in spite of the vocabulary differences, the cylinders representing confusability in memory are highly similar for the two groups of subjects. [McNeill (1972) argues for cultural and technological factors as the main determinants of Berlin & Kay's findings but I believe that her arguments are largely refuted by the Dani studies I have just summarized.]

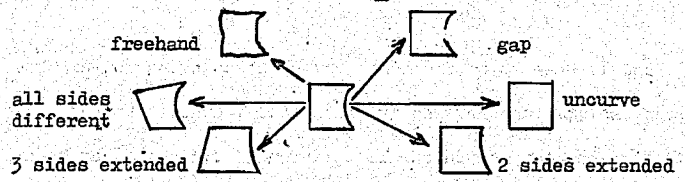
The human retina contains cells specialized for the detection of particular colours. However, since the way in which signals from these cells are integrated and balanced to yield the full range of colours which we can discriminate is not yet clearly understood, the step of correlating Berlin & Kay's prototypes with biologically salient colours cannot yet be taken [See, for example, Cornsweet (1970) or Milner (1971) for an account of the psychophysiology of colour vision.].

Are colour terms perhaps exceptional in having prototypes in their denotation classes? It seems not: when she investigated the relative ease of learning to name a variety of categories of geometrical shapes, Rosch (1973a,b) found results closely comparable to those in the colour-learning experiment. The materials she used were figures of a square, circle and equilateral triangle, together with related forms which varied systematically from these three assumed prototypes. She constructed seven-member categories of the figures. The one depicted below has a square as its central member.



The square is central to this category in that each of the peripheral figures differs from the square by only one geometrical transformation but, ignoring the relationship between the lowest two figures, differs from each of the other figures by two transformations. The category

above is a 'natural' category because it has an assumed prototype at its centre. The following is one of the 'unnatural' categories used [I have reconstructed it from a description; it is not illustrated in either Rosch (1973a) or Rosch (1973b).]:



Twenty-one categories were constructed in this way: 3 'natural' ones, with square, circle and equilateral triangle as central members, and 18 'unnatural' ones, each varying around one of the deformations of the three assumed prototypes.

Dani does not have single lexemes corresponding to square, circle and triangle. And, in pilot tests involving free sorting, three-member oddity problems and two-person communication tasks, Rosch ascertained that Dani subjects did not treat the figures to be used in the experiment as falling into the shape classes 'four-sided', 'roughly circular' and 'three-sided'. Ninety-four Dani, who had been in neither the pilot tests nor in the colour-learning experiments, participated in the main experiment. The 94 subjects were divided into seven groups roughly equal in size. One of the groups learnt a name for each of three 'natural' categories. Each of the other groups was assigned to learning names for three corresponding 'unnatural' categories. As in the colour categorizing experiment, Rosch found that the subjects had learnt conceptual categories, rather than specific pairings of the three names and each of the twenty-one figures

seen by any given subject. This was demonstrated by near-perfect performance in a transfer task requiring subjects to name figures related to the central members of the particular categories which they had learnt but which had not previously been seen.

Subjects were also asked to rank the members of each of the categories they had learnt, from most typical to least typical representative of the category. Regardless of whether or not they were the central members of categories, two of the presumed prototypes - square and circle - tended overwhelmingly to be chosen as the most representative member of categories in which they occurred. The equilateral triangle however, although usually ranked high on the scale of typicality was only marginally better than the other straight-line, three-sided figures. The freehand and 'one curved line' three-sided figures were very seldom judged to be highly representative of categories in which they appeared.

In the learning of the names of individual members of the categories, the circle and square - regardless of whether or not they were central to a category - were generally learnt with fewer errors than the other figures. The equilateral triangle did not prove to be significantly easier to learn than the other straight-line, three sided figures. The circle turned out to be an easier figure to learn to name than the square. Overall, the natural categories were learnt with significantly fewer errors than categories centred on the distorted forms.

Why are circle and square natural prototypes? I cannot, as with

colours, attribute their singular status to properties of human retinal cells [Although, see Dodwell (1970) for a survey of some of the highly functionally specific visual receptor cells whose existence has been established in mammals.]. However, Garner (1970) offers a persuasive account, founded in information theory, of why some figures, such as square and circle, are 'good' and others not. Garner and his coworkers have conducted experiments in which subjects are asked to rate patterns of dots for their 'goodness'. Their general finding is (p.39) " ... that poor patterns have many alternatives, good patterns have few alternatives, and the very best patterns are unique." As an aid to intuiting the kind of explanation Garner offers, without going into the details of his analysis, compare the consequences of rotating the prototype square through steps of 90° with doing the same to, say, Rosch's gapped square. The gapped square will be shown to be a member of a subset of four patterns whereas the prototype square is unaffected by orthogonal rotations. The circle, an even better prototype, is unchanged by any rotation within the plane; so it has even fewer alternatives than the square. Having few alternatives entails the possibility of more economical description and this, I presume, is why Rosch's experiment yielded the results it did.

In a painstaking and original study of similarity in visually perceived forms, first published in 1936, Goldmeier (1972) found many examples of what he called singular [Ger., prägnant, i.e., 'significant' or 'exceptional'.] values of geometrical parameters. For instance, a small change in the curvature of a curved line may pass unnoticed. Other singular values found by Goldmeier were 90°

angles of which one leg is vertical, vertical axis symmetry, parallelity and regularity of design. I introduce these here as examples of visual properties which evidently make certain patterns relatively easy to store in the mind. The singularity of some of these properties, e.g. the importance of the vertical, may have a simple biological explanation of the kind I suggested for colour prototypes. The others might also but, in any case, they appear to be susceptible of an explanation in Garner's information theoretic terms. Whatever the explanation, the singularity of these properties is well established. Given that certain visual forms are easy to store it would be natural for them to be prominent in categories they were involved in. Denotation classes with some singular members (or some members with singular properties) and some non-singular members will not be homogeneous classes.

It may be felt that simple geometrical figures and colours are an insufficient basis for generalizing about the denotation classes of natural language lexemes. Rosch (1973a), however, provides further experimental results which indicate that the phenomenon of differential typicality in denotation classes may be found beyond the rather specialized categories considered so far. She gave subjects six instances of each of the following categories: fruit, science, sport, bird, vehicle, crime, disease and vegetable; and asked them to indicate on a seven-point scale the extent to which each instance was a "good example" of its category.

The first interesting result is that this proved to be a readily

comprehensible request; none of the 113 subjects questioned the task or protested at it. They also made their judgements quite rapidly. There was also a high level of agreement between the subjects on the ranking of the instances in each category. As an example of the results consider the averages of the ranks assigned to the six given instances of science:

chemistry	1.0
botany	1.7
anatomy	1.7
geology	2.6
sociology	4.6
history	5.9

The fact that chemistry received the average rank 1.0 means that every one of the 113 subjects assigned it the highest rank possible on the seven-point scale, namely 1. The generally high level of agreement can be gauged from the spread of the average ranks. If subjects had, for each instance, randomly chosen between the seven ranks the average of the ranks would have approximated to 4.0 for each of the instances in the category. It is not possible to take the average ranks given above completely at face value because Rosch (1973a, p.132) says that a correction was used to compensate for subjects' tendency not to use the lower end of the scale - unfortunately, without indicating the extent of the correction applied. She does state though that the distribution of ranks accorded to all but two of the 48 instances departed significantly from a chance distribution. The spread of ranks across the instances seen in the science category, above, is virtually replicated in the categories fruit, bird and vehicle. Vegetable, disease and sport show a spread too, but not as wide. Crime did not yield the same clearcut results: murder was uniformly

allotted rank 1 and vagrancy was regarded as a poor example of crime but stealing, assault, blackmail and embezzling were bunched together, closely following murder.

Despite my cautions, above, I believe that Rosch has convincingly demonstrated hierarchies of typicality in categories, other than those for which straightforward explanations can be offered in terms of specificities of sensory cells or stimulus informational characteristics. [Rosch (1975, experiment 1) has repeated and extended the demonstration, using additional categories and 50 - 60 hyponymous instances of each category.] I surmise that the reasons why apple was found to be the best example of fruit, chemistry of science, football of sport, robin of bird, car of vehicle, murder of crime, cancer of disease and carrot of vegetable, are socio-cultural. What I mean is that it seems a very reasonable guess that these instances are prime examples of their categories because of the interests and preoccupations of the culture, North American, to which the subjects in the experiment belonged [Cf. Brown (1958, p.208).].

Thomson & Chapman (1975) have demonstrated differential typicality even within young children's 'overextended' denotation classes. This finding is strong evidence against Clark's (1973) developmental version of the theory of criterial attributes. Five children, aged between 1;8 and 2;3 participated in the study. Through interviews with their parents and testing of the children, using coloured photographs or pictures, four words which were overextended - by adult standards - were identified for each child. This preliminary testing also enabled

Thomson & Chapman to find at least five appropriate exemplars and at least ten examples of overextensions for each word. These pictures were used to construct 64 test pairs of pictures for each child: 4 words x 16 pairs per word. Ten of the pairs for each word consisted of a picture of something which an adult would consider to be a member of the denotation class of that word and a picture to which the child had applied the word in violation of adult norms. Five pairs pitted pictures of members of the 'overextension' of the denotation class against pictures of members of some other denotation class of the child's. The last pair for each word consisted of two such non-exemplars. It must be emphasized that, except for the seven non-exemplars, all of the pictures relating to a given word in the test for each child were ones to which that child had applied that word.

For each pair of pictures the child for whom that particular test had been designed was asked to "Point to X", where X was the word being tested. Four of the five children refused to respond to the pairs which consisted of two non-exemplars. Overextensions were generally favoured over non-exemplars. The interesting question, however, was what would happen in the ten pairs for each word which contrasted an appropriate exemplar and an overextension. Thomson & Chapman treated a ratio of 8 out of 10, or better, in favour of appropraite exemplars as indicating no overextension in this comprehension task. In terms of this criterion, one child showed overextension on all four words and hence is no grist for my mill. However, one child on all four words, two children on three words each, and the remaining child on two out of four words, went the other

way, choosing the appropriate exemplar in preference to an over-extension 8 or more times out of 10.

It is worth remarking further that, having found between 16 and 56 exemplars for each of these words in the preliminary investigation, Thomson & Chapman examined the known denotation class for each word in an attempt to discern necessary and sufficient conditions for the application of each word. By and large they failed:

> When individual exemplars are examined in relation to appropriate exemplars, Clark's conclusions are supported that that relation is usually one of perceptual similarity. But the dimension of similarity varies from one overextended instance to the next: The picture of productive overextension based on one to few systematic dimensions of meaning which we have obtained from diary and anecdotes fades rapidly as the number of observed instances of the overextensions is increased, as it was in this study. (p.66).

1.3.2 The role of prototypes

With regard to shapes and colours, Rosch (1973b) suggests (p.330) that "When category names are learned, they tend to become attached first to the salient stimuli (only later generalizing to other instances), and by this means 'natural prototypes' become foci of organization for categories." More generally (1973a, p.142) "It is possible that children initially define a category by means of its concrete 'clear cases' rather than in terms of abstract criterial attributes."

I agree with Rosch. What, however, does it mean to say that denotation classes are defined in terms of prototypes or that

prototypes are the foci of organization for denotation classes? I propose that the (phonological) form, or forms, associated with a lexeme serves as a retrieval cue for a fairly detailed mental representation of the prototype/s of its denotation class. As metaphors for this process, consider the form to be an index card which locates a drawer containing one or more video-tape recordings of prototype objects. Comprehending the meaning of a word will then consist in replaying the prototype recording/s retrieved by it. Deciding what to call a presented object will be a process of comparing sensory input with the recordings in the drawers of one's filing system and, after selecting the one which matches the input most closely, reading the label off the associated index card. Bluntly put, this may seem naive. However, I believe that many of the details can be filled in satisfactorily and that all of the objections which have occured to me are answerable.

An immediate objection is that a video-recording for the prototype of each lexeme would require an immense amount of storage space. The theory of criterial attributes calls for a minimum of information to be stored; only those features necessary to distinguish the denotation class of a lexeme from other denotation classes need be held in the head. I shall, however, present evidence in §1.4 to establish that humans do not require such economy: our memory stores have immense capacity.

Another line of objection is that, in deciding on the applicability of a lexeme, either the search through the filing system for a matching tape will take too long or referential chaos will result from there being too many similarities. In illustration of the latter possibility

consider the following misidentification made by a little girl, Ja (Age: 2;3¼) [See §2 for details of subjects.]. Her mother showed her a coloured picture of a rural scene. Nestling between two hills there was a farmhouse. There were cows grazing on one of the hills. The other hill was ploughed and a flock of rooks was scattered over it. This hill partially obscured a red-roofed haybarn which stood beside the farmhouse. The roof of the barn was long, and rounded in cross-section. The barn was filled to the roof with orangey hay. Ja correctly identified the house in response to a question from her mother. Then she pointed out the barn and said "That's a bus, Mummy". One way of looking at it, the mistake was reasonable: the roof of the barn was very like that of a bus. However, it would have required many more similarities, between what I saw and my stored prototype of a bus, to persuade me, an adult, that what I saw was a bus in a farmyard. The reason is that buses do not belong on farms.

This illustration suggests to me that one of the ways in which comparison between input and prototypes is rendered sufficiently finite to be feasible and by which confusion is avoided is through the organization of vocabulary into lexical fields [See Lyons (1963, 1968) for an account of this notion.]. By delving only into that part of the filing system which contains fields currently of relevance in a conversation or situation the number of drawers to be scanned will be greatly reduced. I shall try to show in the empirical part of this thesis, §2, that a major difference between adult and child vocabularies is that the latter are not differentiated into numerous, intersecting, lexical fields.

Ja's response also illustrates in another way the need to include a consideration of relationships between lexemes: 'overextensions' are a function of which other lexemes there are in the lexical field. Ja not only lacked barn but also did not have other candidate lexemes such as shed and haystack. As an example of the process of comparing current input to stored prototypes consider the following from J, a boy aged 2;1⅔. He was handed a grey plastic elephant and as he handled it said: "a cow, sheep, another cow". Perhaps he was hunting about doubtfully in this way among his prototypes because after he had identified the same toy elephant as a sheep, a month earlier, the adults present had gone on to talk about it as an elephant and he had on that occasion imitated the form elephant. The suggestion of this paragraph is in the spirit of Kirkpatrick (1891, p.175) who - to continue a passage quoted in §1.2.3.1, above - says of a child who calls a goat dog: " ... he classifies it with the group of animals it resembles more closely than any others with which he is acquainted."

Another line of attack on my proposal might be its dependance on internally stored relics of percepts. How could a system of this kind develop into one which is also able to store the meanings of abstract words? This is not a pressing concern for me because, as I have already suggested, young children's nominals are hardly ever abstract. However, I do not regard the system which I advocate as being applicable only at a certain early stage of linguistic ontogenesis. I think it very likely that abstract lexemes are understood in terms of memory traces of our experiences of the concrete world. An experimental investigation by Bugelski (1970) points clearly in this direction.

Bugelski re-examined a hoary technique in the psychologist's repetoire: free association to words. The psychologist presents a word and the subject is required to respond with the first word brought to mind by the stimulus word. Bugelski points out that the association is not strictly free because the subject is constrained to respond with another word. A typical result from word association tests is that 84% of people respond chair to the stimulus table. Bugelski says that, in psychological circles:

> It is a widespread, implicit assumption that subjects who say CHAIR thought of a chair when someone said TABLE. Such an assumption is manifestly absurd as no one in his right mind would [immediately, P.D.G.] think of a chair when someone said TABLE under any other conditions than those of a verbal association test. (p.1005).

Bugelski devised a freer version of the test and, using 32 common words, applied it to 57 university students. They were instructed to write a description of their first reaction to each word he read out. My interest in the results is that although some of the test words were abstract an overwhelming proportion of the responses (p.1005) " ... could, with some justice, be described as images". For instance, in response to communism (an abstract word) one subject wrote: "I saw a red velvet wall with a large yellow hammer and sickle". Bugelski concludes (p.1006):

> ... so-called abstract words are only 'so-called'. The responses brought out are concrete. If you say FLOWER, a categorical term, the subjects think of daisies or roses, and highly specific daisies or roses. If you say ANIMAL, another categorical term, they report dogs and horses and, again, highly specific animals at that: their own, their neighbors - they specify breeds, colors, actions. If you say DEMOCRACY, they report a variety of imagery, practically none of which refers to governmental

operations. Government by the people becomes an image of a crowd at a political rally.

Why, it may be wondered, then, are people ever able to offer intensional definitions of a kind different from those which merely appeal to resemblances to one or more prototypes, which are mentioned or ostended? Fumbling, everyday explications of usage, dictionaries and linguists' componential analyses attest to such an ability. I surmise that we continually operate upon our gross store of experiences; replaying, as it were, videotapes, constructing partial concordances and cross-references and noticing common properties of recordings filed under like labels. Some of this may be done in formal education, some of it in idle reverie. It may even take place unconsciously; perhaps it is the process which manifests itself as dreams in our sleep. I see no reason for new abstract (that is, not perceptually-grounded) primes either to arise out of or enter into this process of cross-referencing and classification. In this way, it seems to me, the theory of prototypes could allow for the possibility of humans devising a theory of criterial attributes, which offers coarse-grained accounts of the likely characteristics of the internal prototypes stored by members of a given culture.

In §2 I shall present empirical evidence, from the growth of children's vocabularies, in support of the theory of prototypes and in §1.4 I shall offer some psychological props to buttress its plausibility. Before doing so, however, some advantages of a general nature which accrue to the theory of prototypes are worth remarking upon.

One virtue is its compatibility with the facts of semantic change. Ullmann (1962, p.211) in his chapter on change of meaning says: "No matter what causes bring about the change, there must always be some connexion, some association, between the old meaning and the new." Informed by the theory of criterial attributes it would be reasonable to expect the connection to be shared (criterial) semantic components. I cannot prove that this is not the case but it seems to me extremely unlikely in view of the diverse catalogue of similarities which Ullmann cites as having supported semantic changes. Consider, for instance, the presumed connection (via rosaries) between bede, a prayer, and bead, small globular object. Surely it would be perverse to claim that there were so many shared criterial attributes in the denotation classes {beads} and {prayers} that when one or two of them were discounted or wavered in the flux of time the transfer was a natural one to make. How much easier it is to imagine someone storing a memory trace of a person counting bedes and later using the labelled trace as a basis for calling the beads bedes. The same comments hold for the etymology of muscle (from Latin musculus, diminutive of mus 'mouse'). In terms of overall visual properties - the quick smooth movement of a small hunched rounded object - the similarity is straightforwardly intelligible. On the other hand, if the criterial attributes SMALL and QUICK MOVEMENT (to guess at some of them) are the relevant mediators why are the 'golf-balls' on some electric typewriters, cheeky sparrows and shooting stars not called muscles or mice? I trust that these two examples - of metonymic and metaphoric change, respectively - will suffice although many more could be given.

Another phenomenon which can readily be explained in terms of the theory of prototypes is the use of the definite article in sentences such as:

> I cannot use my bicycle this evening because the tail light is out of order.

The label of any part of one's internal recording of a prototype may be used in definite form if the prototype has already been introduced into the conversation. Of course, there should be a qualification to the effect that in the interests of communication one should also believe that the item in question is a part of addressee's stored prototype. A possible counter to this argument is that tail lights are, at least in law, a criterial attribute of bicycles used at night and that "criterial attribute" could be substituted for "any part of one's internal recording of a prototype" in my rough formulation of the rule. There are many cases where this will be inadequate, however. Consider the natural Danish translation of I got paint in my hair [A French example would have served equally well.]:

> Jeg fik malefarve i håret.

håret, 'the hair', is the definite form of hår, 'hair'. To make the possession of hair a criterial attribute of possible speakers ignores the existence of bald people. Perhaps this sort of case could still be covered by the theory of criterial attributes if it were relaxed to permit disjunctive composition of components: human = ... & ± HAIR. But I believe that my next example, five lines from Burns' poem Tam o' Shanter, renders this proposal ludicrous:

> While we sit bousing at the nappy
> An' gettin' fou and unco happy,
> We think na on the lang Scots miles,
> The mosses, water, slaps and stiles,
> That lie between us and our hame,

The definite article before mosses, and tacitly before the other words in the penultimate line, is reasonable because mosses, bogs etc. are part of the image evoked by "lang Scots miles", for anyone who understands the poem; though they are quite unrelated to the fact that a Scottish mile was longer than an imperial mile. I am, as seems entirely reasonable to me, taking the penultimate line of this citation as being in apposition to the lang Scots miles and not merely as second, third, fourth and fifth conjuncts of a conjoined noun phrase.

Finally, a terminological point: if I am correct in believing that our mental intensions of lexical items are detailed prototypes to which input is compared in deciding on the applicability of a lexical item, then denotation and reference are almost coterminous. A lexeme denotes its denotation class. The denotation class of a lexeme is the set of entities in the world to which tokens of the phonological type(s) associated with that lexeme may reasonably be made to refer. Reference is a conversational process in which the utterance of an expression [that is, the utterance of a token(s) of the phonological type(s) associated with a lexeme or a phrase co... of more than one lexeme] is used to pick out for the addressee a particular individual entity; the particular individual entity which the speaker intends to pick out for the addressee. I am claiming that denotation classes are linguistic constructs based on relative similarity to mental representations of encounters with particular individual entities, the prototypes. The qualifier relative is introduced as a reminder of the role of sense relations between lexical items. Reference therefore differs from denotation largely in a concern on the part of the speaker that

the memory trace evoked in the addressee's mind by means of a referring expression should be a trace of an encounter with the same entity as the one recorded in the memory trace which is currently indexed for the speaker by the expression used and not merely a similar one. This justifies my use of reference in the title of this thesis. I recognize that this account of reference is oversimplified - one need not have encountered an entity to take a reference to it. However, I believe it to be the start of a correct account.

1.4 Psychological props for the theory of prototypes

"It is characteristic of natural language that no word is ever limited to its enumerable senses, but carries with it the qualification of 'something like'." (Bolinger, 1965, p.567). The proposal sketched in §1.3 is that the benchmark reference items in this comparison are internally stored prototypes. In the present section I shall try to buttress the proposal with experimental and clinical observations drawn from the field of psychology. In §1.4.1 I offer some grounds for believing that we ordinarily recognize things by attending to wholes and not by checking for the presence of criterial attributes. In §1.4.2 I assemble evidence which points to human memories having enough storage capacity and being able to record with sufficient fidelity to hold an enormous number of detailed prototypes. The videotape analogy of §1.3.2 presumes a distinction between the contents of memory 'drawers' and the labels on those drawers; §1.4.3 is concerned with establishing the existence of such a distinction in human minds. Prototypes may appear to be indistinguishable from images; §1.4.4

examines the connection with image theories, some criticisms which have been levelled at the latter, and ways of escaping refutation-by-association. §1.4.5 is a note on stabilized retinal images, the nature of whose fluctuations might be thought by some to run counter to my thesis.

1.4.1 Wholes vs. parts

Rock et al (1972) report an interesting series of experiments in which they tested subjects' ability to recognize either the outline or the internal details of fairly complex figures which they were shown briefly. The following is one of the figures used, with its outline and internal configuration shown separately on the right.

The figures were displayed for 5 seconds during the course of an experiment which subjects were led to believe was an investigation of visual afterimages. At the end of the display they were unexpectedly given sheets containing 10 alternatives from which they were required to select a copy of what they had just seen, or some part of it. Subjects who had viewed only the outlines of figures or only the internal configurations were very well able to select correctly a copy of what they had just seen; proportions of subjects showing correct recognition varied between 62% and 86%. Subjects who were exposed to the entire composite figures were not quite as good at choosing between 10 variations of the outer contour; proportions of subjects

who marked the correct item were between 36% and 56%. However, subjects who saw the whole figures and then had to try to select the internal configuration which had been contained in the figure were essentially unable to do so, whether or not the configurations in the ten-choice recognition test were presented within copies of the original outline; proportions of subjects choosing the correct internal configuration varied between 0% and 11%. On the basis of these and other similar experiments Rock et al conclude (p.655): " ... those features of a figure which are immaterial to its over-all, global shape are typically not recognized even immediately afterward; whereas those same features exposed in isolation under the same conditions and for the same period of time are recognized." This is nicely in harmony with an introspective opinion expressed by Pillsbury & Meader (1928, p.176): " ... if one will watch carefully the imagery as any object is recalled or remembered, it will be seen that everything is represented very schematically. Details are very largely lacking; rough outlines are made to do duty for much more than they reproduce."

It is a well-established fact that people recalling items from random lists which they have memorized tend to rearrange the contents of the lists into contiguous clusters of similar items [see Bousfield (1953) for a pioneering study of this phenomenon]. Frost (1971) in a careful and ingenious experiment has demonstrated that an important dimension of similarity forming the basis for such reorganization of lists is the gross orientation of a subject's visual image of an object. In the description of her work which follows I am keeping what I regard as the most significant evidence for present purposes

until the end; it may well be contended that the first results recounted are merely curious artifacts of a particular experimental technique.

Frost used line drawings of 32 common objects as stimulus material. Each object was drawn so as to have either a predominantly vertical, horizontal, left-slanted or right-slanted orientation. As an aid to visualizing these pictures the reader may find it useful to imagine a rolling pin, one of Frost's stimulus objects, in each of these orientations. [In a partial replication of the experiment, which yielded essentially the same results, Frost reassigned half of the stimulus objects between the four orientations. Thus, if the rolling pin had been depicted in perspective slanting up to the left for the main group of subjects, the subjects in the replication might have been shown a picture of a horizontal full broadside view of a rolling pin.] Before the test, subjects were given some practice trials designed to lead some of them to believe accurate memory of the pictorial information would be important and to encourage others to believe that visual specifics of the tokens they were shown would be irrelevant. The former were shown practice pictures and required, in a subsequent recognition test, to select replicas of the pictures they had seen from among sets of pictures containing different views of the same objects [None of the practice pictures fitted the four shape categories, vertical, horizontal, left- and right-slanted.]. The subjects who it was hoped would pay less attention to pictorial properties saw the same practice pictures but were subsequently tested for their ability to pick out from sets of common nouns the names of

the objects which they had been shown. The subjects were told to expect the same testing procedure in the experiment proper. This was either a 'white lie' or a piece of sophistry but in terms of expectations derived from the practice trials the two groups may now be distinguished as the PP (picture-picture) group and the PW (picture-word) group. The experiment proper followed immediately: each subject was shown each of the 32 pictures once, in fairly rapid succession - 1.5 seconds per picture. A different random order of presentation was used for each subject in a given group, but the orders of presentation were replicated across the two groups. After a 15 minute interval, during which they were occupied with syllogism problems, subjects were asked to recall orally the names of the 32 objects they had seen. Next, each subject was asked a number of questions about which I shall have more to say presently.

A control group were not shown any pictures. Their practice consisted in reading a list of printed words and then trying to recognize the previously presented words from among sets of words containing distractor items. In line with the terminology employed above, they were a WW (word-word) group. For them the experiment proper consisted in viewing the names of the 32 objects - in a different random order for each subject - then, as for the PP and PW subjects, solving syllogistic puzzles for 15 minutes before being asked for oral recall of the 32 words and, finally, answering questions in the post-experimental interview. Each subject's list of items recalled was quantified to indicate the extent to which it had been reorganized so as to present the items from each of the four orientation categories in immediate

succession. I shall omit here an account of the method of computing the amount of clustering (and also of certain other important statistical controls which were undertaken.) However, the highest figure would be obtained by a subject who recalled the items from each orientation category en bloc before proceeding to list the items from the next category. The WW control group, who had not been exposed to the experimenter-imposed orientation categorization, showed no tendency to impose this categorization on the sequences of words which they recalled. By comparison the PP group, as might have been expected, and the PW group showed highly significant tendencies to recall in immediate succession items which had been depicted in the same orientation; the difference between the PP and PW groups being so slight as to be of no account statistically. The post-experimental interviews with the PP and PW groups indicated that the subjects were able to recall the shape/orientation of each picture much better than chance but (p.413) "Not only did Ss report that they did no more than recognize and name the drawings in the stimulus set, but none of the 45 Ss who saw the stimulus drawings indicated any awareness of the shape categories." The experimenter's categories thus seem to have exercised their influence at a subconscious level.

PP and PW subjects were also questioned about intrusions in their recall lists; words which named objects which had not been presented in the experiment. There were few intrusions " ... and, in the great majority of cases, S described an object similar in shape to the object preceding the intrusion. For example, one S recalled the word "shoe", followed by "fish" (an intrusion). His description of the fish was

very detailed and of a distinctly horizontal projection (as was the shoe)." (p.413).

What I regard as of even greater interest is a result derived from rescoring the recall lists of the WW group. When they had been used as a control, their protocols had been scored for a tendency to cluster into orientation-defined categories the names of objects which the other subjects had seen in vertical, horizontal, left- and right-slanted projections. They had shown no such tendency. However, information on their personal image orientations was available from the debriefing interviews (p.412): "The WW Ss, who often reported spontaneous visualization of the objects during stimulus presentation, were asked to classify their images according to the four shape categories. When no image was recollected, S was asked to select one of the four categories in which he would most expect to see the object drawn." Using these personal categorizations as the basis for determining the extent of clustering by orientation it was found that there was a considerable amount present and the differences between the WW and the PP and PW groups almost disappeared " ... giving experimental support to the WW Ss' reported use of visual imagery." (p.413).

Two (linguistic) investigations of numeral classifiers, Adams & Conklin (1973) and Friedrich (1970) may be cited as immediate examples of the relevance of the type of investigation undertaken by Frost and Rock et al for linguistic studies. Many languages require the speaker to specify the units in which items referred to by a common noun are measured, whenever the common noun is qualified by a numeral; and in

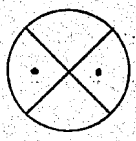
certain other contexts [See Lyons (1968, p.288) for a good brief description.]. If English were such a language we would have to say three head of cattle and would not have the option of saying three cattle, in the appropriate circumstances of course. Chinese is a language which has obligatory numeral classifiers. For instance, the following noun phrases would be ungrammatical if the classifiers, zhī, 'long slender object' and zhāng, 'flat object' were omitted:

sānzhī	bǐ
three-long-slender-object	pen
'three pens'	
sānzhī	chuán
three-long-slender-object	boat
'three boats'	
sānzhāng	dìtú
three-flat-object	map
'three maps'	

Adams & Conklin surveyed the numeral classifier usages of thirty-seven Asian languages. They found that (p.8) "One of the most fascinating facts of numeral classification is its dependence on the visual feature of form." The shapes longish, flattish and bulkily rounded " ... are by far the strongest metaphors which occur in the numeral classifier construction." (p.5). Friedrich gives a detailed account of numeral classifiers (and other shape-influenced grammatical categories) in Tarascan, an Amerindian language of Mexico. He also provides a less detailed survey of the same phenomena in other Amerindian languages, and a few languages from other parts of the world. He shows clearly that, in the classification of inanimates, categories which (p.399) " ... relate to physical experience - above all, visual experience." figure prominently in these languages and, as in the case

of the languages investigated by Adams & Conklin, categories which emphasize one dimension (long objects), two dimensions (flat objects) and three dimensions (bulky round objects) appear to be very common. This sort of classification would be easy for humans who store perceptual icons of objects with the phonological representations of the names of those objects, which is what I have been contending. These gross outlines are characteristics which Rock et al have shown we can easily store faithfully and which Frost has shown to be tacitly employed even by speakers of English, a language in which shape is hardly grammaticalized at all.

To revert to Psychology, I should like to recount an experiment performed on human infants by Bower (1966). At the lower end of the phylogenetic scale the responses released to a given stimulus configuration are approximately equal to the sum of the responses which are elicited by each of the components of the configuration when they are presented in isolation. This is known as heterogeneous summation. At the higher end of the phylogenetic scale, on the other hand, Gestalt perception prevails: the whole elicits more responding than the sum of its parts. Bower conditioned six infants at each of the ages 8, 12, 16 and 20 weeks to make a leftward head movement in response to a circular disc containing a cross and two dots, thus:



When this response was reliably established he tested the infants to see how many responses could be evoked, in the absence of reinforce-

ment, by the disc, the cross and the dots separately and by the whole ensemble. He obtained the results shown in the following table.

age in weeks	mean number of responses				
	disc	cross	dots	sum of parts	whole
8	40	14.66	15	69.66	69
12	67	13	21	101	100.5
16	55	15	31	101	114.33
20	23	10	16	49	106

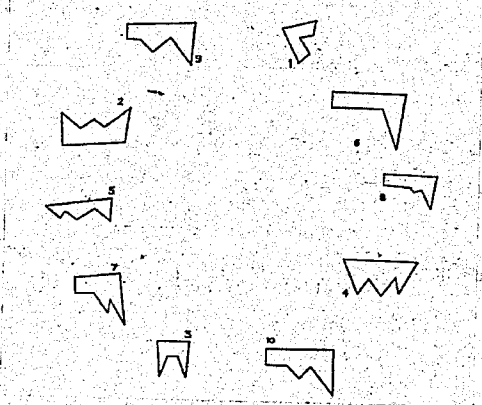
Firstly, it is clear that while 8- and 12-week old infants followed the law of heterogeneous summation, the Gestalt prediction is borne out by 20-week old infants. I take this to be an indication that the theory of criterial attributes would almost certainly be valid for the meanings of the words of infants up to the age of approximately three months, if they could speak. After that age the theory of prototypes seems more likely to be in harmony with the nature of human minds. Secondly, notice that, in keeping with the findings of Rock et al (1972), at each of the age levels, the outer contour of the configuration - the disc - is the most effective of the parts.

1.4.2 The size and quality of human memory

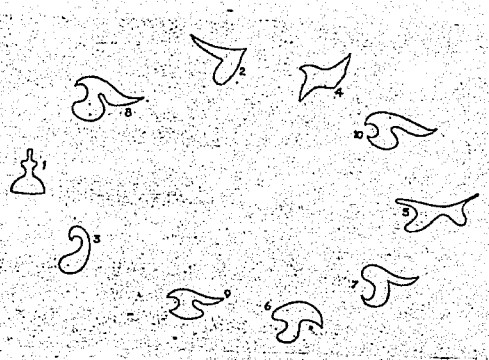
The theory of prototypes would be infeasible if humans had only a rather limited amount of storage capacity for memories: all of us use thousands of words and the theory of prototypes requires room for the filing of detailed memory traces of one or more exemplars for each content word. The theory could be ruled out of court simply by

adducing evidence which showed that human memory is small; that we need the economy of criterial attributes - short lists of simple cues the presence or absence of which reliably classify the external world. Accordingly, I shall seek to demonstrate in this section that human memory is enormous, that we characteristically store not only many memories but also that they may be very detailed and enduring. I begin with an account of some experimental studies of memory for recognition. Next, I recount some case studies of unusual individuals. The section concludes with a discussion of some psychological and neuropsychological theorizing on the nature of memory.

Rock & Engelstein (1959) used the shapes depicted below in an attempt to discover whether the memory trace of a visually-presented shape changes with the passage of time.



[Reproduced from Rock & Engelstein (1959, p.223).]



[Reproduced from Rock & Engelstein (1959, p.226).]

Each subject was shown either the rectilinear figure numbered 10 or curvilinear figure number 10 for a period of 20 seconds. Subjects who viewed the rectilinear figure were told that the experiment was an investigation of extrasensory perception. For the curvilinear figure the inspection was disguised as an experiment on visual after-imagery. The subjects were thus not encouraged to make any special effort to commit the shapes to memory. After the initial exposure subjects were dismissed and led to believe that the experiment was over. However, they were summoned back after intervals of 15 seconds, 1 day, 2 days, 1 week, 2 weeks, 3 weeks or 4 weeks and asked to draw the figure they had been shown. There were striking degradations in the accuracy of reproduction, even after 15 seconds and much more so after a week. 'Recall' memory was thus poor and decayed with the passage of time. [An appropriate control demonstrated that the low scores were not attributable to poor draughtsmanship.] For present purposes, however, the results of a recognition test based on the drawings of these subjects is of greater interest.

Four judges selected the two sets of figures numbered 1 to 9 in the reproductions above from among the recall subjects' drawings. They attempted to select figures which were very similar to the originally presented shapes [The ones they judged to be most similar to the originals are numbered 9.], drawings which were similar to the originals only in being closed rectilinear or curvilinear figures [These are numbered 1.] and a range spanning these two extremes [2 to 8]. These sets of figures were used to make the recognition test blanks which I have reproduced above; the numbers indicating the judges ratings were not present on the versions used in the experiment. Other subjects were shown one or other of the original figures - nos. 10 - under exactly the same conditions as the recall subjects and were then unexpectedly invited back at different time intervals ranging between 15 seconds and 4 weeks - different subjects for each of the retention periods, as before - and asked to indicate, from among the ten figures on the appropriate recognition test blank, the shape they had earlier been exposed to. Rock & Engelstein present their results in terms of median scores but are somewhat negligent in not stating the ranges. However, from the results which they do present it is clear that for most of the subjects recognition memory was at least as close to perfection as the difference between the figures numbered 9 and 10. The lack of detailed distributional evidence can perhaps be compensated for by stating what can be derived from the presented medians and some other hints to be gleaned from their paper. For the rectilinear figure at least 50% of the subjects, at each of the time intervals, were able to identify the one they had been shown initially. That rather more than 50% of them did so is suggested by the statement

(p.224) that after 3 weeks - the longest retention interval tested with the rectinlinear figure - only 3 of the 17 subjects tested for this particular interval failed to select the correct figure. The curvilinear figure proved to be slightly harder but even so 72 of the total of 102 subjects tested correctly identified the figure which they had seen before. "Even after four weeks, 9 Ss selected the correct figure and 6 Ss the one rated 9." (p.227) out of " ... approximately 20 ...." (p.226) subjects tested after this interval. Again, it should be emphasized that these subjects had not been instructed to remember the shapes; in fact, some attempts had been made to mislead them into believing that they need not remember what they had seen.

Shepard (1967) attempted to assess the amount of information which people can store in memory for purposes of recognition and whether printed words, printed sentences or pictures could be stored more effectively. His method was to display to subjects a large number of items (either words, sentences or pictures) in succession and then present them with a test series of pairs of items. One item in each pair was 'old', i.e. had been included in the original serial display, and the other item in each test pair was 'new', but drawn from the same pool of items which had provided the original set of to-be-remembered items. Seventeen university students each read a set of 540 different words, all between 5 and 7 letters in length, half of them high-frequency words and the other half rare. Immediately afterwards they took a 60-item test in which they had to indicate which member of each pair had been included in the original 540. The mean

proportion of words correctly recognized as 'old' was 88.4%. To test memory for sentences Shepard was able to find a collection of 1360 different sentences originally compiled for articulation testing. Seventeen students each read a 612-item subset of these sentences. Two additional subjects read a double-length, 1224-item, selection of the sentences. On a subsequent 68-item test the subjects who had seen the set of 612 sentences were able to correctly identify, on average, 89% of the 'old' sentences. The mean proportion of correct choices of 'old' sentences in the pairs test for the subjects who had read the double-length set was 88.2%. These figures strike me as impressive but the retention of pictures was even better, in terms of the proportion recognized correctly.

The illustrations chosen for presentation in the picture test were mostly culled from magazine advertisements. Shepard intended they should be individually of high salience and memorability and, collectively, low in similarity and confusability. From a total of 748 such pictures he constructed a 612-item memorization series. The remaining 136 pictures were used as the 'new' items in constructing two 68-item recognition tests. In the recognition tests each 'new' picture was paired with a different 'old' one, randomly selected from the 612 presented for memorization. The subjects were 34 technical and clerical employees in the laboratories of a telephone company. Each subject viewed the 612 pictures, projected in colour on to a screen, at a personally chosen pace. The average time each person spent looking at each picture was 5.9 seconds. Immediately afterwards they were shown the first set of 68 recognition pairs and asked to indicate the

previously seen 'old' pictures in each pair. Nine of the 34 subjects were able to do so with 100% accuracy. The mean score was 96.7%. Half of the subjects achieved a score of 98.5% or better. The inter-quartile range was 4.4%, which means that three-quarters of them achieved a score of no lower than (and probably higher than) 94.1%.

Sixteen of these subjects were retested, using the other 68 recognition pairs, after 2 hours, 3 days, 1 week or 4 months; four subjects were tested for each of the retention intervals. The mean percentage of pictures correctly identified after each of these periods was, respectively: 99.7%, 92%, 87%, 57.7%. In a two-choice test 50% is the score one would expect if chance alone determined the responses. The results are even more striking, it seems to me, when it is remembered that these feats were performed as an aside from the ordinary lives of the subjects, merely to satisfy a psychologist's scientific curiosity. In Shepard's words (p.160): "Evidently, after 20 or more years of absorbing visual information, Ss are still able to take in as many as 612 further pictures without any particular effort and, then, discriminate these from pictures not previously seen with (median) accuracy of over 98%."

A possible objection to the general validity of Shepard's results lies in his having used advertisements, with which subjects might have been familiar, and in his having selected pictures which were, subjectively, highly distinct from one another. This objection is met in an investigation reported by Standing et al (1970); an investigation which also used even larger ensembles of stimulus pictures. In one

experiment four subjects who viewed a succession of 1100 reproductions of photographs drawn haphazardly from magazines scored 99%, 95%, 96% and 96% on a 100-item recognition test presented 30 minutes after they had seen the last of the memorization items. The recognition test, as in Shepard's (1967) work, consisted in pairs each containing one 'old' and one 'new' picture from which subjects were to select the 'old' member. In another of their experiments Standing et al used a large collection of 35mm. slides provided by amateur and professional photographers. From these they randomly selected 2560 slides to be presented for memorization. Almost all of the slides were coloured and very few contained letters or numbers. The slides could be apportioned as follows according to subject matter: 37% human, 5% animal, 13% vegetation, 7% mineral, 24% urban scenes, 13% mechanical objects, 1% miscellaneous.

Five subjects were shown the 2560 slides by means of an automatic projector, which displayed each slide for 10 seconds, with a delay of half a second between successive slides. A ten-minute rest was allowed after each hour of viewing. Three of the subjects saw 640 slides a day for four days and the other two had 1280 slides a day over two days. One hour after the last slide in the learning series each subject took a recognition test, of the same kind as those described above, consisting of 280 pairs of pictures. The subjects whose initial exposure had been spread over four days were able to select the 'old' pictures correctly 95%, 93% and 85% of the time. The two subjects who had seen the original series in two days scored 89% and 90%. We are told (p.74) that among the 2560 slides there were " ... 300 pictures of

single adult male figures and 200 single female adults." which allows the conclusion, given the high levels of accuracy which were nonetheless achieved, that the stored memory traces must have been quite detailed.

Entwisle & Huggins (1973) have performed similar experiments with young children ["first grade", in the U.S.A.] using 40 pictures of " ... unremarkable landscapes or cityscapes ... [which] were completely unfamiliar to these children, insofar as we knew." (p.392). In one experiment they were projected in black and white and the children were tested by means of a 40-pair recognition test approximately 2½ hours later. The mean number of correct recognitions for the 23 children tested was 31. The lowest score was 23 and the highest 38. Thirty other children saw the same series of pictures in colour and after 2½ hours scored between 25 and 40 out of 40 in the recognition test; the mean was 34.2. A third group (of 29 children) also saw the pictures in colour but were tested one week after the initial display. They succeeded in identifying the 'old' picture 31.9 times out of 40, on average; the scores ranged between 24 and 39. See Brown & Scott (1971) for a report of a similar experiment with comparable results.

At various times during its development psychology has shown an interest in eidetic images. These are strikingly clear and detailed revivals of previously-perceived visual scenes which some, but by no means all, people report having experienced. Eidetic images are not to be confused with visual after-images. Visual after-images are produced by staring fixedly at simple shapes under strong illumination

and they are colour-negative, e.g. staring at a yellow circular disc will yield an after-image of a disc coloured blue. By contrast eidetic images are reportedly of much longer duration, usually colour-positive and can be evoked by pictures too complicated to yield an after-image. They can be voluntarily recalled after a considerable lapse of time. Allport (1924), who provides a good summary of early research in this field, studied eidetic imagery in 11-year old children. He showed them a picture on a large sheet of dark grey paper for a period of 35 seconds. After removal of the picture he asked them to continue looking at the grey paper and report what they saw. Their reports often contained very detailed descriptions of the picture. For instance (p.109):

> I found that a number of children whom I examined were able to spell correctly, or almost correctly, from their image the German word Gartenwirthschaft, which was for them quite meaningless. The exposure of 35 seconds was not sufficient to permit a 'learning' of the word, especially since the picture itself was filled with incident and detail of lively interest which the child had likewise to describe. The essential features of the picture were described with more fluency, to be sure; but upon being pressed to 'observe' their image more closely each child was able, often to his own surprise to 'see' the small letters over the door.

Allport (1924, p.101) claims of eidetic imagery: "There is an observable retreat of the ability during adolescence ..., though among poets and artists a large number, perhaps the majority, are in respect to their imagery 'grown-up children' ...." Stromeyer & Psotka (1970) found a 23-year old artist with apparently very powerful eidectic ability. Their report describes an ingenious test of her capacity for storing detailed traces of visual input. They made use of Julesz

random-dot stereograms. Each member of the stereo-pair is a pattern of dots created by randomly filling or leaving blank the cells in a large square matrix (typically 100 x 100). The two patterns are identical except that in a chosen region of one of the patterns all of the dots are shifted a few cells laterally. The resulting empty cells are randomly filled or left blank to patch up the overall appearance of a random scattering of black dots. Each of the patterns is thus completely random but the region which is decorrelated between the two patterns is seen as a figure in depth when the pair is viewed through a stereoscope.

Stromeyer & Psotka allowed their subject to view one member of a random-dot stereo pair with one eye only. After a delay, which in one case was 24 hours, they presented the second member of the pair for viewing with her other eye. She was able to identify the shape of the decorrelated region, which she claimed she could see in depth as clearly as when she later viewed the pair through a stereoscope. This test allows a more impressively objective demonstration of the effect than Allport's technique. However, some caution is warranted because (a) the figures were extremely simple: a square and a T in two different orientations and (b) the experiments were not double-blind, i.e., the experimenters had knowledge of the shape of the decorrelated region. Stromeyer & Psotka claim, without giving details, to have subsequently performed successful double-blind tests with the same subject, with intervals as long as 3 days between the two presentations for 100 x 100, and 4 hours for 1000 x 1000 stereograms. My reason for introducing Eidetikers, and the mnemonists which follow, into the discussion

is that I do not believe human brains could possibly vary so greatly in their cyto-architecture and physiological functioning as to give some people orders of magnitude more memory capacity than the rest of us. In the conclusion of this section I speculate that the differences may be attributable to different ways of using a human brain.

Stratton (1917) reports anecdotes about three different 'Shass Pollaks' recounted to him by other people. "Shass is the abbreviation for the Hebrew terms for the Talmud, and Pollak is a Pole; nearly all these memory experts came from Poland; a Shass Pollak then is a Pole who has memorized the entire contents of the Talmud ...." (pp.244-5). These people were said to be able to specify which word occupied a given position on any page of the Talmud. A pin would be pricked into a word on one page and, it is claimed, the mnemonists could specify the word through which the pinprick passed on any other page. It is worth noting too that two of the people who supplied Stratton with his information stated that the 'Shass Pollaks' they had met lacked a scholarly grasp of the contents of the Talmud, despite knowing the text by heart. These accounts are not well substantiated, but informal enquiries which I have made among friends suggest to me that many academics have had the experience of hunting through a text for a quotation and knowing, correctly, where on the page they would find the object of their search.

A better-documented case is the mnemonist, S, who was studied by A. R. Luria, an eminent psychologist, over a period of almost thirty years. S's memory was so faithful as to be an embarrassment to him;

for instance, he would fail to recognize acquaintances whose appearance had changed in some small detail. He was, to pervert a trite saying, unable to remember the wood for all the minute features he recollected about the trees. The only occupation he succeeded in was giving demonstrations to audiences of his phenomenal ability to remember lists, tables and texts. The following passage from Luria's account (1969, pp.11-12) will give the reader an idea of the man:

> ... it appeared that there was no limit either to the capacity of S's memory or to the durability of the traces he retained. Experiments indicated that he had no difficulty reproducing any lengthy series of words whatever, even though these had originally been presented to him a week, a month, a year, or even many years earlier. In fact, some of these experiments designed to test his retention were performed (without his being given any warning) fifteen or sixteen years after the session in which he had originally recalled the words. Yet invariably they were successful. During these test sessions S would sit with his eyes closed, pause, then comment: "Yes, yes ... This was a series you gave me once when we were in your apartment ... You were sitting at the table and I in the rocking chair ... You were wearing a gray suit and you looked at me like this ... Now, then, I can see you saying ..." And with that he would reel off the series precisely as I had given it to him at the earlier session. If one takes into account that he had by then become a well-known mnemonist, who had to remember hundreds and thousands of series, the feat seems even more remarkable.

Wilder Penfield [Penfield (1959), Penfield & Roberts (1959)] evoked similar detailed recollections from some patients by means of localized electrical stimulation of the cortex. The patients were to undergo neurosurgery for the relief of epilepsy. Before performing the operations Penfield 'mapped' parts of their brains in order to determine which parts should be preserved at all costs and which parts could relatively safely be interfered with. He did this by exposing parts of the brain and then

probing its surface with electrodes carrying small alternating electric currents. The operations were performed with only local anaesthesia so that the patients remained conscious throughout; the cortex itself is without sensation. The type of response with which I am concerned, and which Penfield calls experiential, was aroused only by stimulation of the temporal lobes; never by stimulation of other areas. The anterior and deep portions of the temporal lobes are also the parts of the cerebrum in which [Cf. Penfield (1959, p.1723).] Hughlings Jackson observed that epileptic discharge would produce 'dreamy states' and reminiscences. And, in the dominant hemisphere, the temporal lobe contains areas of central importance in the use of language.

One of Penfield's patients, M. Ma., [Cf. Penfield & Roberts (1959, p.59).] exclaimed when the current in a suitably placed electrode was switched on: "Oh, a familiar memory - in an office somewhere. I could see the desks. I was there and someone was calling to me - a man leaning on a desk with a pencil in his hand." As another example, consider the following [Penfield (1959, p.1720).]:

> A boy (R. W.) heard his mother talking to someone on the telephone when an electrode was applied to his right temporal cortex. When the stimulus was repeated without warning, he heard his mother again in the same conversation. When the stimulus was repeated after a lapse of time, he said, "My mother is telling my brother he has got his coat on backwards. I can just hear them."
>
> The surgeon then asked the boy whether he remembered this happening. "Oh yes," he said, "just before I came here."

The following case [Penfield (1959, p.1720).] attests to the verisimilitude of the recollections and also to their being recordings in

real time:

> A woman (D. F.) ... heard an orchestra playing an air while the electrode was held in place. The music stopped when the electrode was removed. It came again when the electrode was reapplied. On request, she hummed the tune, while the electrode was held in place, accompanying the orchestra. It was a popular song. Over and over again, restimulation at the same spot produced the same song. The music seemed always to begin at the same place and to progress at the normally expected tempo. All efforts to mislead her failed. She believed that a gramaphone was being turned on in the operating room on each occasion, and she asserted her belief stoutly in a conversation some days after the operation.

The summary from Penfield's preamble (1959, p.1719) will serve admirably for my purposes too:

> There is an area of the surface of the human brain where local electrical stimulation can call back a sequence of past experience. An epileptic irritation in this area may do the same. It is as though a wire recorder, or a strip of cinematographic film with soundtrack, had been set in motion within the brain. The sights and sounds, and the thoughts, of a former day pass through the man's mind again.

The reference to <u>thoughts</u> in this quotation is moved by another kind of response which Penfield was sometimes able to evoke by temporal-lobe stimulation, and not from stimulation in any other part of the brain. These responses, which Penfield terms <u>interpretive</u>, are feelings of fear, familiarity, strangeness, aloofness etc. Penfield suggests that they are the manifestation of a mechanism which evaluates present experience against stored representations of similar past experiences and produces immediate reactions which guide one in deciding whether to flee or approach etc. Again there are parallels in the reports of epileptic patients with disturbances focused in one or both temporal lobes. Since I shall have

more to say about cerebral anatomy later, I must point out that Penfield recognizes that the recollections which he evoked were probably not stored in the temporal area. "On the contrary, one might expect that the local effect of electricity, within a considerable distance surrounding the point of application, would prevent the activation of any elaborate and complicated local mechanism." [Penfield & Roberts (1959, p.49)]. One might instead expect that [Penfield & Roberts (1959, p.42)] " ... there is neuronal conduction away from the area in question. It is conducted by nerve fibres to a less disturbed zone of ganglionic connection. Thus the positive responses identify the function of the ganglionic zone with which the stimulated area has normal, functional cortico-fugal connections."

Evidence of the kind I have presented in the preceding few pages may lead one to ask how the brain manages to store so much detail - for purposes of recognition at least; it is not always readily available when we want to recall something. If this question goes unanswered the reader may be tempted to attack the evidence rather than accept the conclusion. To forestall such a reaction I propose to summarize here a neurophysiological hypothesis about the nature of the memory mechanism. The author of the hypothesis, Fong (1969), argues for his case on the basis of a number of facts of neuronal molecular chemistry which seem tailored to fit his proposal (but would otherwise have to be regarded as mere coincidences) and on his model explaining several psychological properties of memory.

Fong proposes that RNA macromolecules are the 'tapes' in mental tape

recorders. The only form in which information reaches our brains is as trains of, electrical, nerve impulses. The impulses in a train all have approximately the same intensity, 120 milli-volts, and the same duration, 1 millisecond. The strength of stimulation impinging on a receptor cell, from which a train of impulses comes, is coded in terms of the spacing of the impulses: impulses in rapid succession represent strong stimulation, a wider spacing of impulses signals a weaker input. It is these trains of impulses which Fong believes are recorded on RNA molecules.

The bases of an RNA molecule are attracted to one another so that they form something like a stack of coins held together with a rubber band. As with such a stack of coins, force is required to dislodge a base from the stack - to leave it projecting from the side of the stack ('held there by the rubber band'). The amount of energy in a 1 millisecond 120 millivolt nerve impulse is equal to the quantity needed to displace a base from the RNA molecule. Fong (pp.34-5) points out that, whereas a smaller impulse would only rotate a base slightly and not push it far enough out of line for its neighbours to close up ranks, too large an impulse would provide enough energy to jostle the whole stack and allow the displaced base to resume its place; nerve impulses are of just the right size. This provides an account of how a single nerve impulse might leave its mark on a RNA molecule. To record a train of impulses the molecule would have to be moved linearly through an electrical field created by the arriving impulses. Now, RNA molecules - the stacks of coins - are synthesized by enzymes which extrude them at a rate of 0.5 microns per second. During 1 millisecond, the duration of a single nerve impulse, an RNA molecule in the process of being formed will, therefore,

advance about 0.5 millimicrons. This matches the thickness of a single RNA base, 0.34 millimicrons, quite closely. Thus each impulse in a train could act on one base in an RNA helix. In the end the RNA macromolecule will have a base displaced from the stack for each impulse; and an undisplaced base wherever an impulse could have occured in the train but did not. In short, it will be an accurate recording of the train of impulses, preserving the frequency information of the original. RNA is known to be implicated in the process of memory and known to be produced during learning. Fong (pp.28-9) estimates that the amount of RNA required to store a reasonable representation (recordings of the light intensities of 10,000 points) of each frame in 52 two-hour cinema shows - a year's viewing at the rate of one a week - would be 2 thousand-millionths of a gramme "... which is well within the capacity of the brain."

There is apparently some likelihood that the enzymes which create RNA molecules ingest other RNA molecules as templates in the process. This provides Fong with a hypothesis about the source of the linear motion required for 'replaying' RNA molecules. When a base is displaced from its stack its electrical field is no longer cancelled by its neighbours and is of the same order of magnitude as a nerve impulse, about 150 millivolts at a range of 100 millimicrons, so it could be used as a replica of an original nerve impulse, without any amplification being required.

Fong (p.39) points out that random thermal fluctuations in the brain would soon result in some RNA molecules stretching enough to allow displaced bases to fall back in line. This would account for the ephemeral nature of some memory traces. If, on the other hand (p.39), the RNA

molecule were to bind with a protein molecule - and protein is known to be involved in memory - it would not, in ordinary circumstances, be possible to lengthen it to make place for displaced bases. This would explain the relative permanence of some of our memory traces.

Fong's model has enough capacity to explain a conclusion which Bugelski (1970, p.1008) reached after conducting an experiment in which subjects were instructed not to learn the material presented to them: "I argue that all that is required for learning is that the learner attend to the stimulation for an adequate time." Do we then store a representation of every noise made within earshot and of every scene whose image strikes our retinas? I feel not: I have failed to recognize streets I have been in before, people I have met, etc. The solution to this puzzle seems to lie in what is covered by Bugelski's term attend. What is needed is a notion of conscious focal attention. Human vision is a sensory system which lends itself readily to a fairly concrete explication of this notion. About 95% of the striate cells in the occipital cortex, the cortical destination of visual input, are innervated from the foveal regions of our retinas. The fovea is a small region near the centre of the retina. It is densely packed with sensory cells and it is here that the optical image of anything visually fixated upon falls. Karmel & Maisel (1975) have assembled an impressive array of neurophysiological and psychological evidence to support the contention that visual stimulation elsewhere on the retina serves almost exclusively the purpose of finding interesting things for the fovea to examine [In the last phrase I am paraphrasing in commonsense psychological terms, for the sake of clarity, a tight neuropsychological specification.]. Perhaps it is largely foveal

stimulation which is stored as the record of (visual) consciousness.

Finally, it should be noted with regard to Fong's model that he offers no account of how coherent wholes might be organized in storage: a specification of the intensity of each of 10,000 spots of light is not a picture. I shall return to this issue later. However, his model is reassuring about the gross capacity for storing records of sensory input. Another question I shall return to is that of the fidelity of mental records. The experiments summarized in earlier parts of this section suggest that our internal representations are fairly accurate but a similar experiment conducted by Goldstein & Chance (1971) shows that memory traces are less than perfect. They exposed subjects to a series of 14 pictures of faces or 14 inkblots or 14 pictures of snow crystals. Forty-eight hours later the subjects were able to correctly recognize, on average, 72% of the faces but only 43% and 30% of the inkblots and snow crystals, respectively. Evidently they were not storing sufficient detail to discriminate accurately among the members of these relatively homogeneous arrays. Another point raised by these results is that they might indicate that familiarity with a particular type of material enhances recognition; the subjects may reasonably be expected to have been more familiar with faces than with the patterns of snow crystals. The relative homogeneity of the arrays was not quantified so this is not the only conclusion possible. The effect of familiarity is proved though by a result obtained by de Groot (1965) in his study of chess masters. He found that masters could reconstruct a chess position almost perfectly after studying it for about 5 seconds, whereas weaker players generally could not. That the masters did not possess a superior sort of short-

term memory was shown by the fact that they and novices were equally inept at reconstructing random arrangements of chess pieces on a chessboard. This effect betokens organization of the gross store of memory traces. In §1.3.2 I suggested that the fact that people are able to offer componential definitions for words could be explained by assuming that we engage in organizing and classifying the contents of our memory stores whenever we can spare the time. I should like now to show that this assumption is compatible with a distinction which has often been drawn by psychologists between two kinds of memory.

The terms which Tulving (1972) uses for the distinction are episodic memory and semantic memory. I shall not follow Tulving in every detail but I shall adopt his terms as they are now widely current. Essentially the same distinction is characterized by Katona (1940) as the difference between individual traces and structural traces, by Maccurdy (1928) as the difference between memories which derive their significance through their me-ness and those which are more objective, and by Reiff & Scheerer (1959) as the difference between remembrances and memoria. Bartlett (1932), a modern pioneer in the study of memory, devoted most of his investigations to the study of objective settings or schemata, which are not very different from what Tulving calls semantic memory, and he would, I am certain, have been in sympathy with Tulving's distinction. The distinction is implicit in many other studies of memory. What I shall now present, using Tulving's labels, is a composite of these views.

Episodic memory traces are detailed recordings of specific items of personal past experiences. They are dated in relation to other items of

one's past experience. Maccurdy (p.135) says they are: " ... useful, even essential, for the innumerable, trivial adaptations of daily life. For instance, 'Where did I leave my pen?' can be answered only by evoking the simple kind of isolated image memory." [Maccurdy's "only" results in an overstatement of the case.]. Because episodic traces carry autobiographical indices they are the basis for the kind of recognition required of subjects in the experiments summarized in this section. In the words of Reiff & Scheerer (p.32): "Recognition carries with it the implication that this specific experience is the same as a specific experience 'in my past'." For Katona (p.195) episodic traces " ... are characterized by a certain degree of fixation and rigidity, while structural traces [i.e., the contents of semantic memory] are more readily adaptable and flexible." Tulving (p.386) says exactly the opposite but I take Katona's view on this point. I follow Katona because it seems to me that the feats of memory I have described above fit the other specifications for manifestations of episodic memory and the evidence appears to indicate that the traces involved are stable and durable. The occasional difficulties people have in recalling items from episodic memory suggests that these traces are not organized per se, other than in terms of spatial and temporal contiguity between events which gave rise to them.

Traces in semantic memory, on the other hand, are organized into systems. Tulving (p.386) calls semantic memory "a mental thesaurus". In general, the traces lack autobiographical indices: I know that Paris is the capital of France, that whales are mammals, that insects have six legs, etc. without remembering the specific occasions on which I first

discovered these facts. Items may enter semantic memory either through perception or as a result of cogitation. Systems of semantic memory traces are not encumbered with an excess of detail.

The fact that so many psychologists have been led to the same distinction is encouraging to me although, of course, the mental reality of the distinction is not thereby established. If the reality of episodic memory is accepted - and I hope that the bulk of this section will have persuaded the reader to accept it - then some superordinate organization is obviously necessary to explain how we avoid too time-consuming a search in retrieving stored information. Allport (1924) whose study of eidetic imagery I recounted earlier, and whose work embodies the episodic/semantic distinction implicitly, says (p.116) that we cannot rely on episodic memory alone [to paraphrase his words] because then " ... our mental life would be an inextricable chaos of photographically accurate records. Such a state would not facilitate the organizing, fusing, abridging, and interchanging which allow the individual to vary his reaction; an image too closely bound to a specific previous situation would tend inevitably to stereotype his modes of response." A graphic account of this chaos was given by Luria's (1969) mnemonist, S, in a description of the problems he encountered in trying to read (p.116): "Even when I read about circumstances that are entirely new to me, if there happens to be a description, say, of a staircase, it turns out to be one in a house I once lived in. I start to follow it and lose the gist of what I'm reading. What happens is that I just can't read, can't study, for it takes up such an enormous amount of my time ...."

When S became a professional mnemonist he developed a shorthand system for using images to commit lists of words to memory. Since his method seems to me to be a plausible account of how semantic memory might be merely a way of organizing and classifying the contents of episodic memory by means of cross-references, I shall quote another of S's autobiographical reports [from Luria (p.42)]:

> Formerly, in order to remember a thing, I would have to summon up an image of the whole scene. Now all I have to do is take some detail I've decided on in advance that will signify the whole image. Say I'm given the word horseman. All it takes now is an image of a foot in a spur. Earlier, if I'd been given the word restaurant, I'd have seen the entrance to the restaurant, people sitting inside, a Rumanian orchestra tuning up, and a lot else ... Now if I'm given the word, I'd see something rather like a store and an entranceway with a bit of something white showing from inside - that's all, and I'd remember the word. So my images have changed quite a bit. Earlier they were more clear-cut, more realistic. The ones I have now are not as well defined or as vivid as the earlier ones ... I try just to single out one detail I'd need in order to remember a word.

It seems to me that the difference between S and most other people is that S did not carry this process of indexing his episodic memories and extracting generalizations, such as that restaurants were usually distinguished by having white tablecloths visible through a doorway, as far as others do. For instance, S's response to a request that he explain the meaning of a nonsense word, zhuk, which he had coined in his childhood, shows that he had not sought a generalization or even to pare down the number of relevant images to a few prototypes. I trust I may presume upon the reader's patience once more by presenting Luria's (p.84) account of S's response:

A zhuk - that's a dented piece in the potty ... It's a piece of rye bread ... And in the evening when you turn on the light, that's also a zhuk, for the entire room isn't lit up, just a small area, while everything else remains dark - a zhuk. Warts are also a zhuk ... Now I see them sitting me before a mirror. There's noise, laughter. There are my eyes staring at me from the mirror - dark - they're also a zhuk ... Now I'm lying in my crib ... I hear a shout, noise, threats. Then someone's boiling something in the enamel tea-kettle. It's my grandmother making coffee. First she drops something red into the kettle, then takes it out - a zhuk. A piece of coal - that's also a zhuk ... I see them lighting candles on the sabbath. A candle is burning in the holder, but some of the tallow hasn't melted yet. The wick flickers and goes out. Then everything turns black. I'm scared, I cry - this is also a zhuk ... And when people are sloppy pouring tea, and the drops miss the pot and land on the plates, that's also a zhuk.

I believe it is even possible to point to a neuroanatomical basis for the distinction between episodic and semantic memory in the specialization of the two cerebral hemispheres. In most people, damage to certain parts of the left cerebral hemisphere interferes with their ability to use language whereas damage to the corresponding parts of the right hemisphere does not do so [Cf. Geschwind (1970).]. It will simplify the following discussion if the minority of people whose right hemisphere controls language are ignored. Experiments conducted on people whose brains were surgically sectioned at the corpus callosum, for the relief of a severe form of epilepsy, and who consequently had two relatively independent hemispheres have confirmed the pre-eminence of the left hemisphere for language. They also suggest that the right hemisphere is specialized for visual-spatial tasks [Cf. Gazzaniga (1975, p.567).]. Levy (1969), who says (p.615) that the right hemisphere seems " ... immediately to abstract the stimulus Gestalt - that is as an integrated whole." and that the language hemisphere has

" ... a strong analytic propensity ...." has demonstrated this difference in a comparison of the scores of left-handed and right-handed people on different types of question in an intelligence test [the Wechsler Adult Intelligence Scale]. Penfield (1959, p.1725) reports that visual illusions, of the kind I described earlier in this section, and illusions of recognition were evoked by the application of electrodes to the temporal lobes on the non-dominant side only (i.e., usually, the right side of the brain).

I shall argue below for the primacy of vision among human perceptual systems. Assuming this for the moment, it seems to me very likely that the right hemisphere contains, or is at any rate fundamentally involved in the business of storing, episodic memory traces. An observation which has been made in connection with the Wada test for hemispheric dominance [Cf. Penfield & Roberts (1959, p.86).] suggests this very strongly too. For the Wada test, sodium amytal is injected into the carotid artery on one side to temporarily 'anaesthetize' the corresponding cerebral hemisphere. The patient is instructed to count aloud and flex the fingers of both hands for the duration of the test. While the dominant hemisphere is affected the counting ceases and the patient suffers a hemiplegia of the contralateral side of the body. Sodium amytal acting upon the non-dominant hemisphere does not disturb counting but does result in opposite hemiplegia. The interesting point - using the simplification of calling the dominant, language, hemisphere left and the non-dominant one right - is that after recovery, which takes about 5 minutes, from a sodium amytal injection in the right hemisphere the patient denies

the hemiplegia. After recovery from interference with the left hemisphere, on the other hand, the patient usually admits to having suffered the hemiplegia. This is exactly what would be expected if the right hemisphere were responsible for autobiographical, episodic memory. The left hemisphere, I suggest, is the one which orders and indexes the contents of episodic memory.

In summary, I have argued the non-dominant hemisphere contains an immense data base of remembrances. It is against these episodic memory traces that fresh input is matched. These memories also provide the subject matter for cogitation. I regard the language hemisphere as primarily responsible for the maintenance and use of this data base; for cross-referencing the entries in it, for selecting subsets of the items stored under a given label as best instances - prototypes - of that category, and for sometimes noticing that there are common properties possessed by most of the members of a category. Some of these statements may appear to presume the existence of a homunculus in the left hemisphere. I shall consider some ways of avoiding such a presupposition in §1.4.4 but I turn now to some evidence for the existence of separate verbal and visual codes in human minds.

1.4.3 Contents vs. labels

Most of the experiments discussed in the previous section related to memory for visual input. I was concerned to show that we have a very large capacity for storing visual input because I believe vision

to be our primary sensory modality. Is this belief justified? Man may, after all, be defined as homb loquens and sound is generally agreed by linguists to be the principal medium for the transmission of linguistic signals. Bransford & Franks (1972) have conducted experiments which give strong support to the commonsense view that the natural way to treat a linguistic utterance heard in the ordinary course of life is not to memorize it, but to extract the information it contains and then discard it. For instance they showed that subjects were strongly, but erroneously, convinced that they had read certain sentences earlier if those sentences summarized information which had been presented to them by means of other sentences. 'New' concise summary sentences were often rated more familiar than previously exposed sentences which had carried the same information piecemeal. The centrality of language in human life then does not seem to be a good argument for the promotion of auditory over visual memory.

It is often contended that thought is internalized speech. The manifest ability of the deaf to think adequately argues against this, for their command of language is often poor. Vernon (1967) reviewed thirty-one investigations of the intelligence of deaf people, spanning the period 1930 to 1966, and concluded that (p.331): "There is no functional relationship between verbal language and cognition or thought process." And: "Verbal language is not the mediating symbol system of thought." Touch, fairly broadly interpreted, is the only other sense with even a remote claim to the place which I hold is occupied by vision. Berkeley and Condillac [Cf. Pastore (1971).] argued that we learn how to see shape, size and distance by relating

visual input to the information gained from tactile exploration of the environment. Rock & Harris (1967) report an ingenious series of experiments which show that when visual input and tactile input conflict, unbeknown to the subject, vision triumphs over touch in judgements of size, shape and direction. They also showed that vision could 'teach' touch. For example, subjects practised drawing while looking through a prism which performed a left-right inversion of their visual input. After four 15-minute spells of such practice, spread over four days, they were blindfolded and asked to write 10 dictated letters and numbers. They were warned that their experience with the prism might result in their writing some of the letters and numbers backwards. They were instructed to report it if they felt that they had written an item backwards. Despite the fact that writing is a highly-practiced skill these subjects wrote many of the letters and numbers backwards and often failed to report that they had done so. They also reported feeling that they had written backwards some of the items which they had, in fact, written correctly.

There has recently been a strong revival of interest in mental imagery among experimental psychologists. Several things have been clearly established. One is that the concrete nouns which name a series of unrelated pictures are better recalled when subjects have been shown the series of pictures than when they have been shown only the nouns (in printed form). Another is that recall of lists of unrelated concrete nouns is better than lists of unrelated abstract nouns; this is apparently attributable to the greater ease with which subjects can conjure up mental images for concrete nouns. Also,

if in committing lists of words or pictures to memory (either intentionally or under a pretext which leads subjects to believe that memorization is not required), subjects are instructed or otherwise persuaded to generate a mental image of each item, recall is about twice as good as when subjects under comparable conditions are instructed or by other means led to store only the linguistic label of an item: a mental picture is worth two mental words. The studies which justify these claims are legion. One of the most carefully controlled series of experiments in the genre is reported by Paivio and Csapo (1973). This paper also presents some evidence for the independence of verbal [= phonological?] and image codes in memory. Rather than go into the details, however, I would prefer to recount some experiments of a different kind performed by Lee Brooks, which point in the same direction.

Brooks (1968) required subjects to summon up from memory either sentences or line diagrams, which had been previously presented, and then to signal certain information about the sentences or line diagrams. The methods by which the information was signaled were varied: the subject might, for instance, be required to signal vocally or to do so by pointing to symbols in a spatial array. In a series of seven experiments on seven different sets of subjects, Brooks sought to determine whether concurrent vocal output would interfere with the process of recalling a sentence from memory more than a visuo-spatially monitored output; and whether the converse would be true for the recall of line diagrams. The results "... suggest that spatial and verbal information is recalled and processed in a modality-specific manner."

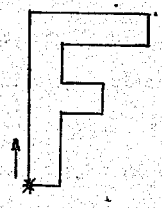
(p.349). Before I present a summary of the experiments which justify this conclusion I should point out that verbal is not here construed as widely as it might be by a linguist: the 'verbal' tasks required literal recall of spoken sentences and rather superficial decisions about the categorization of words in those sentences. They were non-semantic tasks which I feel might be within the scope of mental mechanisms responsible for phonological and (surface) syntactic processing. That is to say, I believe that Brooks' investigations of 'verbal' recall are relevant to the labelling end of prototype storage, in my proposals, and not to the whole gamut of mental mechanisms deployed in normal language use.

The sentences used in most of Brooks' experiments were all ten words long and exhibited a variety of syntactic structures. One of them was: "A bird in the hand is not in the bush". On a given trial in the main experiment, the sentence was read aloud once to the subject who then repeated it. The subject's next task was to signal by means of a sequence of yesses and noes whether or not each word was an article. Practice trials ensured that the task, including the ways of giving responses, were clearly understood. No grammatical sophistication was required of the subjects, who in all the experiments were undergraduate students: they were given lists of the nouns and articles in each sentence, since ability to perform the categorization per se was not the focus of the experiment. The correct response from a subject asked to monitor the specimen sentence above for nouns would be: no, yes, no, no, yes, no, no, no, no, yes. Three different forms of response were employed to signal the sequence of yesses and noes: the subject

either uttered the sequence or tapped with the left hand for yes and the right for no or used a pencil to point at Y (for yes) or N (for no) on each line of a chart of Ys and Ns. The ten-line chart exhibited a Y and an N on each line, for each of the ten decisions, but the Ys and Ns on successive lines did not form regular columns. The columns were staggered and subjects were asked to actually touch each Y or N with the pencil point, not just indicate the general vicinity, in order to make this a task which required close visual attention. After hearing the sentence and repeating it, on a given trial, the subject was told which form of output signal would be required, asked to repeat the sentence once more and only then told whether nouns or articles was the relevant class for the categorization. The type of categorization required was not presented until this stage to avoid the possibility of subjects simply translating the sentences into sequences of yesses and noes on first hearing, and then relying on direct recall of that sequence. The amount of time elapsing between a subject being told "nouns" or "articles" and completion of the response sequence was measured. After signaling the response in one of the three ways for a given sentence subjects were next required to do so in the other two ways. They repeated the sentence aloud again once more before each sequence of responses. The orders in which the three forms of output were required (and the orders in which the decision categories, "nouns" or "articles" were used) were counterbalanced for each sentence.

The task involving line diagrams was closely analogous. The figures used were 10-sided block diagrams of letters of the alphabet,

such as the F reproduced below.



The arrow indicates the order in which the corners were to be classified and the asterisk the point at which the classification was to start. On some trials subjects had to indicate whether or not each corner was vertically extremal (i.e., at the very top or bottom of the figure), in which case, proceeding clockwise from the asterisk, the correct response sequence for this figure would be: Yes, yes, yes, no, no, no, no, no, no, yes. On other trials left-right extremal position was the relevant category. Decision category and form of response - vocal, tapping or pointing - was varied in counterbalanced fashion for each figure, as for the sentences. On a given trial, the subject was shown the figure, then asked to draw it from memory (clockwise, starting at the asterisk), then told which form of response signal would be called for on that trial. Next the subject was asked to "mentally recall" the figure for approximately two seconds before being told the decision category, "top-bottom" or "outside". The time taken from this moment to the completion of the response sequence was recorded. After testing via the other two response modes, with two seconds of mental recall allowed before the test each time, subjects proceeded to the next figure.

Half of the subjects were tested first on sentences then on figures and the remainder were tested on figures before sentences. "The subjects reported that they 'could say the sentence to themselves' while tapping or pointing, but not while saying 'yes' and 'no'. The diagrams could be 'pictured' while subjects were tapping or saying 'yes' and 'no', but not while they were trying to point. These conflicts reportedly had the effect of making it easier to lose track of where one was in the sentences or the diagrams." [Brooks (1968, p.354)]. The table which I reproduce below, omitting information on standard deviations [which was relevant only in choosing which statistical test to use], provides objective support for these reports.

	mean output time (seconds)		
	pointing	tapping	vocal
sentences	9.8	7.8	13.8
diagrams	28.2	14.1	11.3

[After Brooks (1968, p.353).]

Each figure in the table is an average of 24 data points (3 trials x 8 subjects). The results were highly consistent across subjects: only one subject showed a shorter time, in the case of only one sentence, for vocal output than for the other two types of output. With one of the diagrams, a single subject produced times which run counter to the average tendency. Statistically, the main burden of this table is highly significant: vocal output takes more time than the other two modes when it relates to a mentally recalled sentence and visuo-spatial output takes a longer time than the tapping or vocal output

when a diagram is being recalled.

In his second experiment Brooks further substantiated the conflict between saying one set of words while recalling another set of words by showing that the strength of the effect was related to the articulatory complexity of the output and to the difference between the vocal output and the internally recalled words. This experiment differed from the previous one only in the form of output required: the output was always vocal and subjects spoke their responses normally to signify yes but whispered to signify no. The words they whispered or spoke were either the words of the sentence being recalled, or the syllable la or the word january. Thus, indicating normal voice by means of capitals and whisper by means of lower case, the correct response from a subject monitoring a bird in the hand is not in the bush for nouns would be: a, BIRD, in, the, HAND ... or la, LA, la, la, LA ... or january, JANUARY, january, january, JANUARY .... It was obviously not possible to use the first type response in connection with block diagrams of alphabetic letters but la and january were used with diagrams. In order to get a baseline measurement of response execution speed subjects were retested after the experiment, using the same material but not having to rely on memory for it; the figures or written versions of the sentence remained visible throughout.

For sentences, the results showed that january took significantly longer than la which, in turn, took significantly longer than simply modulating the words of the original sentences (by whispering or not whispering them); due allowance having been made for baseline

differences in the speed of execution of the three types of response. As Brooks says (p.356): "These findings would suggest that word compatibility, not simply vocal activity, is important for producing the conflict between recall and output." And the articulatory complexity of the output, la vs. january, has an effect, over and above the baseline differences between la-responding and january-responding when the sentences were there to be read directly. This effect was specific to verbal memory because although january output tended to require more time than la with diagrams also, it did not do so differentially more when subjects were working from memory as compared to the baseline measurement in which they had the diagrams before them.

Brooks' third experiment was similar to the second one but the focus was on line diagrams. Subjects responded only in writing this time: a tick for yes and a cross for no. The ticks and crosses were either made on top of each other or one below the other, without the subject looking at exactly where the signs were placed, or they had to be carefully placed in little boxes on the response sheet. No significant differences were found between the three types of response for sentences but for diagrams visual monitoring of the output resulted in every subject taking longer for the condition in which the ticks and crosses had to be precisely positioned. Movement alone - having to move down the page in making the responses induced, on average, but not for every individual, a moderately significant delay when subjects were signaling their classification of the corners of mentally recalled diagrams.

Brooks, reviewing experiments II and III, realized that it might be argued that the differential difficulty of _january_ over _1a_ with sentences and of visually-monitored writing over writing without looking, in the case of diagrams, were not necessarily specifically verbal and visual effects, respectively. Perhaps any increase in complexity of response would lead to disproportionately longer response times provided that modality-specific conflict had first been induced. "In both cases, it might be that simply one more complication was being added to the lot of a subject who was already coping with a confliotful task." [Brooks (1968, p.359)]. In his fourth experiment Brooks ruled out this possibility by ingeniously combining features of the second and third experiments. Subjects were required to respond both vocally (voiced vs. whispered _1a_ or _january_) and in writing with ticks and crosses (either in a visually-unmonitored column or placed in small boxes). For diagrams visually-unmonitored writing combined with _1a_ yielded the shortest average response times. Substituting _january_ for _1a_ did not increase the response times significantly. But (whether in combination with _1a_ or with _january_) every subject took a longer average time to respond when the ticks and crosses had to be visually monitored. The results were not as clearcut for sentences, because for these particular subjects _january_ responding was not as significantly more difficult than _1a_ as it had been for the subjects in experiment II. There is a potential explanation of this embarrassment in terms of additional practice which was required to train subjects to make the complex responses. However, for present purposes, it suffices to say that the results tend in a direction which supports Brooks' earlier interpretation: with sentences, the slowness of responding attributable

to the difference between la and january is greater than the slight increase in time attributable to visual monitoring of the response.

In his fifth experiment Brooks contrasted auditory presentation of sentences with sentences which subjects saw in typed form. Sentences which had been seen proved to be triflingly less susceptible to inference from vocal output than sentences which had been heard but (p.363) " ... the recall of both written and spoken sentences clearly conflicts mainly with the articulatory responses." That the vocal interference effect was not attributable to auditory feedback was shown by a partial replication of the first experiment (experiment VI) in which subjects either said "yes" and "no" aloud or merely mouthed these responses. Silent mouthing output took a little longer but did so to approximately the same insignificant extent with both sentences and diagrams. In his seventh experiment Brooks showed that the difficulty induced by the monitoring of ticks and crosses during the recall of a diagram was spatial rather than specifically visual. The outputs compared were: (a) making a rough column of ticks and crosses without looking and (b) feeling, with eyes closed, for small holes in a piece of cardboard in which to make the marks. The tactually monitored output, b, took slightly longer than the other form of output when sentences were being recalled but very much longer when information about a mentally recalled diagram was being signaled.

I have recounted Brooks' experiments in detail because it appears to me to be strong evidence for a distinction in forms of memory traces between ones which are to some extent isomorphic with visuo-spatial

perceptions and ones which are something like phonological representations. A commonsense term for the former would be images. If my proposals amount to suggesting that the meanings of lexemes are essentially mental images they fall into a long and vigorously disputed area of psychology. It is therefore necessary to examine now the relationship between 'prototypes' and images and to consider whether any of the arguments which have been advanced against the role of images scathes the theory of prototypes.

1.4.4 Image theories

"In large measure I think, that is, I mean and I understand, in visual pictures." [Titchener (1909, p.16)]. Titchener, one of the founding figures of American psychology, doubted whether meanings arose into consciousness on every occasion when words were understood [Cf. Titchener (1909, p.178).]. However, he believed that, in his own case at least, conscious meanings were mainly carried by images. Bearing in mind his caution about verbal reports on introspections (p.28): " ... language is discontinuous, and our descriptions must substitute a word-mosaic for the moving pictures of experience ....", consider the following personal description of a part of Titchener's mental life (pp.13-14):

> ... my mind, in its ordinary operations, is a fairly complete picture gallery, - not of finished paintings, but of impressionist notes. Whenever I read or hear that somebody has done something modestly, or gravely, or proudly, or humbly, or courteously, I see a visual hint of the modesty or gravity or pride or humility or courtesy. The stately heroine gives me a flash of a tall figure, the only clear part of which is a hand holding up a steely grey skirt; the humble suitor gives

> me a flash of a bent figure, the only clear part of which is the bowed back, though at times there are hands held deprecatingly before the absent face. A great many of these sketches are irrelevant and accessory; but they often are, and they always may be, the vehicles of a logical meaning. The stately form that steps through the French window to the lawn may be clothed in all the colours of the rainbow; but its stateliness is the hand on the grey skirt.

There is a striking similarity between these vignettes and the shorthand mnemonic images which Luria's mnemonist, S, developed [Cf. the description in §1.4.2 of an image of a spurred boot standing for a horseman.]. The fact that S, the mnemonist, had taken some halting steps towards mental economy in the same direction as Titchener, a very successful professional person, reinforces my belief that the mnemonist's brain was not of a radically different sort; he merely exhibited one aspect of mental functioning in extreme form. Titchener's introspective report also conveys clearly the notion of conscious focal attention, as opposed to peripheral awareness, which I suggested (in §1.4.2) might explain why we cannot remember everything set before our eyes; cf. his faceless humble suitor.

It may well be asked what the use of an image is, if what words retrieve are indeed mental images. One answer is that there are certain types of problem in the solution of which visual images are very useful. Baylor (1973) presents an interesting computer simulation of the way humans characteristically solve problems from Guilford's Block Visualization Test, such as

> Two sides of a 2 inch cube that are next to each other are painted red and the remaining faces are painted green. The block is then cut into eight 1 inch cubes. How many cubes have one side painted red? How many cubes have no sides painted red? How many cubes have three unpainted faces?

People usually report solving these problems by summoning up images from memory to construct a composite image which matches the specification in the statement of the problem, mentally slicing the image into pieces and then counting the pieces which have the requisite characteristics. Baylor's program stimulates this process and could make errors of a type which humans often do too, such as counting particular pieces twice because they appear in two faces of the cube which may be 'looked at' separately. I shall return below to the question of the objective validity of the claim that it is possible to manipulate images and to a consideration of the virtues of such an ability. At this point, however, I must face up to the possibility that problems which can, perhaps must, be solved by recourse to images play a much smaller role in our lives than I think. I do not have the requisite data to rebut a charge that Guilford's Block Visualization Test is recherché. Instead I shall review an experiment which suggests that the normal treatment we give to statements is to use them to construct a mental 'picture'. It may be recalled that I suggested earlier [§1.4.3] that people do not normally memorize sentences: they extract the gist and then discard them. The experiment described below supports this view and offers a hint as to the nature of what is left in the mind after a statement has been processed.

The experiment is the first one reported in a paper by Pompi & Lachman (1967). They used two passages each 79 words long and each containing 75 different words. I shall consider only the passage which produced the most patent results. It is reproduced below. [The results achieved with the other passage support identical conclusions

and were statistically significant too.[7]

MAJOR SMITH WATCHED HORRIFIED AS WITHERING FIRE CRUMPLED
AN IMMEDIATE SUPERIOR NOW HE MUST GUIDE THE SMALL GROUP
ON THEIR IMPORTANT JOURNEY URGING HIS TEAM TO KEEP
SILENT THEY MOVED THROUGH DENSE SNAKE INFESTED FORESTS
SUDDENLY CLATTERING CATERPILLAR TREADS SOUNDED NEARBY
AFTER RAPIDLY CRANKING IN ONE ROUND HE ESTIMATED DISTANCE
AND ELEVATION HIS FINGER CAREFULLY TIGHTENED AND THE
STEEL MONSTER WAS BLOWN APART FAST THINKING SAVED THEM
ALTHOUGH THIS HAD BEEN ONLY A MINOR INCIDENT AMONG
ENDLESS DESPERATE ENCOUNTERS

Half of the subjects assigned to this passage read the words in the order given above. The other half of the group read the same words in random order. The passage lacks punctuation in order to increase the similarity of these two tasks. Furthermore the words, both in the normal and in the random presentation, appeared singly on cards and 1.5 seconds was allowed for reading each card. In a pretest with other subjects it had been found that presentation in this manner, in the normal order, made it possible for most subjects to apprehend the theme of the passage, i.e., they reported: "It was an incident in a war" or words to that effect. The wording of the passage was chosen so that, individually and out of context, the words were not strongly related to the theme of the passage. The reason for this will shortly become plain. The subjects in both experimental conditions, normal and random order, were instructed to "learn" the material during their single pass through the deck of cards.

Approximately two minutes after reading the original cards subjects were given another deck of 225 randomly ordered cards. There

was a single word on each of these cards: the 75 words which had appeared in the passage and 150 others. Among the latter set, 75 words were highly associated to the martial theme of the passage [The 15 most highly associated words were: fighting, enemy, explosion, trigger, attack, battle, command, ground, rifle, target, war, weapon, aimed, bullet, gun. It may be that ground is a misprint; perhaps, of grenade.]. The other 75 were only weakly associated to the theme [They were in fact words strongly associated to the theme of the other passage, which described a cancer operation, e.g.: hospital, nurse, suture, tissue, incurable.]. I shall omit a description of the fashion in which these 150 words had been compiled and rated for level of thematic association. Let it suffice to say that it was carefully done and involved the labour of 45 people. The experimental subjects were asked to sort the 225 cards into words recognized, from the learning phase of the experiment, and words not recognized.

Subjects who had read the words of the passage in normal order recognized slightly but not significantly more of its words on average than subjects who had read the words in random order (50.2 vs. 45.5). 'False-positive' recognitions, however, are the results of major interest. Subjects who had read the normally-ordered passage identified, incorrectly, on average 21.67 of the thematically associated words as ones which had occured in the passage. The mean number of weakly associated ('medical') words which they incorrectly identified as having been seen in the earlier part of the experiment was by contrast only 3.87. Statistically this result is highly significant. Those subjects who had read the words of the passage in random order claimed,

incorrectly, to recognize on average 10.07 of the words which were associated with the theme of the passage and 8.67 of the 'medical' words. The difference between the last two figures is not statistically significant. The authors interpret these results as demonstrating (p.144): " ... that a unified theme in meaningful discourse initiates surrogate processes in that S stores some arrangement of words, visual images, and schemata that may reflect the 'essential ideas' of the passage." And (p.148) " ... the surrogate processes produce lexical associations to themselves during retrieval." Notice that the high rate of thematically associated 'false-positive' recognitions cannot be attributed to associations to individual words in the passage because the subjects in the random presentation condition read exactly the same words. Subjects who read the passage in its normal form must have translated it into some surrogate structure different from its superficial linguistic form for the purpose of storage and then used this surrogate as a basis for performance in the recognition task. What is the nature of the surrogate structure? Pompi & Lachman leave open the possibility that it might have contained other words. Such a translation, however, would be willfully wasteful except in cases where a phrase could be replaced by a word, or a longer word by a shorter and/or commoner word. Do we translate linguistic input into something akin to Basic English? I suspect not much of the time. Something which, when conscious, is an image seems a more attractive surmise to me.

T. H. Huxley [Quoted in Titchener (1909, pp.14-15).] claimed that:

> An anatomist who occupies himself intently with the examination of several specimens of some new kind of animal, in course of time acquires so vivid a conception of its form and structure, that the idea may take visible shape and become a sort of waking dream. But the figure which thus presents itself is generic, not specific. It is no copy of any one specimen, but, more or less, a mean of the series ....

That people do extract something generic - not necessarily an image - from specific exemplars has been demonstrated objectively by Franks & Bransford (1971). They used families of geometrical patterns. The families were created by performing transformations (permutation, substitution and deletion) upon prototype patterns. Subjects were shown subsets of the patterns in a family and then required, in a subsequent recognition test, to rate the degree of confidence with which they believed they had previously seen each of a set of patterns, some 'new' and some 'old'. Their confidence ratings proved to be inversely related to transformational distance from the prototype. Prototypes received the highest ratings even when they had not been included in the initially exposed subsets. A generic image might appear to be a contradiction in terms but it would be an admirable prototype. I shall therefore pursue this course a little further.

Sir Francis Galton's (1883) fascinating technique of "composite protraiture" was an attempt to create (externally) visible analogues of (pp.353-4) " ... the generic images that arise before the mind's eye, and the general impressions which are faint and faulty editions of them ...." Galton assembled large numbers of photographic portraits of individuals who all fell into the same category, e.g., consumptives. The component pictures for a given composite had all to be taken from

the same viewpoint. He then superimposed negatives of these pictures to make a single composite print. Important features such as the pupils of the eyes and a line passing between the lips were always focused on to the same position on the printing paper. Component negatives in an n-component composite were each exposed for one-nth of the time required to make an adequate print. Galton's book contains some examples of composite portraits and they support his statements that:

> The effect of composite portraiture is to bring into evidence all the traits in which there is agreement and to leave but a ghost of a trace of individual peculiarities. There are so many traits in common in all faces that the composite picture when made from many components is far from being a blur; it has altogether the look of an ideal composition. (p.10).
>
> They are real generalizations, because they include the whole of the material under consideration. The blur of their outlines, which is never great in truly generic composites, except in unimportant details, measures the tendency of individuals to deviate from the central type. (p.353).
>
> It is, indeed, most notable how beautiful all composites are. Individual peculiarities are all irregularities, and the composite is always regular. (p.361)

Gomulicki (1953) dismisses the idea of 'mental composite portraiture' in the following words (p.15):

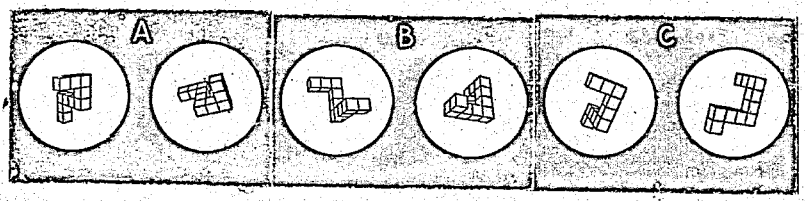
> Galton could standardize his portraits and provide almost uniform stimuli for the camera; there is no such standardization with sensory stimuli. Strict point-for-point correspondence between stimulus and [memory] trace, which Galton presumably accepted, would produce a multitude of dissimilar traces unsuitable for 'mental composite portraiture'. The photographs for Galton's composites were carefully aligned in advance; what mechanism similarly aligns memory traces?

Brown (1958, pp.87-8) raises the same objection. He further (p.88)

argues that "The trouble with the notion of a portrait in which each noisy attribute assumes its modal value is that such a portrait does not represent the full range of variation in the membership of a category." This latter point may be met in two ways. Firstly, people sometimes fail to recognize members of a category precisely because they differ greatly from the prototypes of the category. Secondly, I grant the possibility of a category being represented by more than one prototype; my prototypes for mammal are, at least, a cow and a whale.

To return to Gomulicki's question (1953, p.15) " ... what mechanism similarly aligns memory traces?" The context indicates that this was intended as an unanswerable rhetorical question. However, I believe that there is now the outline of an answer to it. The answer lies in an experiment conducted by Shepard & Metzler (1971); an experiment whose results are quite exceptionally clearcut, in comparison to the great majority of psychological studies directed towards non-trivial topics. They demonstrated that the amount of time required to make 'same/different' judgements on pairs of pictures was a linear function of the angular difference in orientation of the two objects portrayed.

The objects, depicted in perspective line drawings, were constructed of 10 solid cubes attached face-to-face to form rigid armlike structures with 3 right-angled elbows. Three examples of the pairs of drawings used are reproduced below.



[From Shepard & Metzler (1971). "Examples of pairs of perspective line drawings presented to the subjects. (A) A 'same' pair, which differs by an 80° rotation in the picture plane; (B) a 'same' pair, which differs by an 80° rotation in depth; and (C) a 'different' pair, which cannot be brought into congruence by any rotation." (p.702).]

In all, 800 pairs of pictures representing members of this family of objects were used. Two hundred pairs were pictures of objects which could be rotated into 3-dimensional congruence in the picture plane. Two hundred pairs were of objects which could be rotated 'in depth', about a vertical axis, to achieve congruence. In the remaining 400 one member of each pair differed from the other in that one of its arms had been reflected, so that no rotation could bring the members of the pair into congruence. The rotational differences depicted ranged between 0° and 180°.

Eight adult subjects were tested individually on a 1600-item test; each pair occurred twice in the random series of test items. Each trial consisted of a warning tone followed by an interval of half a second, presentation of a pair of line drawings and, then, the subject's response. Subjects responded by operating one lever to indicate that they judged the members of the pair to be the 'same' and another lever for pairs illustrating 'different' objects. The time elapsing between the onset of the display and subject's response was

measured on each trial. Subjects were asked to respond as quickly as possible while keeping errors to a minimum. The 1600 trials for each subject were spread over between 8 and 10 one-hour test sessions.

The average error rate was negligible: 3.2%. In post-experimental interviews:

> ... all subjects claimed (i) that to make the required comparison they first had to imagine one object as rotated into the same orientation as the other and that they could carry out this "mental rotation" at no greater than a certain limiting rate; and (ii) that, since they perceived the two-dimensional pictures as objects in three-dimensional space, they could imagine the rotation around whichever axis was required with equal ease. [Shepard & Metzler (1971, pp.701-2)].

The reaction times for correctly judged 'same' pairs are entirely compatible with these reports. For each subject the graph relating response time to degree of angular difference between the members of the pairs was strikingly linear, that is to say, suggestive of smooth rotation. Subjects differed slightly in the rate at which they could perform the task: approximately 1 second was required for response for 0° rotation but between 4 and 6 seconds for 180° rotation. But this is a difference in slope not in linearity. The average rate of 'mental rotation' for these particular objects was a little less than 60° per second. Separate graphs drawn for picture plane and 'in depth' rotations do not show marked differences. [The average length of time for a correct 'different' response was 3.8 seconds. The figures for 'different' judgements were not included in the results given above because the amount of rotation required to yield congruence is an undefined quantity for objects which cannot be rotated into congruence.]

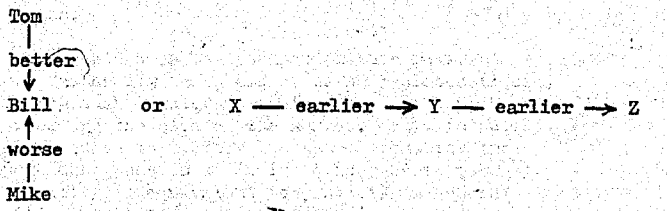
To further substantiate the claim that mental rotation of images takes place, Cooper & Shepard (1973) performed an experiment in which subjects were asked to imagine a letter of the alphabet or a numeral rotating, in the picture plane, within an externally visible blank circular field. The rate of rotation was externally paced. At random intervals during this process normal or backward versions of the imagined character were flashed on to the field. The presented character was either in the orientation which the subject's imagined figure should then have been assuming or at some other randomly chosen orientation. It was found that subjects could decide whether the presented stimulus was normal or backward significantly more rapidly when its orientation coincided with that of their image. The possibility of such template-like matching suggests that the internal representation of the character was in some sense isomorphic with the external character and that during the course of mental rotation it continued to have a one-for-one correspondence with its rotating objective counterpart.

Shepard & Feng (1972) have shown that rotation is not the only geometrical transformation for which a measurable mental analogue seems to exist. Subjects were shown pictures of six connected squares which could have been cut out and folded into cubes. They were required to decide whether or not two arrows, each drawn on the edge of a different square, would meet if the pattern was folded into a cube. The time taken for such decisions (between 2 and 15 seconds) proved to be a linear function of the complexity of folding which would be required to determine the answer by actually folding paper.

Allport (1924) in his study of eidetic imagery, which I referred to earlier, noted that people report that their eidetic images are to some extent under voluntary control. Thus (p.110): " ... a carriage was made to drive away, turn a corner in the road, and so to disappear entirely from the image. People could be made to enter and leave, and to perform normal actions. The range of flexibility is very great indeed but it does not extend to include the ridiculous or unnatural." Allport's observation on the naturalness of the transfigurations of the images suggests that they may be another product of memory. Perhaps to perform mentally a geometrical rotation, translation, dilatation etc. of an object one has to retrieve a memory record of a similar object which has previously been perceived going through such a transformation, superimpose or substitute the desired object and then run the record to ascertain the outcome. I realise that I have not satisfactorily answered Gomulicki's request for a specification of the mental mechanism which performs such operations. I believe I have shown, however, that the question is worth posing because there evidently is such a mechanism.

Another general objection to image theories of meaning is that: "The ideas of relation are, all agree, not represented in consciousness by distinct images. .... The same may be said of the notions of spatial and quantitative relations such as greater or equal to, above and below, before and after, and the active relation of cause and effect." [Pillsbury & Meader (1928, p.156). Roughly the same view is put forward by Stern (1932, p.48).] In §1.3.2 I cited Bugelski (1970) in support of the concreteness of even our imagery for abstract nouns.

Here I should like to mention some experimental results of Handel et al (1968) which suggest that the 'general agreement' which Pillsbury & Meader sense in connection with relational terms may be, at least partly, an erroneous consensus. Handel et al determined the relative difficulty of syllogistic problems such as Tom is better than Bill, Mike is worse than Bill, Is Tom worse than Mike? for eight different combinations of premises and four different types of question. Other relational terms used were: father/son, more/less, earlier/later, [be the] cause/effect [of], faster/slower, farther/nearer, [have] lighter hair/darker hair [than]. The results were in large measure predictable on the basis of an assumption that these problems are solved by constructing mental spatial analogues such as



and further straightforward assumptions such as that, in the culture of these particular subjects, construction and assessment of these analogues proceeds more easily from top to bottom and right to left. Handel et al also asked their subjects to indicate, after the main test, the directions in which each of these relations seemed to them to be most appropriately portrayed. This was not regarded as a puzzling request by the subjects and there were positive correlations between the pattern of assignments of directions and the pattern of relative difficulty displayed by the set of relational terms.

Fodor (1971) [Cf. also Brown (1958, p.88).] raises a further problem which can be illustrated by means of a quotation from Titchener (1909, pp.17-18), describing his image of a Lockean generic triangle:

> My own picture of the triangle, the image that means triangle to me, is usually a fairly definite outline of the little triangular figure that stands for the word 'triangle' in the geometries. But I can quite well get Locke's picture, the triangle that is no triangle and all triangles at one and the same time. It is a flashy thing, come and gone from moment to moment: it hints two or three red angles, with the red lines deepening into black, seen on a dark green ground. It is not there long enough for me to say whether the angles join to form the complete figure, or even whether all three of the necessary angles are given. Nevertheless, it means triangle; it is Locke's general idea of triangle; it is Hamilton's palpable absurdity made real.

Fodor and Brown argue that images such as this would have to be supplemented by rules.

> The rules would have to distinguish such relevant features as having three sides, being a closed figure, etc., from such irrelevant features as the length of the sides and the size of the angles. But, to supply rules adequate to specify the set of features that an image must possess if it is to represent abstract triangularity is equivalent to providing a general definition of 'triangularity'. And it is very unclear that a speaker who had associated such a definition with the word triangle would also need an image in order to use the word correctly to refer to triangles. Presumably, the word refers to all and only those things that satisfy the definition, so that, given the definition, appeals to the image would be redundant. [Fodor (1971, pp.348-9).]

But the definition is framed in words. What is the basis of application of these words? Other verbal definitions? How are their words, in turn, defined? Somewhere one has to attach significance to the elements by giving them content. In any case, Titchener's 'little triangular figure from the geometries' should suffice for most ordinary purposes; it would surely be more similar to most presented triangles than would

the prototypes for square, circle and other candidate lexemes.

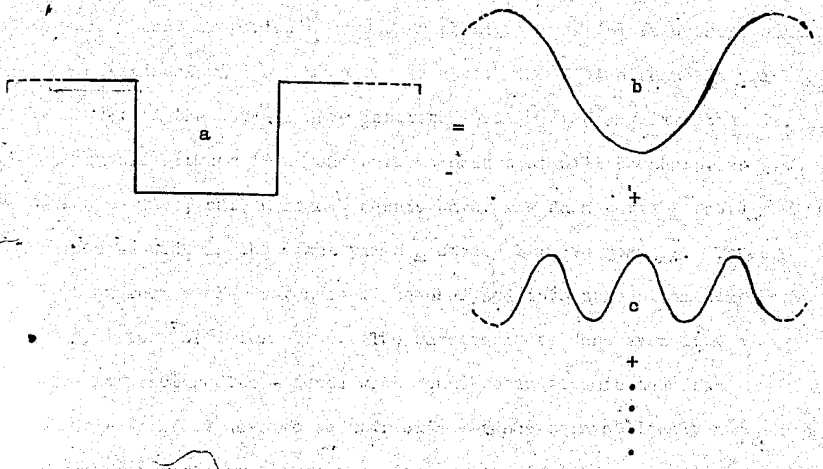
An objection which I believe is more telling is simply that not everyone, or not everyone all of the time, feels aware of images accompanying speech and thought [Cf. Brown (1958, pp.89-91), Stern (1932, pp.47f.), Woodworth (1906).]. In the face of this, pure image theorists are forced to resort to presumptuous claims such as that the doubter's images, though present, must have been too fleeting to be noticed. I would prefer not to have to adopt this sort of stance. I shall therefore regard images, when present, merely as further evidence for the fidelity of the memory traces upon which they are based; a being who stored only verbal definitions or 'taxonomic schemata' [Cf. Harrison (1972).] or lists of criterial attributes would be incapable of having images.

Pylyshyn (1973) ridicules image theories of, for example, recognition by pointing out that they seem to require that the 'mind's brain' should compare what is in the 'mind's eye' with what is on the retina and decide whether or not there is enough similarity to warrant recognition; and this simply pushes the explanatory problem further into the dark. In his critique of mental imagery Pylyshyn raises other issues (for example, the question of whether the brain has enough storage capacity) which I believe I have already dealt with. It seems important though to attempt to offer some proposals concerning the way in which similarity between perceptual input and prototypes stored in memory might be assessed, without the aid of a brain within the brain. The suggestions which I shall review, only in broadest outline, are

that the human brain performs a Fourier analysis on sensory input and that holographic storage is implemented in the brain. What I assume is that components yielded by Fourier analysis, to some degree of delicacy, are stored holographically. I have no clear opinion about the relative roles of the two processes, that is, about where the second takes over from the first. The hypotheses embodied in these suggestions relate to a grosser level than the molecular biochemical one at the focus of Fong's (1969) speculations, which I sketched in §1.4.2. Having argued in §1.4.3 that vision is the primary human sensory modality, what follows is explained in terms of the processing and storage of visual input but the processes are not incompatible with the other senses.

Fourier analysis is the decomposition of a wave into component waves which vary sinusoidally. It has been demonstrated mathematically that any complex wave can be analyzed into simple sinusoidal components varying in amplitude, frequency, and phase. Superimposition of the components will yield the complex wave. As a simple example of this process consider the square wave, a, below. It can be decomposed into, or created out of a sine wave, b, of the same frequency, superimposed on all of the odd harmonics (3rd, 5th, 7th etc.) of b. The third harmonic of b, that is, a wave with three times the frequency, is shown below b as c, in the diagram overleaf. To yield a perfect square-wave an infinite number of odd harmonics would have to be added to the fundamental component, b. However, short of infinity, any desired level of approximation to a square wave can be achieved by using a larger or smaller number of odd harmonics. Any other wave shape could

be produced from, or decomposed into, different suitably selected sets of component waves.



Now, a black-and-white visual scene may be regarded as a two-dimensional distribution of brightnesses. If a long, narrow rectangular slit is placed over the scene what is revealed through the slit may be regarded as a complex wave whose amplitude ⌈brightness⌋ varies in space. If the variation in brightness along the length of the slit is regular we may speak of it as having a certain spatial frequency; a fixed number of cycles (of brightness variation) per degree (of visual angle - the angle subtended at the viewer's eye). A fence uniformly illuminated from behind will provide a simple illustration. Imagine that the fence has a large post every twenty yards and a thinner post every five yards (except where there is a large one) and that it has strands of wire uniformly spaced six inches apart. Viewed through a horizontal slit the fence may be described as a complex periodic wave

composed basically of two different spatial frequencies: a low frequency which represents the recurring large posts and another four times as fast for the thin posts. Viewed through a vertical slit the fence is another periodic wave of much higher spatial frequency, since the strands of wire are much closer together. If the fence is crisply silhouetted the waves I have described will be rectangular; that is, the cutoff between light and dark at each post will be sharp, as with a square wave, but, unlike a square wave, the dark parts [posts] will not be as wide as the light parts [spaces between posts]. These complex rectangular waves could be analyzed into sinusoidal components without loss of information. The same could be done even if the wave were not rectangular - fence with round posts illuminated from the front - or if it were to be aperiodic - fence seen obliquely and hence subject to foreshortening, or a fence with missing posts.

Campbell & Robson (1968) investigated the visibility of gratings (patterns made up of regularly alternating light and dark strips in a single direction) of various spatial frequencies and wave-shapes. One of their studies concerned the point at which the contrast in a faint grating was just sufficient for it to be visible. At this level of contrast a square-wave grating is indistinguishable from a comparable sine-wave grating of the same spatial frequency. The difference becomes detectable at the same level of illumination as that at which the third sinusoidal harmonic of the square wave is first visible when it is presented separately. This, and other results of Campbell & Robson, relating to rectangular and saw-tooth waves and their sinusoidal components, can be neatly explained if it is assumed that our visual

apparatus independently detects the various spatial frequency components in brightness distributions on our retinas.

To analyze the sorts of scenes which we commonly look at into sinusoidal components whose amplitudes, frequencies and phase relationships will represent those scenes in the degree of detail to which we are accustomed would require (probably parallel) analysis along several different axes. In several species of mammal, cells have been found in the visual cortex whose responses [Pollen et al (1971, p.76). Cf. also Robson (1975, p.110).] " ... to a given slit width are independent of the position of the slit, so long as it is oriented in the preferred direction and is within the overall receptive field of the cell." Slit here means a bright line of light. These cells are sensitive to the width of the lines they detect and they also require parallel adjacent strips of retina to be relatively unstimulated if they are to respond maximally. They occur in a variety of sizes. In short, they are sensitive to spatial frequencies in particular orientations and are likely to be the physiological hardware of neural Fourier analysis. Pollen et al (1971, p.76) also note that a timing mechanism for the registration of phase relationships is available in the form of periodic brain rhythms such as the alpha-wave.

Fourier analysis of spatial frequencies has several important virtues [Cf. Leibowitz & Harvey (1973) and Pollen et al (1971).]. Firstly, they allow a mechanical comparison of patterns, say, a perceptual input and a stored prototype. Each pattern, after Fourier analysis, will be a set of spectra. The spectra can simply be 'lined

up' and degree of overlap between them will be a measure of similarity; no homunculus is needed in the brain to ponder over such issues as whether incoming stimulation from Bessie is more similar, in some weighted average of a large number of dimensions, to the prototype cow, horse or guitar. Furthermore, Fourier spectra possess important invariance relationships with the objects which produce images on human retinas. The relative Fourier spectrum for a given view of an object remains invariant with changes in size of the object; and we can recognize objects equally easily over a wide range of viewing distances. The spectrum is also substantially unaltered by translational motion or changes in brightness.

Robson (1975), in a very conservative assessment, concludes that (p.112) " ... if the visual cortex is a spatial frequency analyzer, it is certainly an analyzer of very modest capabilities, able to do no more than analyze patches of the visual image into their first three harmonic components." This conclusion follows from studies (on monkeys) which suggest that the orientation selectivity of the cells in the visual cortex, which I mentioned above, is coarse; the orientations which the cortex seems to sample proceed in jumps of about 15°. And from the fact that these cells seem never to have more than three parallel excitatory strips of retina in their domain. I have no way of estimating whether this 'modest capability' is adequate or not. However, Robson appears to ignore the possibility of coupling insensitive elementary mechanisms to yield a vernier-like mechanism of greater sensitivity. Blakemore (1975, p.259) says, in a different context: "This concept of collaboration between coding neurons to provide a

signal more precise than any single coding element is familiar in the consideration of color recognition based on only three different absorption pigments."

In ordinary photography, the film records spatial variation in the amplitude of a wavefront of light coming from an object. Some of the information contained in the wavefront is lost in this time-averaged recording process, namely, phase relationships. The absence of this information from the photograph is one of the reasons why it looks flat and may usually be distinguished from the actual object it portrays. Our eyes can evidently see, for example, that a part of the wavefront which emanated from an indentation recessed a non-integral number of wavelengths below the surface arrives on the retina with its crests out of phase with the crests of waves from the surface of the object; the camera cannot. In 1948 Gabor invented a process called optical holography by means of which all of the information in the wavefront may be recorded on a photographic film [See his Nobel Prize address, Gabor, (1972), for an interesting account of the discovery and of subsequent developments.].

In order to make a hologram a photographic plate is exposed to two wavefronts simultaneously. One of them might be light from an object and the other a reference beam. An interference pattern is set up between the two wavefronts: Where a pair of crests (or troughs), one from each wavefront, arrive at the same time they reinforce each other and where a trough from one coincides with a crest from the other they cancel out, etc. Both wavefronts have to be monochromatic and coherent

for this interference pattern to be stable. A stable interference pattern recorded in this way has the interesting property that if it is illuminated with one of the original incident wavefronts and viewed from the correct angle the other original wavefront, slightly attenuated, will be seen. Thus if the reference beam is shone through the hologram, the object will be seen in a way which is visually indistinguishable from the original, because both phase and amplitude information has been recovered. Alternatively, a replica of the reference beam may be created by illuminating the hologram with a wavefront from the original object; using the same light, and optical geometry, as was used in making the hologram. In this way three processes analogous to memory are possible with holography: (a) associative holography, in which wavefronts coming from two objects, A and B, compose the interference pattern and a replica of A is created by subsequent presentation of B, and vice versa, (b) identification holography, in which the original wavefronts come from an object and a 'label' for the object - subsequent presentation of the object yields the 'label' [or, given the 'label', a copy of the object may be produced], and (c) recognition holography, in which a reference wave and an object enter into making the hologram and subsequent detection of a replica of the reference wave is a sign that what is illuminating the hologram must be a replica of the wavefront from the original object.

If the hologram is made through a diffuser, such as a ground-glass screen, then [Gabor (1972, p.304)] " ... any small part of it, large enough to contain the diffraction pattern, contains information

on the whole object, and this can be reconstructed from the fragment, only with more noise." Further (p.310): "A binary store, in the form of a checkerboard pattern on microfilm, can be spoiled by a single grain of dust, by a hair, or by a scratch, while a diffused hologram is almost insensitive to such defects." This dispersal of storage into many independent wholes allows many different interference patterns to be stored on the same photographic plate. Provided they are not so similar as to interact, only a deterioration in clarity will result because it is unlikely that a given bit of pictorial information will be obscured by superposition of another when it is reproduced in so many places on the film.

Julesz & Pennington (1965) drew attention to the parallel between the robustness of human memory and the resistance to insult of diffused holograms. Longuet-Higgins (1968) provides a mathematical account of a dynamic version of holography, called holophony, which could respond with the termination of a sequence given its onset, and which might be instantiated in the brain. The idea of holography in the brain, with the durability and economy which such distributed storage would entail, has since attracted many theorists [Cf., e.g., Pribram (1969).]. For my purposes recognition holography and what I called identification holography, above, are the most interesting possibilities. If humans can use such processes that would explain the enormous capacity demonstrated in recognition experiments [Cf. Standing et al (1972); summarized in §1.4.2.] and how prototypes for lexemes could be looked up, and how a lexeme could be found for sensory input which matched a stored prototype. Most importantly, the re-creation process in

in holography does not require a clever homunculus to make decisions about similarity. In the recognition process the reference wavefront is either recreated with sufficient clarity to 'throw the switch' or the input is not recognized and mutatis mutandis for labelling.

Of course, we do not normally see the world lit in coherent monochrome. If mental holography exists it must be based on interference between waves of nerve impulses, perhaps after Fourier analysis. Cavanagh (1975) presents a detailed mathematical demonstration of the possibility of neural holography which is compatible with known neurophysiology and some psychological results. In his model the coherence and stability, which optical holography derives from laser beams, is provided by the structure of fixed interconnections between neurons.

I have sought in this section to persuade the reader that an apparent obstacle to traditional image theories of meaning - How are images manipulated (rotated, expanded, contracted etc.)? - is in practice not an obstacle to the brain; these processes are performed by our brains and the means of their doing so may be some combination of Fourier analysis and holography. Both of these latter processes also make it reasonable to speculate that similarity may be evaluated without recourse to a sentient being in the brain doing the job.

1.4.5 A note on stabilized retinal images

If an (optical) image remains at rest upon the retina for more

than a few seconds it ceases to be perceived. Thus the intricate tracery of blood vessels which lies in front of the retina, in a fixed position, is not normally seen; although it may be seen if one eye at a time is carefully opened for only a brief interval after a night's sleep. Stabilized retinal images may be artificially produced by securing a picture to a properly fitting contact lens and in various other ways. Evans (1965, p.123) reports that when this is done:

> Experienced subjects, within seconds of settling down in the aparatus, will notice changes in the stimulus material. These changes vary from time to time, but the general trend is for there to be an almost immediate reduction of contrast between the target and its background. This is followed, again within seconds, by a distinct, and at first surprising, disappearance. This disappearance is occasionally of the complete figure, but is most often of some part or parts of it. .... Reappearances either of the image as a whole, or of parts of the image, occur at intervals of from 1 to 5 sec.

Speaking speculatively and teleologically, one might suggest that once something has been perceived it can be ignored for so long as it neither moves nor changes. Alternatively, since parts of a stabilized image often disappear separately, one might surmise that this is a way of eliminating 'noise', to sharpen the objects of our perception during fixation. There is some support for the latter hypothesis in Evans' (1965) finding that jagged angular figures vanish more readily than rounded ones and that an ellipse will disappear sooner than a circle [The work of Garner (1970), mentioned in §1.3.1, showed that informationally simple figures such as a circle are rather special perceptual objects.]. Using either of these guesses as a guiding hypothesis one might hope to discover what kinds of things are unitarily perceived by determining what disappears, reappears or remains visible as a unit.

The theory of criterial attributes would gain some credence if it could be shown that sub-parts which might count as distinctive features oscillate between visibility and absence in unitary fashion. Evans (1965) addressed himself to a question of roughly this kind.

He asked his subjects to report for each fragmentation of a stabilized image whether or not it was 'structured'. The figure being viewed was a circle crossed by a vertical and a horizontal diameter line, i.e., a circle divided into four equal quadrants. A structured fragmentation was defined as one which involved one or more entire lines or arcs between the intersection points on the figure. Thus disappearance of an entire arm of the cross, the whole circle, any arc of the circle between points where the arms of the cross touched the circle, an entire quadrant, bar of the cross, etc. counted as a structured fragmentation. Changes involving only parts of the lines between intersection points formed the complementary category. "Before the experiment subjects were shown a number of drawings of possible fragmentations of patterned targets. They were told to report a structured configuration only when one of these clearly delineated figures occurred and persisted. If odd, random parts of the figure remained, even in association with some obviously non-random shape, they were not to report a structured configuration." [Evans (1965, p.128)]. Under these conditions, approximately 15% of the fragmentations were 'structured'.

Cornsweet (1970), one of the originators of the study of stabilized retinal images, has reservations about the significance of

even small effects such as this. His critique is directed primarily at studies of the reappearance of parts of stabilized retinal images but the burden carries over to studies of disappearance. He notes that reappearance is more common with loosely-fitting contact lenses than with ones which are very secure but (p.408):

> Several authors have suggested that reappearance is not a consequence of uncontrolled retinal image motion. They say, instead that some internal process causes the reappearance, and that by studying the appearance of the restored image, they can study the nature of this process .... When stabilized images reappear, they are often fragmented and these fragments frequently are described as simple or meaningful units, rather than simply as a random selection of elements from the original figure. Such reports have been interpreted as providing support for the contention that reappearance is not a consequence of contact-lens slippage.
>
> However, both the simplicity and the meaningfulness of these forms would be expected even if the reappearance were entirely due to uncontrolled retinal image motion. When a contact lens slips, it does so in some particular direction. Those components of the target that are lines or edges perpendicular to the direction of slippage will be most strongly affected by the slippage, and thus are more likely to reappear. This introduces "simplicity" or "systematization" into the appearance of the regenerated picture. Furthermore, when a subject is presented with a series of random and nonrandom shapes under ordinary viewing conditions and is later asked to describe them, his report is very likely to contain more meaningful than nonmeaningful shapes, and more simple than complex ones. [Cornsweet (1970, p.408)].

I should like to sum up this section and the others under §1.4 by quoting a part of the preface of a recent book on form detection [Uttal (1975)]:

> ... the Gestalt descriptions of visual processes still ring true, despite the fact that their theories have been supplanted. These descriptions suggest that the human perceiver operates on global factors of stimuli rather than on the details of their component features.

> Yet much recent research, it seems, has been focused on the analysis of figures into parts rather than on considerations of overall organization, in spite of the fact that people seem to do just the opposite.

Finally, can the research work in these sections be ignored by linguists because, to a large extent, they are general psychological studies of memory, recognition etc. and do not always have a specifically verbal focus? I think not. To do so would be to fail to wield Occam's razor, without good cause. Recently I found my scissors, amongst the confusion which litters my desk, by the very tips of the blades alone, which were projecting from beneath a book. There was no need to see the pivot or the handles or the manner in which they were used; the pointed ends matched something I had stored in my mind well enough for identification. Surely an organism with this kind of capability has no need of an independent strategy for deciding the applicability of known lexemes? As soon as I knew they were scissors I knew they were scissors.

1.5 A note regarding the philosophical background

I make no pretence to philosophical expertise and in writing this section I have relied solely on secondary sources such as Staniland (1973) and the introduction of Eberle (1970). In the hope of not blazoning my ignorance and lack of sophistication as a philosopher, I shall be brief. My reason for trespassing is that the issues which permeate the rest of this thesis have been of interest to philosophers for centuries, under the heading "The

Problem of Universals". When I remarked on p. 4, above, that the theory of prototypes was "old" I had in mind similarities between it and the Platonic 'theory of forms', and certain proposals of Locke and Berkeley. Therefore I feel obliged to try to point to the tiny pigeonhole which my suggestions occupy in the vast edifice of Western Philosophy.

The linguistic aspect of the problem of universals is the question of what is the basis on which entities in the world are grouped under 'general names' (i.e. common nouns such as person and adjectives like green). Does a 'general name' refer to an entity of some kind - a universal - the way that a proper name refers or is this perhaps a wrong-headed way of looking at the matter? Answers to these questions have fallen into two broad categories: realism, on the one hand, and nominalism/conceptualism on the other.

Plato, a realist, posited the existence of transcendental forms, ideal objects in which the imperfect entities of our perception somehow participated. Ordinary things could be classified together and given the same 'general name' if they were related to the same form. My suggestions are in harmony with this to the extent that I claim that the members of individual denotation classes are united by all bearing relationships to something outside of themselves: a (set of) prototype(s). However, I accept the main criticisms which Aristotle, the father of another brand of realism, levelled at Plato's doctrine. Namely that [Mackie (1976, p.127)]

"It is uneconomical to postulate a whole realm of supersensible entities. No coherent account can be given of how they are known or of how the knowledge of them contributes to our ordinary knowledge of things that are perceived by the use of the senses." Aristotle located his universals in the world of things. Without the common objects of our perception there would be no universals. My prototypes too, unlike Plato's forms, are not in heaven. Aristotle's realism lay in a belief that there was a single natural categorisation inherent in things in the world. The readiness with which I find myself able to agree with claims such as: "There is no limit to the number of possible classifications of objects." [Bambrough (1960, p.203)] leads me to the conclusion that I lean more towards nominalism.

In its strongest form medieval nominalism asserts that the entities in the compass of a general name are bound together only in that they are each called by that name. This is in blatant conflict with intuition and nominalism is usually watered down by granting that a given classification, out of the many potential ones, may be more or less justifiable according to the extent to which there are <u>resemblances</u> within each class, between its members. Conceptualists claim that classifications are imposed by human minds and that the universals to which 'general names' have reference are <u>abstract ideas</u>; external objects are usually held by them to be ordered in terms of their relative similarity to different abstract ideas. My theory also appeals to a notion of similarity; and it is conceptualist in its reliance on mental representations of things.

It is nominalist insofar as I grant the possibility of more than one prototype being stored in association with a given lexeme.

I find myself greatly in sympathy with the ideas of Locke, a conceptualist, except in the matter of abstraction. Locke argued that 'general ideas' - to be the referents of 'general names' - arose through comparing particular ideas, which come to us via the perception of individual objects in our surroundings, and, for each class of particular ideas, suppressing their differences and abstracting what was common to them. Although I allow that we do this, and although I argued in §1.4.4 that we are capable of something akin to mental composite portraiture, I do not believe that our prototypes are in general abstractions which preserve only the properties which are invariant through a class. The theory of criterial attributes is a blend of Lockean abstraction and Aristotle's views on categories.

Berkeley attacked the possibility of abstract ideas on the grounds that no idea (and he appears to have thought of ideas as images) can avoid having specific values for its attributes. Specification of details which may vary across a species is inimical to an idea being truly abstract. This was the beginning of the usual line of attack on image theories, which I reported in §1.4.4. What I take from Berkeley, though, is the notion that generality comes about through the way in which we use our ⌈ for him, almost unalterably ⌋ particular ideas. A prototype can be the focus of a denotation class by being used to represent things

which are merely similar to it.

I should like next to say a few words about Wittgenstein's notion of family resemblances. This is a proposal which Bambrough (1960) maintains solves the problem of universals but is neither realist nor nominalist. The class of games was one of the examples Wittgenstein used in putting forward his ideas. According to Bambrough (1960, p.199):

> Wittgenstein says that games have nothing in common except that they are games.
>
> Wittgenstein thus denies at one and the same time the nominalist's claim that games have nothing in common except that they are called games and the realist's claim that games have something in common other than that they are games. He asserts at one and the same time the realist's claim that there is an objective justification for the application of the word "game" to games and the nominalist's claim that there is no element that is common to all games.

The objective justification for sorting games, or the members of any other denotation class, into the same pile is that each of them exhibits some but not necessarily all of the features which characterise that 'family'. Since any member may lack any of the familial stigmata one cannot, in general, hope to find class-defining features which are present in every one of the members of the class. However, members of the class will be recognisable as such in virtue of having some of the features of the class. A given member, A, of the class might have no features in common with another, B, but there is likely to be some other member, say C, which shares features with both A and B. Hence there will be a family resemblance running through the group.

In a series of psychological experiments, Rosch & Mervis (1975) have shown that degree of judged centrality in a category is strongly correlated with extent of family resemblance, when this latter is quantified. In §§2.3.2 and 2.3.5 I cite some examples of children's denotation classes within which no feature can uniformly be found in every member [unless it is of such ubiquity as to be found in the members of many other classes as well]. Family resemblances is thus an attractive notion for me. Furthermore, the theory of prototypes may be straightforwardly regarded as a special case of the theory of family resemblances: a theory in which, to continue the 'family' metaphor, such resemblances as there are depend on the members being similar to the same progenitors - the prototypes. To my mind this interpretation renders Wittgenstein's insistence that what Xs have in common is that they are Xs less gnomically obscure.

My acceptance of Wittgenstein's solution is in no way to be understood as conced[illegible]at the theory of criterial attributes could be made viable if it admitted disjunctive definitions. If definitions may be conjunctions or disjunctions of attributes and are not further constrained there is no reason why some of the arbitrary classes it would then be possible to construct should be learnable, in the sense that one who has been introduced to some members will be able to recognize new instances of the class; and the application of lexemes is learnable. There must be a family bond between the members of any given denotation class: relationship to the same ancestor or wedded couples of ancestors. See Dennis et al

(1973) for an experimental demonstration that humans are almost incapable of discerning the basis of classification in classes which are formally like Wittgenstein's but which bring together arbitrary collections of features rather than ones defining kindred entities.

2.0 An empirical study of early vocabulary development

In this part of the thesis I present an account of a longitudinal study of the nominals used by three young children up to the age of two and a half years. The investigation is restricted to nominals whose denotation classes comprised relatively concrete entities. Nominals is used as a cover-term to encompass all nouns, common and proper, regardless of whether they filled sentential roles analogous to those of adult English noun phrases or were constituents of noun phrases. The term also includes isolated forms judged to denote entities; rather than actions, processes, qualities, affects etc. Since my concern is with the intensions of lexemes - with what it is that unites the diverse members of denotation classes - I shall have next to nothing to say about syntactic structure. In fact the bulk of my data consists of isolated forms. Such syntactic clues as there were have been used without specific acknowledgement. Three clues, in the main, when they first appeared in the children's records, served to corroborate the earlier designation of many ancestor lexemes as nominals. They were noun phrases marked by either articles or attributive adjectives, or both, and possessive structures such as Aladdair's bike and my mummy's pens. Obviously, noun phrases of the latter kind offer suggestive evidence of a nascent common vs. proper distinction but I do not treat this issue here. I have likewise largely ignored distinctions in the uses of the children's nominals: vocative, predicative, sentence-subject etc. Most of my examples were cases in which the children were responding to a 'what's that' question, asked with respect to an ostended object, or instances of children spontan-

eously naming an object which they had moments earlier discovered or noticed.

2.1 The data

The data were derived almost exclusively from two sources: questionnaires completed at weekly intervals by the children's mothers and transcripts of tape-recordings of weekly play-sessions with the children, individually. For each child, data-collection by questionnaire began some time before the first tape-recorded session was undertaken. For each child, the collection of data ceased at the age of approximately three years. For present purposes I have used questionnaire and taped data spanning the period, in the case of each child, from his first questionnaire to the point at which he had reached the age of at least two and a half years and we had records of taped sessions covering at least six months. Questionnaires were posted or otherwise delivered to the mothers of children once a week. Each questionnaire was received back by post, or fetched, after it had been filled in, one week later. Use of the post resulted in these records being very nearly uninterrupted week-by-week accounts of the children's linguistic development. Sickness, holidays and other disruptions occasionally led to the omission of taped sessions.

The questionnaire item of greatest use to me was one which asked the mother to "Please list all new words used by ... this week" and to state, for each word, "how the new word was used". Other questionnaire items which yielded some relevant data were ones which asked for any

examples observed that week of the child "joining words together", "saying anything that sounded like a question" and "trying to count". Information regarding specific lexical items - pronouns, prepositions, negators, attention-drawers and comments on absence and repetition - was also solicited. However, these tables produced little of relevance to the present study.

The children who are the focus of this investigation were three little boys (G, J and K). The table below presents the salient ages and quantities in the body of their data which I have used. Ages, here and elsewhere [as noted earlier], are expressed in the form: number

child	age at 1st. q'naire	age at 1st. taping	age at end of this study	total taped utterences	total nominal lexemes
G	1;1 5/6	1;8 1/5	2;6 1/6	3833	159
J	1;9	1;10 4/5	2;6 1/6	2786	219
K	1;9 1/2	2;0 1/2	2;6 1/2	2649	113

of years, semi-colon, number of months, followed by fractions of a month, if any. The smallest fraction which I have employed is one-sixth, i.e. five days. The upper age-limit of two and a half years keeps the amount of data manageable but includes the age-range within which Clark (1973), in her review of diary studies, found 'over-extensions' to be a common occurrence. Note that the total number of nominal lexemes given in the table are based on a count of types, not tokens. Reference to the appendix at the end of this thesis will show that the number of tokens involved was far greater.

All three children were growing up in suburban English-speaking homes in Edinburgh. G's mother was a housewife and his father a printer. He had a sister two and a half years older than himself. J's mother was an archaeologist working in a psycholinguistic research unit. His father was a civil engineer studying for a higher degree in linguistics. J had a brother slightly older than himself and a sister who was a little older than both of them. K's mother was a housewife and his father a civil servant. K's only sibling was a brother two and three-quarter years older.

2.1.1 The larger project

The collection of data by questionnaire and tape-recorder was done in collaboration with my colleagues on a Social Science Research Council project, "The linguistic development of young children", under the direction of Professor John Lyons, in the Department of Linguistics, University of Edinburgh. The aims of the project were longitudinal studies, confined to the first three years of life, of the acquisition of prepositions, tense and aspect, modal verbs, questions, certain selectional restrictions, pronouns, deixis, reference and definiteness. Griffiths et al (1974) is a short general description of this project.

2.1.2 Selection of children

Through approaches to the mothers of children attending a research nursery associated with the Department of Psychology, University of Edinburgh, contact was established with a number of families who had

young children who had either just begun to use language meaningfully, in the judgement of their parents, or who had not yet started. These families were visited and the nature of the project was explained to them. Information such as the child's date of birth, number of siblings and parental occupations was recorded during these visits. A questionnaire was left with each set of parents and they were asked to return it as soon as it proved possible to make the first entry. Following receipt of the first questionnaire, subsequent ones were dispatched and collected weekly. After the initial visit we paid a second call on each family specifically to assess the likelihood of our being able to enter into cooperative relationships with the children. No attempt was made to compose a sample which would reflect a balanced cross-section of society. We were concerned only with the children's ages, their willingness to interact with us and domestic factors such as street noise and the presence of other children; factors which would have made it difficult to obtain clear tape-recordings. Two sets of twins were not taped because of the difficulty which recording them would have presented.

Taped play sessions were commenced immediately with two of the children because they appeared to have started using words meaningfully at around the time of our initial visit. One of them was a little girl, Ja, from whose record I cited an example in §1.3.2. She was an only child whose father and mother were, respectively, a plumber and a typist working at home. We visited the other children whom we felt were potentially suitable at approximately monthly intervals to assess their progress and to accustom them to our presence. After the

return of the initial questionnaires we continued to collect data in this manner from the children's parents, including most of those whose children were not included in the tape-recorded subset. Together with a few children added to the sample through personal contacts, questionnaire data was collected on the linguistic development of twenty-four children in all.

J, one of the children who is included in the table of §2.1, above, and a little girl, R, were contacted through acquaintances shortly after we had begun to tape-record the first two children. They had clearly started to use language and they were added to the tape-recorded sample immediately. J soon proved to be more advanced, linguistically, than we had realized; so it is fair to say that some important early phases of his development were lost to us. The addition of three other children to the tape-recorded sample brought it to the final total of seven. Two of the last three children came from the original sample. The other was P, a friend's child, from whose record I drew some examples used in §1.2.3.1. P had no siblings. His father was a college of education lecturer and his mother a former secretary.

I have chosen to concentrate on the vocabularies of G, J and K because they were the three children whom I knew best in the tape-recorded sample. It was the policy of the research team that one member should be a fairly constant figure in the life of each of the children. This person should attempt to be present at every recording session with that particular child and should be the child's principal playmate during recordings. The assignment of children to research

staff in this way was partly organized to suit our convenience and partly dictated by the preferences shown by the children. G, J and K were the children in whom I took a special interest; we became friends. In writing this thesis I have been influenced by the data we gathered from the other children but I have confined detailed analysis to the material gathered from G, J and K.

In serious studies of child language a great deal hangs on intuitive interpretations of children's utterances. It is therefore of paramount importance that one's intuitions be founded on familiarity with the particular child involved. The dubious validity of the glosses assigned to children's utterances by adult strangers also makes longitudinal methods more likely to yield truth than cross-sectional studies.

2.1.3 Recording and transcription

With the exception of J, who was often recorded in the project offices because his mother worked nearby, the weekly recorded play sessions took place in each child's home. Usually, three members of the research team would be present: the child's 'playmate', a phonetician and a commentator. One or both of the child's parents usually chose to attend as well. We took with us a box of toys, the contents of which will be described below. After a short 'warm-up' period, during which we set the child at ease and deployed our equipment, recording was begun. The unrecorded preliminaries generally occupied up to half an hour, and the recording approximately twenty minutes.

A portable Uher '4000L' tape-recorder was used with 'standard-play' tape at 3¾ i.p.s. Two Sennheiser omni-directional microphones were led into it through a mixer with an independent gain control for each of them.

One of the microphones was placed on the floor near the child. The other was held by the commentator who sat in the background. The commentator gave a quiet running description of the child's non-verbal activities, trying to identify any object or event to which the child reacted, pointed or otherwise showed signs of attention and to specify the nature of the interaction. In the role of commentator, we soon developed acronyms and other abbreviated forms to refer to the adults present and the toys. This was done to try to ensure that the commentary would influence the child's conversations as little as possible. The children appeared largely to ignore the commentator. If, however, the child showed an interest in the commentator, he or she would exchange roles with the playmate and allow the interaction to proceed smoothly. If the child chose to play with its parent/s or the phonetician the playmate would likewise withdraw temporarily from the centre of activity. The phonetician's task was to attempt to make as detailed a transcription of each of the child's utterances as time would allow.

During the recording sessions our main concern was that the child should talk. Secondarily, we were interested in probing the child's mastery of the forms, structures and types of speech act which it was the aim of the project to investigate. We also often wished to follow

leads suggested by questionnaire entries. These goals were achieved mainly by sustaining the child's interest through varying the type of play as much as possible and allowing the child free rein in guiding the direction of conversation. However, we frequently conducted *ad hoc* elicitation experiments to try to coax a child into attempting types of utterance of special interest to us. If a child showed boredom with any of the toys or appeared to be overwhelmed by the number of them we would leave some of them at the project offices for the next few visits and reintroduce them again later.

Even with the aid of a detailed accompanying commentary it is easy to forget contextual details which are important clues to the meanings of children's utterances, before they have been committed to paper. As a rule, therefore, we transcribed tape-recordings on the day that they were made. The transcription of child language tapes is a lengthy and arduous process; so we found it necessary to conduct the play sessions in mid-morning in order to have the rest of the day free for transcription. Only one child was visited on any given day and it was usually the same day of the week for a particular child. For present purposes the uniformity of timing of the play sessions was a disadvantage. It would have been preferable to have recorded samples of the child's speech in the course of other activities in addition to mid-morning play. The number of words in the appendix which are attested only in questionnaire entries will be seen to be particularly high in the field of terms for food, clothing, items connected with washing, and the names of people. Presumably this is because the relatively stereotyped nature of our recording sessions seldom gave the

children cause to use these words.

All the members of the research team who had been present when a tape was recorded generally participated in its transcription. Transcriptions took the form of numbered temporally-ordered lists of child utterances interleaved with adult utterances addressed to the child (and any others to which the child had responded) and a description of the contemporaneous non-verbal activities of the child and his interlocutor. The children's speech was divided into separate utterances on the basis of pauses and intervening speech by others. Each child utterance was represented both phonetically and, whenever possible, by means of a gloss which represented the research teams agreed best guess as to what the child had been intending to say. Items over which there was disagreement were usually left unglossed, if argument and repeated playing of the relevant part of the tape failed to lead to a consensus. Question marks were prefixed to glosses which either were, by general agreement, dubious or which represented a particularly strongly-held judgement of less than the full number of team members present. When two firm opinions were in contest both glosses were noted down. The glosses were written in ordinary English orthography. They were either presumed adult target forms, commonly-used nursery forms or idiosyncratic forms which we had come to know through acquaintance with the particular child. Forms which we judged, usually on the strength of intonational similarity and sometimes with the additional cue of lack of relation to the non-verbal situation, to be uncomprehending imitations of immediately preceding adult utterances were annotated as 'echoes'. All tapes were preserved for later reference.

2.1.4 The toys

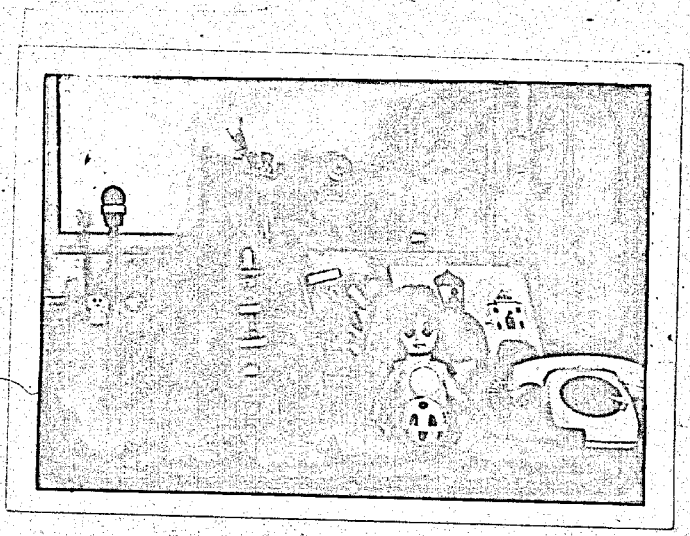
Most of the toys used in the play sessions may be seen in the illustration on the next page. Many of them could be taken apart, which helped to make them interesting playthings. The illustration on the next-but-one page shows some of the relief outline figures embossed on the bases of the plastic stacking beakers. These stark figures are important in my study because the influence of contextual and functional factors in the mediation of their recognition and naming can usually be ruled out. Three of the project's picture books had the same advantage: they presented realistic coloured photographs of everyday objects, toys and animals, sharply-isolated, against austere backgrounds. They were:

Dean Hay (1966) I see a lot of things.

Thomas Matthiesen (1967) ABC: an alphabet book.

Thomas Matthiesen (1967) First things.

All three were published by Collins (London and Glasgow). We also used five Topsy and Tim books, by Jean and Gareth Adamson (London and Glasgow: Blackie, various dates). This series presents stories about the doings of a little girl and a little boy. The text takes up only a small part of each page, most of which is a coloured illustration. These pictures are fairly realistic although they are not photographs. They differed from the pictures in the first three books mentioned in that most of them portrayed scenes filled with action and background detail, instead of isolated objects. My first book by Valerie Hodge and Roger Hall (London and Glasgow: Collins, no date) was intermediate between the two previous types of picture book. Most of its coloured illustrations - non-photographic - were very realistic. Some depicted arrays of

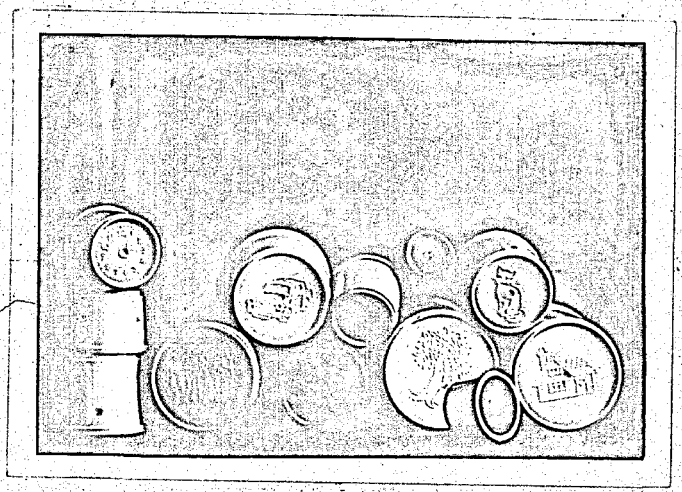


Project toys

Left to right, above: plastic animals and toy jeep on and around animal tin, plastic stacking beakers, plastic elephant, bell, toy London bus, three plastic zookeepers, plastic skittles.

Left to right, below: 'chairoplane' swing with removeable figures in seats, large finger-ball, toy bricks, stacking doll with sombrero, toy train, 'funny man', doll, ping pong ball, yellow ball with holes, elephant jigsaw puzzle, cardboard cylinders, toy telephone.

Not shown here: 'tinkertoy' wooden construction kit, picture books, drawing pad, crayons, Russian 'babushka' nesting doll set, dog glove-puppet, blue toy VW car and duplicates of some of the other toys.



Plastic stacking beakers with relief outline figures

related objects, others single objects against plain backgrounds and others complex integrated scenes. This was the only other picture book which we regularly took to the play sessions.

2.2 Analysis of the data

One way of characterizing what I extracted from the questionnaires and tape-transcripts in the quest for nominals is to indicate the kinds of utterances which were passed over. Pronouns, being worthy of study in their own right, have been neglected here. Temporal terms such as morning were left out because of their relative abstractness. For the same reason the very few precursors of relational nouns, such as edge, were not included; although top, meaning 'lid, plug or cover', was. Door was a problem case: all three children first applied it to doors and then used it for a while to request help in opening, separating and, later, closing and joining things. Griffiths & Atkinson (in press) argue that door - which was used in similar ways by other children observed by the project - was a proto-verb. One of the grounds for this claim is that at times it alternated with stuck and off; another is that the form was subsequently supplanted, in this role, by open and shut. Below, I have noted only those cases of door in which it was clearly applied to things and have overlooked the large number of instances of its being used to summon assistance. Other action-words, such as go and fall, were ignored with fewer qualms; as were forms with locative adverbial/verbial status, e.g., off, on, in and down, and request and donation forms, e.g. here, thank you, please, want. Question forms, predominantly where's x? and what's

that?, were also bypassed. There were very few qualifiers, e.g. nice and they are generally left out of account. However, J used hot in ways which suggested, very inconclusively, that it might have meant 'electrical appliance' for him; so the word will be found in the appendix. Interjections, yes, no and oh, were not considered, nor was the 'completive', there!. Finally, I excluded comments on disappearance and absence, can't-see-it, away, (all) gone, remarks related to taking notice of and drawing attention to things, see, look, and ritual phrases, oops a daisy etc.

Apparently-uncomprehending 'echoes' of immediately antecendent adult utterances had been marked as such at the time of transcription and I ignore them. Cases in which a child repeated a 'name' for an object after it had been uttered by an adult, in correction of the child or in response to a 'what's that' question from the child, and cases of a child using a nominal which an adult had used less than half a dozen utterances earlier, were more problematic. Should such an item be presumed to have entered the child's vocabulary? I decided to be cautious in this matter and left such forms out of account. Usually the form reappeared spontaneously at later points in the child's record and was noted there. There were rare cases of children uttering forms cognate with adult English nouns but bearing no discernible relationship to the child's surroundings at the time. I omitted these unless the word was already an attested meaningful item of the child's vocabulary; in which case I entered "?" in the list of denotata for that lexeme.

I have relied heavily on the glosses provided for the children's utterances at the time of transcription. The glosses have sometimes been my guide in grouping diverse phonological forms together and sometimes in classing very similar forms as related to different lexemes. The variation is suppressed in the appendix and in the discussion below, except in a few extreme cases which are represented in phonetic script. Phonetic transcription is also employed in a few cases where no related adult or generally-accepted nursery form could be identified. The conventional orthographic forms I use should be taken as an indication, but only a rough one, of the children's most frequent pronunciations of the words. I found no grounds for believing that G, J and K deployed plural markers meaningfully and systematically in the age range dealt with here, up to 2;6. Thus no weight should be given to the presence or absence of pluralizing suffixes in the representations of the children's forms.

One of the very few cases in which I decided to depart from the glosses in the tape-transcripts occurred in connection with K's use of house. According to my records [This caveat applies tacitly throughout the remainder of the thesis.], K first used house at the age of 2;1.5/6. His mother indicated in the questionnaire that he applied the word to a picture of a house which regularly appeared in a television programme called Play School. It is very seldom clear from the questionnaire entries whether a child's use of a word was spontaneous (and to what extent it was spontaneous) or whether it was an imitation of a recent utterance by someone else. We did not record anything glossable as house, from K, until four months later (2;5⅓), although we showed him

the picture of a house embossed on the base of one of the project's plastic stacking beakers. At 2;4 he responded "door" when asked "What's that?" of this outline of a house. When he was 2;4½ said [fɜn] when he was again asked what the relief on the base of the beaker was. This particular phonetic form was not encountered again and I have left it out of account.

Our first three recorded examples (2;5⅓) of K's use of a form which we glossed as house - twice preceded by a question mark to indicate doubt in the matter - were perplexing: K was trying unsuccessfully to screw the lid on to the cardboard drum which held our 'tinkertoy' construction set. These tokens are entered in the appendix, in the denotation class of K's house, as "?". A week later K's mother noted on the questionnaire that he had said "car in house". This was offered as an example of "joining words together" and was not accompanied by explanation. During the ensuing month house was attested many times. K said "house" as I refitted an arm to our plastic chimpanzee, he said it while he was trying to extract something from his pocket, as he pointed at the head-socket of one of the plastic zookeepers he had recently decapitated. Pointing at the water in the kitchen sink, in a dish-washing scene, he said "house tap", etc. In all there were 49 tokens of this word, which we glossed as house, being used in such outlandish ways. We were puzzled at the time and, with hindsight, it occurred to me that out would perhaps have been a more appropriate gloss. Of course, phonetic similarity makes this plausible. The revision is strongly supported by the fact that although K's mother marked out as a form which had been used "over 10 times" every week from 2;2 5/6 onwards

[The questionnaires gave the options "not yet","2 - 10 times" and "over 10 times", for a rough indication of weekly proto-prepositional usage.], we never glossed any of K's utterances, or parts of his utterances, as out during the period dealt with here - up to 2;6½. I conclude that the original glosses for these 49 tokens were in error.

Were there perhaps other major errors in the glosses? Could it be that K's house, because it belonged to a system very different from adult English, was neither a noun nor a preposition nor an adverb but something so general as to be applicable to all of the notional fields covered by the nuclear members of these form classes: things, relations and (modes of) action? These are questions that will probably never be answered. However, I believe that reliance on the interpretations of adults who know a child well is both necessary and innocuous. It is harmless because totally private intentions and conceptions which a child never succeeds in communicating to others are no part of language. In essence, language is not a solitary game; it requires at least two players.

All the examples in the appendix are instances of the children's productions; that is to say, I have not systematically listed the evidence to be gleaned from cases of comprehension of the speech of others nor the negative evidence suggested by a child's failure to 'name' something. Failure to answer a 'what's that' question might indicate no more than disinclination. Only if repeated questioning of an apparently willing child did not yield an answer have I given any weight to the episode - and even then, only in the discussion, not in

the vocabulary lists. Failure to 'name' a presented object in the absence of a prompting question shows only that humans are not robots. I have omitted the comprehension evidence from the vocabularies because there were only a few cases in which it was possible to be fairly certain that, for instance, a response to a request containing a nominal had any bearing on the intensions of any of the child's nominals. Without rigorous testing procedures contextual clues as to what the speaker wanted were usually available to guide the response. Clearly-informative examples of comprehension were, however, noted and some of them enter the discussion below. I have included nominals drawn from utterances with desiderative force. This is a practice of dubious validity when a desired object was out of sight and the child's request for it was not consumated, but appropriate annotations prevent such examples from being misleading when they appear in the appendix.

Having cleared the ground it is now possible to give a statement of the analysis of the data. For each child, I scrutinized the questionnaires and tape-transcripts, one week at a time, and listed all the nominals there were, bearing in mind the exceptions and cautions which I have attempted to spell out above. Beside each nom ial I noted each of the entities to which its tokens had been applied. To suit my personal wish to see some order in this undifferentiated mass, and I hope to the benefit of anyone who reads the results of the exercise, the nominals were classified under five headings according to their denotata: ARTEFACTS, PEOPLE, FOOD, ANIMALS and BODY PARTS. This is by no means a rigorous classification and it certainly was not forced upon me by any properties of the data. Some may find the presence of

water, trees and flowers under ARTEFACTS displeasing. However, nothing reported below depends upon this classificatory system. Within the children's own denotation classes, I appended an asterisk to the description of any entity which, by fairly lax adult standards, seemed to represent an aberrant usage. These departures from adult norms-of-a-sort are interesting because they are likely to reflect the child's own generalizations instead of what he has learnt directly from people in his environment. At the end of this process I had week-by-week lists of nominals and descriptions of the entities in their attested denotation classes.

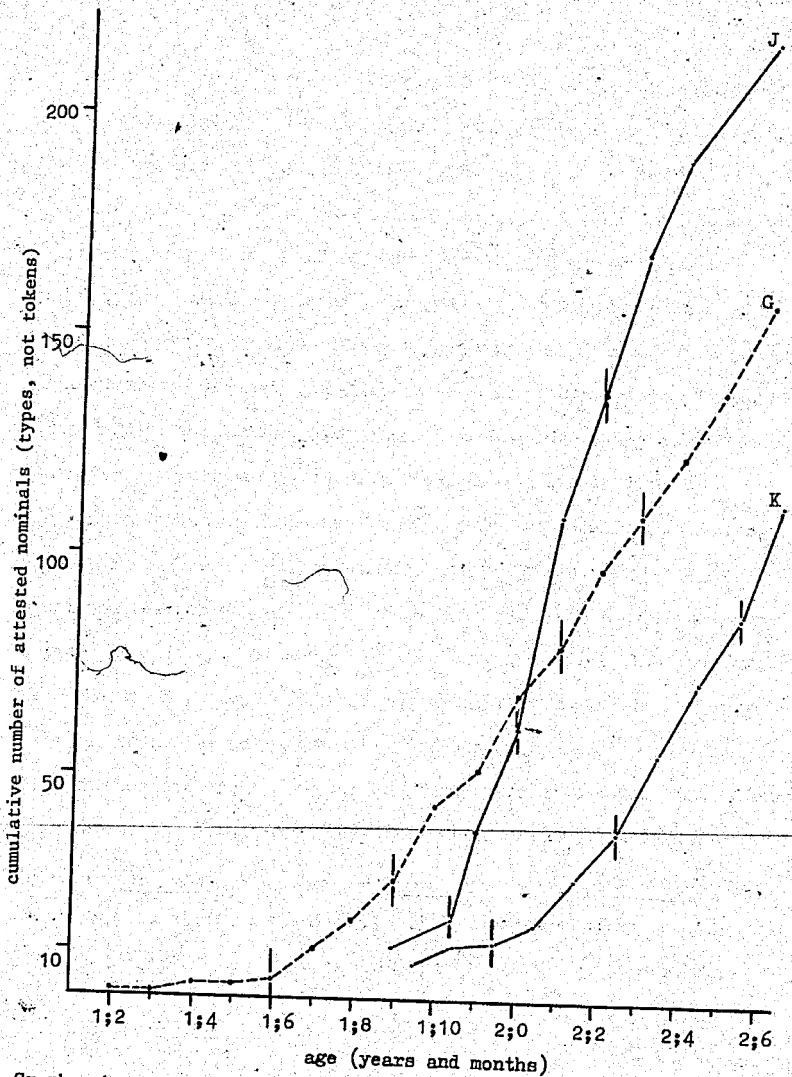
2.2.1 Aggregation into successive vocabularies

The weekly lists represented usages which just happened to have been noted by the children's mothers or to have occurred in twenty minutes of tape-recorded conversation with the child. It was obviously necessary to conflate weeks in order to increase the size of the sample of the members of each denotation class. Amalgamation was also called for to give a fuller picture of each child's overall vocabulary; a week could easily go by without the need to use a particular word arising at all. There are several arbitrary bases on which the longitudinal record could have been partitioned into periods longer than a week, e.g. larger intervals of time or numbers of recorded utterances. I thought it better to try to identify spurts in vocabulary growth and to section the longitudinal record just ahead of rapid increases.

Vocabulary growth curves were derived by summing each child's

nominals month-by-month and plotting the results cumulatively. This was a count of types, not of tokens. The graphs are reproduced overleaf. Cumulative addition means that once a lexeme had been attested, even if only through one token, it was from that point onwards added to the total for each succeeding month. Since we had begun to receive questionnaires from K's mother when he was 1;9½ his graph is not plotted for the monthly anniversaries of his birthday but at 1;9½, 1;10½, 1;11½ etc. The latest points on the graph for G and J are at 2;6 1/6 instead of 2;6 in order to include their last data-weeks considered here; as it turned out, neither of them was recorded at exactly the age 2;6. J's record starts with a questionnaire at 1;9. Then, for reasons which I can no longer remember, we did not receive another questionnaire from his mother until he was 1;10 2/5, a fort-night before the first taped play session. Accordingly, the second point on his graph is at 1;10 2/5. Lexemes entered under more than one of the categories, ARTEFACTS, PEOPLE etc., were counted as if they had appeared in a single category only.

Points on graphs at which the curves bend upwards are points after which there was an increase in the rate of accretion of nominals. The ones which were chosen to demarcate stretches of each child's records for aggregation are signified by vertical bars. It will be seen that five points of acceleration on G's graph and one on K's were not selected as the boundaries of periods of vocabulary. This is because doing so would in each case have led to the recognition of periods which were not very distinct from their precursors, in terms of new nominals added.



Graphs showing growth in vocabulary of nominals, for G, J and K

Vertical bars demarcate periods subsequently aggregated.

The curves thus provided a modicum of motivation for sectioning G's vocabulary into five successive periods and J's and K's into four periods each. It is in no way intended that these periods should be taken to represent natural stages in vocabulary development. They are a convenience dictated by a desire to understand the structural effect, on denotation, of other available lexemes and to reduce long lists to manageable proportions. The appendix to this thesis presents the resulting aggregates. All the attestations of each lexeme in a given period have been brought together in approximately chronological order of occurrence. "Approximately" because order of occurrence of denotata within a given week was largely ignored and because temporally-separated instances which could be covered by a single description were lumped together, with a multiplier added to specify the number of tokens. Multipliers are also suffixed to attestions derived from questionnaire entries [Questionnaire-based evidence is marked in the appendix by "Q:".]. It should be remembered, however, that mothers were asked to list new words. It naturally proved easy to forget which words had been entered on previously-returned questionnaires. This often had the desirable consequence, from my point of view, of a lexeme being repeatedly attested in the parental returns for a given child. The important point though is that small numbers of tokens cited as coming from questionnaire entries bear no straightforward relationship to frequency of tokens: a word might have been filled in more than once because it was used frequently, as easily as it might have been noted again because its previous use in utterance was so far back as to have been forgotten.

Since the absence of recorded tokens of a previously-attested lexeme within even the longish periods of aggregation used here cannot be taken as a sign that that child had lost that word from his vocabulary, lexemes have been carried over into succeeding periods even when forms related to them were not again encountered. This should not cause any confusion because such items stand out clearly in virtue of not being accompanied by descriptions of members of their denotation classes. Where one form replaced another, as for instance when JJ began to call musical boxes music box instead of wikik box and when this form replaced his earlier keekit, the new form is entered in the place where the old one would have appeared. The approximate order of first attestation is carried forward from each period to the next. The order does not reflect the temporal sequence of attestation exactly, because I paid little attention to this matter within any given week and because in about half a dozen cases I moved lexemes closer to related ones. With an eye to functional and contextual issues I have tried to reflect in the descriptions of pictures what the background to the named object was. Where no background is mentioned in the description of a picture it may be safely assumed that the object was portrayed in isolation on a page. With regard to 'real' objects and parts of them I have included contextual information only when it seemed to be of interest; there appeared to be little point in stating that a child was playing with a toy in the way intended by its manufacturer, or to noting that the child had simply seen the object and named it or had used the word in response to an adult introducing the object and saying "What's that?".

2.3 Discussion of the data

I believe that the vocabularies in the appendix contain the evidence for a strong case against the theory of criterial attributes and in favour of intensions being detailed prototypes. It is my intention, here, to try to persuade the reader that this is so by giving an account of my interpretations of the significance of the data. Selected examples rather than every possible relevant instance are used but I have tried to be scrupulously fair in selecting items for discussion. The appendix is there to be used by those who may feel that a different selection from this evidence would warrant a different conclusion.

In this discussion it is sometimes necessary to make guesses about which aspects of a set of objects mediated a child's tacit judgement of similarity or difference. I am aware of the well-known indeterminacy of such guesses [Cf. Quine (1960, 87) and, in the realm of pattern recognition studies, Dodwell (1970, pp.73-4).]. However, I see no way of avoiding such subjective judgements. Of course, the hazards could have been minimized by carefully controlled experimentation but, especially in work with young children, formal experiments run the risk of becoming games in their own right and unrepresentative of normal language use. Also, it is just not feasible to devise, try out and apply rigorous experiments to sizeable portions of a child's vocabulary before the child has progressed to a different lexicon; children's vocabularies are added to and, hence, changed from moment to moment.

Three abbreviations are used extensively below and in the appendix. They are:

Q, to identify evidence derived from mothers' questionnaire entries
P = "picture of"; grammatical articles are neglected after 'P
pr = project

Objects which belonged to the project have been marked because I was extremely familiar with them and therefore feel more confident in talking about their properties and how they might have been perceived by the children. The reader is invited to refer back to the illustrations of the pr toys in evaluating discussions in which these items figure.

2.3.1 Infrequency of errors

Clark's (1973, 1974) developmental version of the theory of criterial attributes explains 'overextensions' by the hypothesis that children initially have only a few criterial features for each of their lexical items. Fewer criteria to meet entails the likelihood of the criteria being met by more items. But, there is a rub here: if children worked in this manner 'overextensions' should be numerous and often far-fetched. Inspection of the appendix reveals that for many of G, J and K's words overextensions were never attested. I grant that some instances of my use of an asterisk or failure to use one are contestable but the broad picture is one of it being relatively rare for a word to be pushed beyond the conventional limits. Notice too that, within denotation classes, cases which seemed to deserve an asterisk are often heavily outnumbered by examples of (fairly) standard

usage. For instance, only one of the nineteen tokens of car attested for K was inappropriately used: as a 'name' for the pr P parked motor scooter in a street scene, in the last period. Among the total of thirty tokens of shoe from him, only one, the pr doll's socks, was deviantly applied.

Also, the degree of aberration was often so slight as to make the asterisks seem the product of pedantry, as in the second example above, or when K called the pr dog glove-puppet bag; it is, after all, a bag with head and arms attached. G's referring to the pr P yellow plastic duck as teddy seems entirely excusable too; the view shown was such that the duck's bill was foreshortened and the tail hidden behind the duck's body. J's calling the pr P zebra and an outline drawing of a donkey horsies is likewise easily excused. Two more exculpable instances, and there are many others, are: K's bus for a P pullman railway carriage and J's book for pr P children's paintings hung on a wall in a nursery school scene - actually, the paintings were stuck on the wall and, but for my knowledge of conventions about what to do with books and the fact that, in the story which this illustrated, the paintings had been done earlier, they might have been books. I do not deny that the appendix contains interesting 'overextensions'. Some of them are discussed below. I merely claim that many putative instances are venial.

There are also cases which are perhaps best regarded as genuine errors. One such case was one of the five (out of 240) in which G misapplied car. In the play session we had with him when he was 2;2 2/5,

I asked G for the engine of the pr toy train he was playing with. He indicated his unwillingness to give it to me by taking it further away. Moments later, while his attention lapsed briefly, I whisked the train away from him. He noticed and grabbed it back saying "my" then "my my car". I submit that he was under stress at the time; fourteen utterances later he called the pr toy train train and he used car appropriately five times in the same session. Or consider the following case from G's record (2;4½): he was paging through a pr picture book. Seeing a P bright beach ball he said "see ball". Then his father asked "What's that?" as G turned to a P red apple on a plate. G said "ball" to which his father responded "No". G then said "eh?" and his father said "What's that?" again. G replied "eh?", then "apple". The following, from J (2;2), is a similar case. M stands for J's mother.

M: What are these? re pr P marbles

J: apple

M: No, those are ... m...
M: What are they?

J: ? marble

M: marble

J: Alasdair marble

Alasdair was his brother. Incidentally, these two tokens of marble, one of them dubious, are not the two listed in the appendix; those came later in the session.

The generally high standards of correctness suggest that the children must have been relying on detailed specifications in determining the application of their words. Notice too that there are lexemes of high related-token frequency in which we never detected an error. For example: G's shoes, bus and spoon and J's bye bye and

telephone. Bye bye was J's first word for a telephone. One of the reasons justifying its inclusion in the catalogue of nominals is that at 2;1⅓ J twice said "yours bye bye" as he pushed a toy telephone towards me. K (2;6) gave evidence of the detailed nature of the memory trace to which he was comparing a picture when he said "eyes" as he pointed to P little boy on which the artist had neglected to add eyes. I have no record of which picture this was but I recall that the boy was small in relation to the rest of the picture and in the background. As a further example, K's use of flower is interesting. The word was attested only three times in his record: Q, as applied to a flower, and twice used for the pr P flower embossed on the base of a plastic beaker. However, when my colleague Martin Atkinson fitted pr 'tinkertoy' wheels to one end of each of a number of 'tinkertoy' rods and held them out to K as a bunch, K replied firmly "No", twice, when Martin asked "Are they flowers?"; K was not to be fooled by stark simple perceptual features.

J's misapplications of people's names, in particular those of his sister, Pippa, and his brother, Alasdair, might appear to contradict what I have claimed above. He knew 'Pippa' and Alasdair as well as anyone knew them. Why did he use their names of so many P little girls and little boys during the last two periods of his vocabulary presented in the appendix? Could it be that his memory traces of even his siblings were so parsimonious as to make them indistinguishable from pictures of other children? The sex-appropriacy of his uses of the names argues strongly against this suggestion. Also, J's mother once told me [Alas, the date of this communication was not recorded.]

that J called all middle-aged women Andis; recorded in the appendix as applying to a person called Aunt Dilys. I asked her to be on the lookout for any grounds for believing that J could tell the difference between the real Aunt Dilys and the others. A week later his mother offered the following observation. Aunt Dilys was a generous provider of sweets. J would demand sweets from her whenever he saw her. Other ladies whom he called Aunt Dilys were immune from this importunity. Alasdair and Pippa were probably not common nouns equivalent to boy and girl because J had these lexemes as well. I think J was either playing a game of assigning roles to children in pictures - as G probably was (2;5 3/5) when he called one pr 'chairoplane' figure Mummy and another Daddy - or else J was somehow commenting on the likeness between the children in the pictures and his brother and sister, but lacked the words and syntax to make it clear that he was doing so. With regard to errors in naming members of the research team I can do no more than point out that even adults forget personal names. In passing, it may be of interest to note that the high frequency item Mummy was almost always vocative for all three children. Among the rare referential cases there were these: G (2;1¾, Q) said "Mummy's pens", J (2;5 2/3) replied "Mummy drawing" when Renira Huxley, my colleague, asked him "Who's drawing, J?" [His mother was drawing a house.] and K spontaneously said "Mummy bath" when he heard his mother running water in the kitchen [The recording was being made in the lounge and K repeated his statement when I asked "What? What's Mummy doing?"].

2.3.2 Diversity within denotation classes

The previous section was an argument against a developmental version of the theory of criterial attributes; a version which limits the number of attributes employed rather severely. I turn now to an examination of whether increasing the number of conjoined necessary and sufficient criteria for membership in a denotation class could rescue the criterial attributes view. After all, with many features one can achieve detailed specification. The argument is simple: some denotation classes have no plausible attributes common to certain extreme members.

Firstly, there are some instances of children 'naming' sounds. At one of the recording sessions (1;8 5/6) G 'pricked up his ears' and said "see birdie" when he heard the noise of an aircraft flying overhead. The recording was being made indoors and the aircraft was not seen. Birdie was not attested again until G applied it to a pr P parrot, six months later. I would like to be able to say that the denotation class of G's birdie was a P parrot and the noise of an aircraft and then proceed to pointing out that these items share no interesting properties in common; that is, properties which are not also shared with countless different things. However, this would surely stretch the reader's credulity too far: the intension of the lexeme might have changed greatly over six months; perhaps someone in G's family had jokingly taught G to say birdie when aircraft noises were heard. The example might be cogent or it might not. The case of K (2;4 1/5) referring to his mother when he heard her running water in the kitchen [cited in §2.3.1, above] is slightly more convincing, but there are better examples.

At 1;9⅓ G said "door" when he heard a knock at the front door in the hall nearby. The word had been noted (Q) in the previous vocabulary period as applying to a door. His mother's note said that G used door when she opened and closed doors. It seems safe to assume that knocking at the door was seldom part of these actions. Phone was added to G's vocabulary at 2;1½, Q. At 2;1⅔ G said "phone" when it was heard to ring in the next room. During the same vocabulary period he also applied phone to the pr white toy telephone and to a pr P light blue telephone. The toy telephone could sometimes be made to 'ting' feebly; the picture incontestably never rang. There is a straightforward account in terms of the theory of prototypes: G had stored a record of a ringing telephone and so the noise, which matched its ring, was called phone and the picture, which resembled the prototype in visual appearance, was also phone. Two Q accounts in the final period of J's vocabulary allow the same interpretation: he said "dog" when he heard an unseen dog bark and "boys" when he heard the voices of some boys he could not see. See the appendix for other, soundless, denotata of these two words.

There are other examples which do not hinge crucially on the fact that sound can go around corners, whereas the propagation of light is rectilinear. During the 2;0 1/6 to 2;2 period of his vocabulary J called a toy crane boat (Q) and his mother surmised, very reasonably, that this was because there had been derricks on the boat which had taken him to Shetland. But during this period he also applied boat to a pr P toy ocean liner. It was a P very simple painted wooden toy without any derricks, or anything else, on the deck. The use of boat

in connection with the crane would be quite understandable if J's 'image' for boat had been a boat with derricks. Provided he was not using either the derricks or the rest of the boat criterially both the crane and the toy liner would have had strong similarities with his prototype. Another case in point is G's use of baby to cover both 'babies' and prams. Or, there is J's application of soap not only to a pr P pink bar of soap but also to salt. The likely prototype would be a white bar to match the salt in colour and the pink bar in shape, or perhaps in surroundings, since it was portrayed in the company of other toilet articles.

Further examples could be cited and the number could be increased still further by introducing a little more speculation. I shall restrict myself to describing two cases of the latter type. In the vocabulary period 2;3 1/6 to 2;6 1/6 G called one pr P man Daddy but a pr P milkman he called man. The milkman wore a peaked cap just like those of the pr plastic zookeepers and, since man was fourteen times applied to these zookeepers during this period it seems likely that the caps were the important similarity which elicited man, but not Daddy, for the milkman; the Daddy man was very similar in appearance to the milkman but he was bare-headed. But the presence of a cap could not have been criterial for man since this lexeme's denotation class included the pr 'chairoplane' figures, which simply had hair painted on their round heads. In the last of J's four vocabulary periods, there were fourteen tokens of car. Two of them are asterisked: (Q) child's scooter in a tree and pr P younger child's tricycle. I know nothing of the characteristics of the scooter but the tricycle

had a substantial front mudguard and small fattish wheels; both a little car-like. Furthermore, during this period, six appropriately-used tokens of bike were attested for J. With one of them he named a pr P older child's tricycle. This tricycle had large wheels with thin spokes and tyres and slim bicycle-type mudguards. If I am right in my guess about what made one of the tricycles a bike and the other a car; namely the shape of the mudguards and wheels, these would fail as criterial attributes for car because a pr P child's very rough painting of a car was also called car, three times. This painting was a side view of a box-shaped car with windows and two blobs for wheels. However, if J is granted a prototype car and the use of some of its features on one occasion and a distinct set of features on others there would be no mystery to solve.

In the next section some evidence is adduced to show the plausibility of assuming that the children indulged in real-time processes of comparison between perceptual inputs and rival prototypes.

2.3.3 Prototype rivalry

Under good conditions, when an object can be clearly seen, it should either meet or fail the criteria of application for a lexeme, according to the theory of criterial attributes. If an object passes the criteria of a given lexeme, within this particular theoretical framework, no other lexemes, except for exact synonyms and superordinate terms ought to be eligible for application to that object. The view which I have been defending, on the other hand, is that

perceptual input is compared to stored prototypes to discover which it matches most closely. Rigid one-answer criteria are no part of this conception, therefore it is quite likely that ties will occur, in which the input is equally similar to two or more lexemes. If the children can be shown to apply tokens of different lexemes to the same object the theory of prototypes will gain in credibility thereby. I do not say "be conclusively established" because there are obvious special pleas which could be introduced by a criterial attributes theorist. The child might have made an honest error, as I myself suggested [in §2.3.1] was the case when G switched to apple after his 'label', ball, for the pr P apple had been queried. Or, to remain with this example, it might be claimed that this shows apple to have been a hyponym of ball in G's lexicon. Alternatively, the problems of performing in a real world might be blamed: perhaps the object has failed to meet the full set of criteria for any lexeme but it satisfies an equal number of (equally important) criteria for two (or more) lexemes; obliged to offer a name, the child tries both. There are relevant instances, some of which I shall now describe. Although the theory of prototypes has no need for the special pleas just mentioned, its proponent has to explain why cases of uncertainty are not much more common than they, in fact, are. I address this problem at the end of the section.

Consider the following episode from G's record (1;10¾). MA abbreviates "Martin Atkinson" and RH "Renira Huxley".

re pr P toy ocean liner

MA: That's a boat.

G: ? what's that?

G: eh?

MA: Boat

MA: Boat

RH: Boat

G: boat

G: car, choo choo

G's imitation of boat was, in acordance with the procedure stated in §2.2, not entered in the appendix. Examination of the table of G's lexemes for 'artefacts', in the relevant period (1;9 1/6 to 2;1), shows 58 tokens for choo choo, only three being inappropriately used, and 130, including four asterisked ones, for car. The only other likely candidate 'labels' for an ocean liner in this period were bus, which was used 60 times for the pr toy London bus and twice (Q) for a toy minibus and a [real] bus, and train, applied 11 times to the pr toy train and once (Q) to a train, not further specified. Perhaps the operative similarities between the P liner and the prototypes for car and choo choo included these latter somehow matching pictures more readily than did the prototypes of bus and train. The essence of the example, though, is that in two successive breaths G called a single entity by two different 'names'.

In §1.3.2 I discussed the episode in which J (2;1 3/5) vacillated between cow and sheep as a term for the pr plastic elephant. Cow had entered his vocabulary at 2;1. What would he call a cow before then? At 2;0 2/5 he set himself the task. He had played with the pr plastic cows before but had not attempted to name them, although he had on one occasion (1;11) used horse of a pr plastic bull; the bulls were nearer in size to the plastic horses than were the cows. Towards the close of the second period into which I have divided J's vocabulary (1;10 2/3 to 2;0) sheep was attested in a Q entry. In the play session taped at

2;0 2/5 J spontaneously and correctly named a pr plastic sheep as he picked it up and, still holding the sheep, he replied "sheep" when his mother asked "What's that?". J then played briefly with the pr plastic animals until his mother picked up a cow and said "What's this? What's this thing, J?". "Sheep" he answered and then immediately "horse". There followed an argument in which his mother told him five times that it was a cow and he insisted another four times that it was a horse, giving up with "oh dear" after his mother had had the last word.

In the same week (2;0 2/5) J first used orange (Q). However, the following exchange took place in connection with a pr P two halves of an orange on a plate during the recorded session that week. M stands for J's mother.

J pages to P orange.

M: That's not a biscuit. What is it?

J: biscuit

M: It's an orange.

J: apple

J: yes

In the next session (2;0 3/5) J's mother held up a pr P red apple on a plate to J and said "There, what's that?", to which he replied "orange, apple" [The comma marks the end of a tone group.].

These examples have the advantage of the two words being in immediate juxtaposition and thus one need not be much concerned about the alternative explanation, that the intensions of one or other or both of the words changed during the time-span of the example. However, the likelihood that these are errors in terms of the child's

own system is increased. Intuitively-speaking, the utterance quoted immediately above sounds like a spontaneous self-correction. Inspection of the appendix will reveal a number of cases in which the same object was 'named' differently and most of these cover longer intervals of time than the ones cited above. One such example concerned the loaded meatstick held by one of the pr plastic zookeepers. J (2;5 1/6) found the zookeeper in the pr animal tin and drew it to his mother's attention, saying "man Mummy". She replied "Yes. There's a man". Then J said as he continued to hold the zookeeper, who in turn held the meatstick, "got lolly". Sixty-three utterances later, during which J had been engrossed in a variety of activities, he said "that's a flower" immediately after succeeding in fitting the meatstick back into the zookeeper's grasp, from which it had been removed in the interim.

We first recorded soldier from K at 2;4. K had been playing with the pr plastic elephant when Martin Atkinson pointed out a pr plastic zookeeper to him and asked "What's this?". K replied "cow" to which Martin said "No! What is it?". K then answered "soldier". Martin, having not heard the word from him before, said "A what?" and he reiterated "soldier". In the next recording session K three times applied soldier to pr zookeepers. Then, during the taping at 2;4½, he called one of them soldier seven times in a row as he handled it, decapitated it and tried to refit its head. Here is the last of the seven and its sequel. MA stands for Martin Atkinson.

MA: Where are you putting it? [i.e. zookeeper's head]

K: soldier, there

MA: There?

K: [unintelligible syllable]

K replaces the head but it falls off.

K: aw

K: baby's ?head off, ?now

MA: Baby's what?

K: baby

K continues trying to refit the head.

K: soldier

MA: Is he alright now?

K: oh, ..., baby

K still holds zookeeper.

K: there baby

Soldier was not used again during the rest of this session, nor in the remainder of this third vocabulary period, nor in the last vocabulary period dealt with here (2;5 3/5 to 2;6½). Had the intension of baby changed in order to allow zookeepers into its denotation class? Evidently not, for in the remainder of the time up to when K was 2;6½ baby was not applied to the zookeepers again. Instead, a new word, man, denotationally synonymous with soldier, entered K's vocabulary at 2;5 1/6. It seems as if the form soldier was replaced by the form man and as if the brief dalliance with baby, for the zookeeper, was a case of prototype rivalry. J's wavering between watch and clock might be a case of rival prototypes or it might exemplify rival forms for the same (set of) prototype(s).

If, as I have been trying to suggest, different similarities come to the fore at different times and none of the properties of members of a denotation class is essential [i.e. necessary; cf. §2.3.2] how do children avoid endless confusion? G, J and K, but especially G and K, kept out of chaos most of the time by operating with high lower-bound limits for sufficiency of similarity. In the vast majority of

cases they simply did not try to 'name' 'new' things. What I mean is that they were cautious and, in general, appeared to require a lot of similarity before venturing to apply a word. This generally manifested itself as a simple unwillingness to answer 'what's that' questions about objects which were not close to central members of the denotation classes already lexicalized.

The following example of non-responses to questions seems to me to go beyond disinclination to cooperate, which was the reason I gave in §2.2 for not noting all such cases. The background to the example is that there were two Q records of J calling playground swings see-saw, 2;2¼ and 2;2⅓. There was also at 2;2½ a single case of a seesaw having been called steadygo, a form which had been applied at 2;2¼ to a pr P nursery chute being used by children and which I grant might not have been a nominal.

Three days after the recording session at 2;2½, J's mother asked me to look after him while she went shopping. We played amicably, spending most of the time drawing. I drew a picture of a see-saw with two children using it. I still have the picture in my notes and it is not a bad representation of a see-saw. Then I tried to get J to 'name' the object in my picture by asking: "What's this? Tell me what this is. What's the name of this thing? This is a boy and this is a girl. It goes up and down. What's this?". J seemed quite interested and he imitated "up and down" but answered none of the questions. I then said "Show me the see-saw" and he pointed it out immediately and unambiguously. The correct comprehension, I surmise,

was a result of J lowering his standards for what would count as close enough to a swing - his prototype see-saw - to warrant application of seeesaw. Presumably he reduced the level of similarity required because my request showed that I presumed my picture to contain a see-saw.

Andersen (1975) found that when 3½ year olds were asked to sort 25 varied drinking vessels into cups at one end of a table and glasses at the other they did so, whereas older children segregated mugs as a third class, neither cups nor glasses. She interprets this as evidence that children have to learn that "boundaries are vague". It seems to me more likely that they were lowering their normal standards under the sway of an experimenter-imposed suggestion that the 25 objects could be partitioned into cups and glasses without remainder.

2.3.4 Vocabulary structure

My overall impression of the three vocabularies is that they lack depth of structure; that they are an array of lexemes, all at the same level, and mutually related by a relationship close to the one which Lyons (1968) calls incompatibility. The cases of prototype rivalry discussed above show that the relationship is not strict incompatibility. In seeking to offer grounds for this general feeling I can point to the paucity of superordinate terms. One candidate for the status of a superordinate is tea in the second period of G's vocabulary (1;6 1/5 to 1;8 5/6), since it was said (Q) to cover food and drinks and G had a separate word, juice for drinks. In the entire period

toys was twice noted (Q) from G and once (Q) from J. In a single recording session (2;5⅓) K uttered eight tokens of toys but the word was only applied to parts of the pr 'tinkertoy' wooden construction kit and, on a single occasion to the pr 'chairoplane' which, dismantled in its box, must have looked very similar. It is even possible that in unpacking for the play session one of us might have named the 'tinkertoy' in K's hearing. K said (Q) "clothes" while he was getting dressed but not much can be learnt from this one token. In the last period into which J's vocabulary has been divided there are three tokens of food and the composite denotation class appears to include denotata (or, in some cases similar denotata) of cake, lunch, nana and, perhaps, biscuit and bread; so they might have been its hyponyms.

The following episode from J's transcripts (2;2 2/3) involves hen, which he three months later applied to a P rooster, and suggests that it might have been a hyponym of bird. M stands for J's mother.

J and M looking through pr picture book.
re P parrot

J: hen

M: It's not a hen.
It's a parrot.

J: parrot - ECHO
J: bird

The following three examples were the only ones of their kind and may be an indication of lexical structural relationships but, equally, they might merely reflect habitual collocations which J had observed. Firstly, at 2;0 2/5, J identified the creatures in a rather vague pr P two fish in murky water as birds. He was corrected and imitated the

correction, fish, twice before saying "fish, water" [The token of fish listed in the appendix dates from a later session, 2;1 3/5.7. Secondly, at 2;2½, J was asked of a pr P little girl telephoning: "What's the little girl doing?". He 'echoed' "girl doing" and then said "boy girl". Thirdly, and even more obscurely, J pointed at a bottle being held by a woman in a pr P woman with a spoon in the other hand and said "there's, that's a, a, fork". Then, in response to Martin Atkinson's "A what? A fork?", he said "this/there's a fork". Perhaps he was simply misled by the picture but it is remotely possible that he might have recognized the spoon, for which he had our word, and then got to fork via a lexical association, though I think it more likely that the spoon merely provided contextual backing for the recognition of something in the woman's other hand as a fork. Lastly, a piece of negative evidence is that in the Q of 2;5 2/3 J's mother noted his first use of Who's that? and added that he had always previously used What's that? in asking about people, as well as, of course, things. In the 2;6 1/6 Q she recorded that he had reverted to using what for who in questions. These observations suggest that even terms and names for people were not a separate lexical field for J.

The appendix offers many examples of denotata deserting an 'over-extended' denotation class as soon as a separate lexeme had entered the child's vocabulary to cover them. For instance, no tokens of girl were attested from G in the period 2;1¼ to 2;2 5/6 and during this time G called a pr P top third of a little girl looking through a large window baby. During the next period girl, as it were, reasserted

itself and was applied to this particular picture (and other girls), whereas baby was restricted to his sister's doll, a pr P baby in a crib and a pr 'chairoplane' figure. This sort of structural effect is to be expected in connection with the incompatibility relationship and it is entirely in keeping with the theory of prototypes.

It seems probable that the foundations for some later lexical fields may be laid at the stage considered in this thesis, through the process of denotation classes splitting. However, because of the conservatism with which the children accepted items into the denotation classes of words, the resulting fields are small and the lack of superordinates makes their very existence somewhat conjectural. The original cement for these 'fields' seems usually to be provided by the exigencies of the environment rather than within language. G's 'labelling' of the pr plastic cows, horses and bulls will provide an illustration. Except for two Q attestations for cow, all the animals involved were pr plastic ones so I shall omit this specification in the descriptions below. These animals were referentially united in that we always kept them in the pr animal tin and part of the play at most recording sessions was the business of getting the tin open and pouring or pulling the animals out.

In the third period of G's vocabulary (1;9 1/6 to 2;1) cow was applied 16 times to cows [+ 2 Q tokens] and five times to horses. In another way too G showed that he regarded these animals as similar: he made lateral clicks when he played with horses and cows (and a bull in the preceding period). The sheep, which also came from the animal

tin, were kept apart as sheep, perhaps because they were smaller and white, although there was a white horse too; or it might be that relatively shorter legs or fatter bodies or distinctive heads made the sheep different. The chimpanzee was three times called teddy and then not named again until the final period when monkey entered G's vocabulary. In the transcript of a recording made at 1;11 2/5, during this third period, there is some slender evidence relating to G's comprehension of horse, a word he had not yet used spontaneously.

A horse and a cow were standing side by side on the floor and G's mother asked him "Where's the horse?". She repeated the question when he said "eh?", whereupon he pointed at the horse saying "see". I said "that's right" and then directed his attention, by calling him by name, to a larger group of animals in front of me. As he looked at them I said to him "Show me the horse. Where's the horse?". G said "see" and gestured at the entire array of animals. His correct response had presumably been correct by chance. If it had represented a lexical distinction for him, it ought to have helped him choose the second time he was asked.

In the fourth period (2;1½ to 2;2 5/6) G added horse to his stock of words and five times applied it to horses and once to a cow. Cow was used nine times for cows, twice for bulls and twice for horses. Lateral clicks were used indiscriminately to accompany the 'walking' of animals. In terms of relative frequencies of denotata cow and horse were growing apart.

In the fifth period (2;3 1/6 to 2;6 1/6) calves were named for the first time. They were about sheep-sized but not sheep-shaped; rather emaciated, in fact. He called them calf fifteen times but once called a calf cow. At 2;4 he indicated good comprehension of calf. He had proprietorially stacked most of the animals on a chair behind himself. Calf was not mentioned by anyone during the process of getting the animals behind him, but he had used calf correctly a few times much earlier in the session. When he turned round to look at his hoard and said "my", I asked him to "Show me the calf". This did not lead to a response; so I said, again "Show me the calf, G. The calf." He then picked it out for me promptly and correctly. A sheep and two horses had been the last animals to be added to the chair so the calf was not distinguished by recency. In this last period, cow and horse had wholly distinct denotation classes - cattle and horses, respectively. However, perhaps their intertwined history would be the basis, later, for a lexical field of large farm animals.

Finally, although I have surmised that the children's lexicons were largely mono-stratal, this level is not always, from an adult point of view, flat. Consider G's teddy, which was applied as follows during the four periods starting with its arrival in the second period.

2nd: pr P yellow teddy bear, *pr P toy panda x2, *pr P yellow plastic duck x6

3rd: pr P teddy bear in relief outline on plastic beaker x2, pr P yellow teddy bear x4, looking through the book for this P teddy bear, *pr P toy panda, *pr P floppy rag doll, *pr P baby dolliin a pram, * pr plastic chimpanzee x3.

4th: pr P teddy bear in relief outline on plastic beaker, * pr dog glove-puppet

5th: pr P yellow teddy bear, *pr P toy panda x2, *pr P yellow plastic duck, pr P teddy bear in relief outline on plastic beaker x5, pr P teddy bear in a bedroom scene

The items stigmatized with asterisks received their marks in terms of my conception of the species teddy bear. However, if teddy was for G more of a genus term, equivalent to something like 'non-human but humanoid toys', perhaps all of the asterisks could be erased. The duck which enters the lists above was photographed downwards and from the front, making its head hide most of its body and reducing the apparent length of its bill; in short, giving it a teddy-bearish face. The narrowing down towards the more conventional denotation class of teddy bear appears to be the result of dolls being taken over by baby and, later, dollies and Bunty, the name of his sister's favourite doll. There is no reason why a yellow teddy bear should not have been G's internal prototype for the lexeme teddy; to match the duck in colour and face, the panda in general shape and facial features, the dolls in shape alone, although the one pictured in a pram had short red curly hair, etc.

2.3.5 Functional definitions and contextual factors

Nelson (1973) performed a content analysis on the 'general nominals' among the first fifty words to be acquired by eight children. In summary her principal finding was (p. 31):

> It is apparent that children learn the names of things they can act on, whether they are toys, shoes, scissors, money, keys, blankets, or bottles as well as things that act themselves such as dogs and cars. They do not learn the names of things in the house or outside that are simply 'there' whether these are tables, plates, towels,

> grass, or stores. With few exceptions all the words listed are terms applying to manipulable or movable objects.

I have no quarrel with this characterization; scanning through the appendix, especially the first three periods for G & K and J's first two periods, appears to bear it out. Perhaps this is simply a consequence of motion being attention-demanding for young children (or perhaps more so for them than for adults) [Cf. Clark (1974, p.114) for a similar opinion and Carpenter & Stechler (1967) for an experimental demonstration of the early attractiveness of motion.].

Nelson (1974) has put forward some suggestions about the acquisition of word meaning in which she assumes that categories of objects to be given the same lexical label cannot validly be based on static appearances alone: category members would have to be grouped together first on account of their participation in similar dynamic relationships with the members of other categories. She takes her (1973) finding that motion and change are common in the denotata of early nominals as an indication of the forming of these 'functional core concepts'. Attention to the salient invariant properties of members of the functional core enables the child to form a hierarchy of attributes to use in identifying new instances of the concept. Later a 'name' may be attached to the concept.

I do not doubt that children can have unlexicalized knowledge. For instance, K, although he had no word for a questionnaire (or even paper or book), when he once found a questionnaire we had collected from someone else and negligently left in the toy box, took it

straight to his mother; not to show her, just to give it to her matter-of-factly before continuing to play with the toys, because he knew questionnaires were her business. We never heard G say knife or sharpen but when he had failed to sharpen a crayon with his teeth he got up silently and fetched a carving knife from the sideboard drawer. At 1;8½, when we first showed G the pr P balloons he blew in and out and puffed up his cheeks, six months before the word loons was first recorded from him.

If Nelson's (1974) proposals include the implication that function is more important than other characteristics of objects in determining the application of words, I dispute it [I have read Nelson's article thrice and I am yet not certain that the implication is there.]. Bowerman (1975) detected such an idea in Nelson's paper and offered examples from her own daughters' linguistic development to substantiate a counter-claim that: "Functional similarities alone very rarely led to overextensions; perceptual similarities frequently did, even when this involved the child's overlooking known functional differences ....".

In my data there are examples of both kinds. Pictures, particularly of isolated objects, are unlikely to have been identified by other than their immediately perceptible static visual properties and the appendix shows these cases to be numerous. I shall shortly cite some cases in which function appeared to be important. Both aspects of objects should be potentially available to a child in deciding the application of lexemes if, as I argued in §1.3.2, we store videotape-like records of our prototypes.

At 1;9 1/6 G and his mother and I were building towers with the pr toy bricks. G stopped and briefly pushed the bus. Then, perhaps noticing some bricks in a line, he said "Mummy, choo choo" and began to build a line of bricks. On completing it he said "choo choo" twice and then "see" and began to push the bricks along the carpet. Previous attestations of choo choo were for his toy train (Q) and for a pr P bright toy train. Perhaps the perceptual similarity between a toy train and a line of bricks is too great for this to be a convincing example of the function of an object mediating its 'naming'. Garage, for G, may contain better demonstrations but they are all flawed in various ways, e.g. through an adult having suggested the word or because the contextual annotations have crucial shortcomings.

Jeremy provided several good examples. In our first recording session (1;10 4/5) he held the pr microphone to his face like an electric shaver and then said "hot"; see other electrical devices mentioned in the appendix in connection with which hot was deployed. More interestingly, he said "bye bye", his word for a telephone when his father took it from him and, holding it in front of his own mouth, said "You talk into it like this.". I regard the following as an even better case in point. It took place when J was 2;1⅓. The words involved, keys, bye bye, watch and clock had all been attested previously in appropriate use; bye bye for telephones. After a spell of playing with the pr toy telephones and naming them and looking at a pr P toy telephone, which he also named, this conversation occurred The pr red toy telephone had a clockwork mechanism and a socket for a winding key but we had never drawn this to J's attention or attempted

to use it in his presence, because the key was lost and the mechanism was broken.]:

J takes red toy telephone.

J: a bye bye,
a bye bye

[Presumably, notices key socket.] J: a bye bye, keys

M: What did you say?

J: keys

M: Kiss?

J: keys

PDG: Keys?

J: keys

PDG gives a bunch of door keys to J.

J: watch, watch

J tries to wind telephone.

J: watch, a keys

Adults fall into discussion.

J: watch, a keys

J: clock a keys

J: clock

J: a keys, in there, Mummy

The first example of clock in the interchange above was an 'echo' of a speculation I was making about what J's actions meant; it will have been noticed that we failed to understand the drift of his thought at first. Notice, and this is important, that during this period watch was also applied to illustrations of two different alarm clocks, both being front views, and to the clock face in relief outline on the base of a pr plastic beaker. For pictures of clocks the winding operation could not have been any part of what led to their identification. The similarity between a telephone dial and a clock also could not be the link, because the white toy telephone was never called clock or watch by J and the red toy telephone was bye bye or telephone when it was not being wound.

At 2;5 2/3 J said "lady" when he saw a P little girl holding a baby. He was corrected and 'echoed' "little girl" before saying "lady" again as he looked at the picture. Door for all three children was so

tied to action as to be perhaps a proto-verb, as I have remarked earlier, but there is at least one case of it being applied to a door which could not be opened: J's (2;1⅓) nomination of the driver's door of the pr toy London bus as door. Thus while functional considerations were certainly important in the use of this word, they were not essential.

K (2;4 1/5) tried to push a pr 'tinkertoy' rod into the slot of the pr white toy telephone and said "penny" twice as he did so. He had often pushed plastic pennies into this slot and he called them penny too but not only while he was pushing them into the slot. A prototype penny going into a coin slot could explain this: the 'tinkertoy' rod would have the same motion and pennies in isolation would have a similar appearance to the coin involved in the operation. K's puzzling word wheel, in the period 2;2 2/3 to 2;5⅛, might have had a denotation class partly articulated via 'rotational motion', but if that was the justification for the presence of a screwdriver there, it was merely a visiting card and not de riguer dress because the screwdriver was wheel when it was used for prising. Having got across the threshold on one pretext screwdriver may have become one of the prototypes and an image of it in use on screws might account for the small silver screw being wheel too. Maybe this is too fanciful. K's box and J's too might have had partly functional definitions.

Not only functions but also context sometimes affected 'naming' of objects. For instance, in the session at 2;5 J's mother pointed at a pink letter being waved by a postman in a pr picture book and said

"What's this?". J replied "um - money". Seven utterances later he called the same letter in a different picture - now floating down from the letter slit inside a front door - letter. In the same week J called one of the pr toy bricks, a flat slab: top when it was resting on three crayon rollers to make a nonce car, roof when he put it on to a house he was building and later gate as he set it beside the house. This sort of performance must rely on prototype scenes in which the labelled object is in clear focus and the rest is background. That the children did store a great deal of surrounding detail for the things they named was often borne out by cases which have entered the appendix as "wanting ....". G many times said car as soon as he saw the book which contained the pr P two-tone drophead coupé or when he noticed the beakers; and then began to hunt through them for the desired page or embossing. This useful peripheral material must have been stored with the rest of the information on these words. There were similar cases in the records of J and K too.

Detailed memory traces, the existence of which the review of [...] was intended to establish, are the keys to the explanation of the observations presented in sections 2.3.1 to 2.3.5.

References

Adams, K.L. & Conklin, N.F. (1973) Towards a theory of natural classification. Papers from the Ninth Regional Meeting, Chicago Linguistic Society, 9: 1-10.

Allport, G.W. (1924) Eidetic imagery. British Journal of Psychology, 15: 99-120.

Anderson, E.S. (1975) Cups and glasses: learning that boundaries are vague. Journal of Child Language, 2: 79-103.

Anderson, T.R. (1968) On the transparency of begin: some uses of semantic theory. Foundations of Language, 4: 394-421.

Bambrough, R. (1960) Universals and family resemblances. In G. Pitcher (ed) (1968) Wittgenstein: the Philosophical Investigations. London: Macmillan, 165-204.

Bartlett, F.C. (1932) Remembering. London: Cambridge University Press.

Baylor, G.W. (1973) Modelling the mind's eye. In A. Elithorn & D. Jones (eds) Artificial and human thinking. Amsterdam: Elsevier, 283-297.

Bendix, E.H. (1966) Componential analysis of general vocabulary. The Hague: Mouton.

Berlin, B. & Kay, P. (1969) Basic color terms: their universality and evolution. Berkeley: University of California Press.

Bierwisch, M. (1970) Semantics. In J. Lyons (ed.) New horizons in linguistics. Harmondsworth: Penguin, 166-184.

Blakemore, C. (1975) Central visual processing. In M.S. Gazzaniga & C. Blakemore (eds.) Handbook of psychobiology. New York: Academic Press, ch. 8, 241-268.

Bloomfield, L. (1935) Language. London: George Allen & Unwin [First published, in U.S.A., in 1933.].

Bolinger, D. (1965) The atomization of meaning. Language, 41: 555-573.

Bond, E.K. (1972) Perception of form by the human infant. Psychological Bulletin, 77: 225-245.

Bousfield, W.A. (1953) The occurrence of clustering in the recall of randomly arranged associates. Journal of General Psychology, 49: 229-240.

Bower, T.G.R. (1966) Heterogeneous summation in human infants. Animal Behaviour, 14: 395-398.

Bowerman, M. (1975) The acquisition of word meaning: an investigation of some current conflicts. [Abstract and conference handout of a paper presented at the Third International Child Language Symposium, School of Oriental and African Studies, London, 3-5 September.].

Bransford, J.D. & Franks, J.J. (1972) The abstraction of linguistic ideas: a review. Cognition, 1: 211-249.

Brooks, L.R. (1968) Spatial and verbal components of the act of recall. Canadian Journal of Psychology, 22: 349-368.

Brown, A.L. & Scott, M.S. (1971) Recognition memory for pictures in preschool children. Journal of Experimental Child Psychology, 11: 401-412.

Brown, R. (1958) Words and things. Glencoe, Ill.: The Free Press.

Bugelski, B.R. (1970) Words and things and images. American Psychologist, 25: 1002-1012.

Burling, R. (1964) Cognition and componential analysis: God's truth or hocus-pocus? American Anthropologist, 66: 20-28.

Campbell, F.W. & Robson, J.G. (1968) Application of Fourier analysis to the visibility of gratings. The Journal of Physiology, 197: 551-566.

Carpenter, G.C. & Stechler, G. (1967) Selective attention to mother's face from week 1 through week 8. Proc., 75th annual convention, American Psychological Association, 153-154.

Cavanagh, J.P. (1975) Two classes of holographic processes realisable in the neural realm. In T. Storer & D. Winter (eds.) Formal aspects of cognitive processes. Berlin: Springer-Verlag, 14-40.

Clark, E.V. (1973) What's in a word? On the child's acquisition of semantics in his first language. In T.E. Moore (ed.) Cognitive development and the acquisition of language. New York: Academic Press, 65-110.

—— (1974) Some aspects of the conceptual basis for first language acquisition. In R.L. Schiefelbusch & L.L. Lloyd (eds.) Language perspectives - acquisition, retardation and intervention. London: Macmillan, 105-128.

Cooper, L.A. & Shepard, R.N. (1973) Chronometric studies of the rotation of mental images. In W.G. Chase (ed.) Visual information processing. New York: Academic Press, 75-176.

Cornsweet, T.N. (1970) Visual perception. New York: Academic Press.

de Groot, A. (1965) Thought and choice in chess. The Hague: Mouton.

De Mauro, T. (1967) Ludwig Wittgenstein: His place in the development of semantics. Dordrecht: Reidel.

Dennis, I., Hampton, J.A. & Lea, S.E.G. (1973) New problem in concept formation. Nature, 243: 101-102.

Dixon, R.M.W. (1971) A method of semantic description. In D.D. Steinberg & L.A. Jakobovits (eds.) Semantics: An interdisciplinary reader in philosophy, linguistics and psychology. London: Cambridge University Press, 436-471.

Dixon, R.M.W. (1972) The Dyirbal language of North Queensland. London: Cambridge University Press.

Dodwell, P.C. (1970) Visual pattern recognition. New York: Holt, Rinehart & Winston.

Eberle, R.A. (1970) Nominalistic systems. Dordrecht: D. Reidel.

Entwisle, D.R. & Huggins, W.H. (1973) Iconic memory in children. Child Development, 44: 392-394.

Evans, C.R. (1965) Some studies of pattern perception using a stabilised retinal image. British Journal of Psychology, 56: 121-133.

Farwell, C.B. (1973) The language spoken to children. Papers and Reports on Child Language Development [Stanford University], 5: 31-62.

Fodor, J.A. (1968) Psychological explanation. New York: Random House.

—— (1971) The ontogenesis of the problem of reference: a review of some theories of linguistic symbols. In C.E. Reed (ed.) The learning of language. New York: Appleton-Century-Crofts, 333-362.

Fong, P. (1969) Brain memory and ferroelectric recording mechanism. Physiological Chemistry & Physics, 1: 24-41.

Franks, J.J. & Bransford, J.D. (1971) Abstraction of visual patterns. Journal of Experimental Psychology, 90: 65-74.

Friedrich, P. (1970) Shape in grammar, Language, 46: 379-407.

Frost, N. (1971) Clustering by visual shape in the free recall of pictorial stimuli. Journal of Experimental Psychology, 88: 409-413.

Gabor, D. (1972) Holography, 1948-1971. Science, 177: 299-313.

Galton, F. (1883) Inquiries into human faculty and its development. London: Macmillan.

Garner, W.R. (1970) Good patterns have few alternatives. American Scientist, 58(1): 34-42.

Gazzaniga, M.S. (1975) Brain mechanisms and behavior. In M.S. Gazzaniga & C. Blakemore (eds.) Handbook of psychobiology. New York: Academic Press, ch. 19, 565-590.

Geschwind, N. (1970) The organisation of language and the brain. Science, 170: 940-944.

Gibson, E.J. (1969) Principles of perceptual learning and development. New York: Appleton-Century-Crofts.

Goldmeier, E. (1972) Similarity in visually perceived forms. Psychological Issues, VIII(1), Monogr. 29. [English translation of Goldmeier, E. (1936) Über Ähnlichkeit bei gesehenen Figuren. Psychologische Forschung, 21: 146-208.

Goldstein, A.G. & Chance, J.E. (1971) Visual recognition memory for complex configurations. Perception & Psychophysics, 9: 237-241.

Gomulicki, B.R. (1953) The development and present status of the trace theory of memory. British Journal of Psychology: Monograph Supplement, XXIX: 1-94.

Goodenough, W.H. (1956) Componential analysis and the study of meaning. Language, 32: 195-216.

Goodman, N. (1966) The structure of appearance. Indianapolis: Bobbs-Merrill [1st edition, 1951.].

Greenfield, P.M. (1973) Who is "Dada"?: some aspects of the semantic and phonological development of a child's first words. Language and Speech, 16: 34-43.

Griffiths, P.D. & Atkinson, M. (in press) A 'door' to verbs. In N. Waterson & C. Snow (eds.) Development of communication: social and pragmatic factors in language acquisition. London: Wiley.

——, Atkinson, M. & Huxley, R. (1974) Project report. Journal of Child Language, 1: 157-158.

Halliday, M.A.K. (1975) Learning how to mean: explorations in the development of language. London: Edward Arnold.

Handel, S., De Soto, C.B. & London, M. (1968) Reasoning and spatial representations. Journal of Verbal Learning and Verbal Behavior, 7: 351-357.

Harré, R. (1961) Theories and things. London: Sheed & Ward.

Harrison, B. (1972) Meaning and structure: an essay in the philosophy of language. New York: Harper & Row.

Heider, E.R. (1971) "Focal" color areas and the development of color names. Developmental Psychology, 4: 447-455.

—— (1972) Universals in color naming and memory. Journal of Experimental Psychology, 93: 10-20.

——, & Olivier, D.C. (1972) The structure of the color space in naming and memory for two languages. Cognitive Psychology, 3: 337-354.

Julesz, B. & Pennington, K.S. (1965) Equidistributed information mapping: an analogy to holograms and memory. Journal of the Optical Society of America, 55: 604.

Karmel, B.Z. & Maisel, E.B. (1975) A neuronal activity model for infant visual perception. In L.B. Cohen & P. Salapatek (eds.) Infant perception: from sensation to cognition. Vol. I. Basic visual processes. New York: Academic Press, ch. 2, 77-131.

Katona, G. (1940) Organising and memorising. New York: Columbia University Press.

Katz, J.J. & Fodor, J.A. (1963) The structure of a semantic theory. Language, 39: 170-210.

Kirkpatrick, E.A. (1891) How children learn to talk - A study in the development of language - Children's vocabularies. Science, 18(451): 175-176.

Kotarbinska, J. (1960) On ostensive definitions. Philosophy of Science, 27: 1-22.

Leibowitz, H.W. & Harvey, L.O. Jr. (1973) Perception. Annual Review of Psychology, 24: 207-240.

Levy, J. (1969) Possible basis for the evolution of lateral specialisation in the human brain. Nature, 224: 614-615.

Lewis, D. (1972) General semantics. In G. Harman & D. Davidson (eds.) Semantics of natural language. Dordrecht: Reidel.

Lewis, M.M. (1963) Language, thought and personality in infancy and childhood. London: Harrap.

Longuet-Higgins (1968) Holographic model of temporal recall. Nature, 217: 104.

Lounsbury, F.G. (1956) A semantic analysis of the Pawnee kinship usage. Language, 32: 158-194.

Luria, A.R. (1969) The mind of a mnemonist. London: Johnathan Cape.

Lyons, J. (1963) Structural semantics: an analysis of part of the vocabulary of Plato. Oxford: The Philological Society.

—— (1966) Towards a "notional" theory of the "parts of speech". Journal of Linguistics, 2: 209-236.

—— (1968) Introduction to theoretical linguistics. London: Cambridge University Press.

McCarthy, D. (1954) Language development in children. In L. Carmichael (ed.) Manual of child psychology (2nd edition). New York: Wiley, 492-630.

Macourdy, J.T. (1928) Common principles in psychology and physiology. London: Cambridge University Press.

Mackie, J.L. (1976) Problems from Locke. Oxford: Clarendon Press, ch. 4, 107-139.

Macnamara, J. (1971). Parsimony and the lexicon. Language, 47: 359-374.

McNeill, N.B. (1972) Colour and colour terminology. Journal of Linguistics, 8: 21-33.

Major, D.R. (1906) First steps in mental growth. New York: Macmillan.

Milner, P.M. (1971) Physiological psychology. London: Holt, Rinehart & Winston.

Nelson, K. (1973) Structure and strategy in learning to talk. Monographs of the Society for Research in Child-Development, 38, Nos. 1-2 (Serial No. 149).

—— (1974) Concept, word, and sentence: interrelations in acquisition and development. Psychological Review, 81: 267-284.

Nida, E.A. (1951) A system for the description of semantic elements. Word, 7: 1-14.

Paivio, A. & Csapo, K. (1973) Picture superiority in free recall: imagery or dual coding. Cognitive Psychology, 5: 176-206.

Pastore, N. (1971) Selective history of theories of visual perception: 1650 - 1950. New York: Oxford University Press.

Penfield, W. (1959) The interpretive cortex. Science, 129: 1719-1725.

Penfield, W. & Roberts, L. (1959) Speech and brain-mechanisms. Princeton, New Jersey: Princeton University Press.

Perez, B. (1889) The first three years of childhood. [Ed. and trans. by A.M. Christie.] London: Swan Sonnenschein.

Pillsbury, W.B. & Meader, C.L. (1928) The psychology of language. New York: D. Appleton & Co.

Pollen, D.A., Lee, J.R. & Taylor, J.H. (1971) How does the striate cortex begin the reconstruction of the visual world? Science, 173: 74-77.

Pompi, K.F. & Lachman, R. (1967) Surrogate processes in the short-term retention of connected discourse. Journal of Experimental Psychology, 75: 143-150.

Pribram, K.H. (1969) The neurophysiology of remembering. Scientific American, 220: 73-86.

Putnam, H. (1970) Is semantics possible? In H. Putnam (ed.) Mind, language and reality: philosophical papers, vol. 2, London: Cambridge University Press, 1975, 139-152.

Pylyshyn, Z.W. (1973) What the mind's eye tells the mind's brain: a critique of mental imagery. Psychological Bulletin, 80: 1-24.

Quine, W.V.O. (1960) Word and object. Cambridge, Mass.: MIT Press.

Reich, P.A. (1976) The early acquisition of word meaning. Journal of Child Language, 3: 117-123.

Reiff, R. & Scheerer, M. (1959) Memory and hypnotic age regression. New York: International Universities Press.

Robson, J.G. (1975) Receptive fields: neural representation of the spatial and intensive attributes of the visual image. In E.C. Carterette & M.P. Friedman (eds.) Handbook of perception. Vol. 5. Seeing. New York: Academic Press, ch. 4, 81-116.

Rock, I. & Engelstein, P. (1959) A study of memory for visual form. American Journal of Psychology, 72: 221-229.

——, Halper, F. & Clayton, T. (1972) The perception and recognition of complex figures. Cognitive Psychology, 3: 655-673.

—— & Harris, C.S. (1967) Vision and touch. Scientific American, 216: 96-104.

Romney, A.K. & D'Andrade, R.G. (1964) Cognitive aspects of English kin terms. In A.K. Romney & R.G. D'Andrade (eds.) Transcultural studies in cognition. American Anthropologist, 66, Part 2, No. 3: 146-170.

Rosch, E.H. (1973a) On the internal structure of perceptual and semantic categories. In T.E. Moore (ed.) Cognitive development and the acquisition of language. New York: Academic Press, 111-144.

—— (1973b) Natural categories. Cognitive Psychology, 4: 328-350.

—— (1975) Cognitive representations of semantic categories. Journal of Experimental Psychology, 104: 192-233.

—— & Mervis, C.B. (1975) Family resemblances: studies in the internal structure of categories. Cognitive Psychology, 7: 573-605.

Sackett, G.P. (1963) A neural mechanism underlying unlearned, critical period, and developmental aspects of visually controlled behavior. Psychological Review, 70: 40-50.

Saltz, E., Soller, E. & Sigel, I.E. (1972) The development of natural language concepts. Child Development, 43: 1191-1202.

Shepard, R.N. (1967) Recognition memory for words, sentences, and pictures. Journal of Verbal Learning and Verbal Behavior, 6: 156-163.

—— & Feng, C. (1972) A chronometric study of mental paper folding. Cognitive Psychology, 3: 228-243.

—— & Metzler (1971) Mental rotation of three-dimensional objects. Science, 171: 701-703.

Standing, L., Conezio, J. & Haber, R.N. (1970) Perception and memory for pictures: single-trial learning of 2500 visual stimuli. Psychonomic Science, 19: 73-74.

Staniland, H. (1973) Universals. London: Macmillan.

Stern, G. (1932) Meaning and change of meaning. Göteborgs Högskolas Årsskrift, 38: ch. IV.

Stratton, G. (1917) Mnemonic feat of the 'Shass Pollak'. Psychological Review, 24: 244-247.

Stromeyer, C.F. III & Psotka, J. (1970) The detailed texture of eidetic images. Nature, 225: 346-349.

Stross, B. (1973) Acquisition of botanical terminology by Tzeltal children. In M.S. Edmondson (ed.) Meaning in Mayan languages. The Hague: Mouton, 107-141.

Thomson, J. & Chapman, R.S. (1975) Who is 'Daddy'? (Revisited): The status of two-year-olds' overextensions in production and comprehension. Papers and reports on child language development, 10: 59-68.

Titchener, E.B. (1909) Lectures on the experimental psychology of the thought-processes. New York: Macmillan.

Tracy, F. (1893) The language of childhood. American Journal of Psychology, 6: 107-138.

Tulving, E. (1972) Episodic and semantic memory. In E. Tulving & W. Donaldson (eds.) Organisation of memory. New York: Academic Press, ch. 10, 381-403.

Ullmann, S. (1962) Semantics: An introduction to the science of meaning. Oxford: Basil Blackwell & Mott.

Uttal, W.R. (1975) An autocorrelation theory of form detection. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Vernon, M. (1967) Relationship of language to the thinking process. Archives of General Psychiatry, 16: 325-333.

Wallace, A.F.C. & Atkins, J. (1960) The meaning of kinship terms. American Anthropologist, 62: 58-80.

Weinreich, U. (1962) Lexicographic description in descriptive semantics. In F.U. Householder & S. Saporta (eds.) Problems in Lexicography. International Journal of American Linguistics, 28: 25-43.

——— (1966) Explorations in semantic theory. In T.A. Sebeok (ed.) Current trends in linguistics, Vol. 3. The Hague: Mouton.

Winston, P. (1973) Learning to identify toy block structures. In R.L. Solso (ed.) Contemporary issues in cognitive psychology: the Loyola Symposium. Washington, D.C.: V.H. Winston & Sons, 3-16.

Woodworth, R.S. (1906) Imageless thought. The Journal of Philosophy, Psychology and Scientific Method, III: 701-708.

Appendix: vocabularies of nominals used by three children (G, J and K) in successive periods

The age range spanned in each period is shown in the sub-headings. Within each period, items are divided into five adult-oriented classes: ARTEFACTS, PEOPLE, FOOD, ANIMALS and BODY PARTS. This results in a few violations of categories, e.g., flowers is listed under ARTEFACTS. Lexemes are identified by a representation of the most common form of their tokens. These are usually related adult forms or nursery forms with wide currency. Phonetic representations, distinguished by square brackets, are used when no familiar related form could be found. Sometimes spellings offered by the children's parents have been resorted to. Descriptions of members of the denotation class of a given lexeme, attested in a given period, appear to the right of the representation of that lexeme. These descriptions are rigorously separated by commas, and commas have been avoided within descriptions. Where more tokens than one (of the formal type/s associated with a given lexeme) were, in a given period, applied to an entity covered by a description, the number of tokens, n, is indicated by xn after the description. Descriptions of entities which seem, by fairly lax adult standards, not to belong in a given denotation class are preceded by an asterisk. A question mark is used before descriptions of entities about whose identity there is some doubt. Attestations taken from questionnaires completed by the mother's of the children are preceded by Q:. P is an abbreviation for "picture of". Toys and other articles belonging to the research project are specified by the abbreviation pr. Thus

nana pr P partly-peeled banana on a plate x3, Q: *carrot, *? P apple

means that, during the period concerned, the child three times applied tokens associated with the lexeme identified by the nursery form nana to a picture, belonging to the research project, of a partly-peeled banana on a plate; that the child's mother noted, in a questionnaire entry, the application of nana to a carrot and that I have a dubious record of a picture of an apple being called nana by the child. Furthermore, the notation indicates that the latter two uses seem deviant to me.

Representations of the lexemes for any particular period are listed in approximately the order in which their related tokens were first attested. The caveat is required because I have not distinguished order within any given week and because I have, very occasionally, moved related items into adjacency. Lexemes are carried over into successive periods regardless of whether or not associated tokens have again been observed. The absence of denotation-class descriptions indicates that there were no relevant attestations in that period. Descriptions of denotation class members of a lexeme in a given period appear in roughly the order in which application of tokens of the form was attested in that period. Here the qualification arises because order of attestation within a given week was ignored and because temporally separated cases have been amalgamated through the use of the 'xn' notation.

G. 1;1 5/6 - 1;6, inclusive

ARTEFACTS: nil

PEOPLE:

Lee Q: his sister

Santa Q: Santa Claus

Grandad Q: his grandfather

FOOD:

juice Q: said when he wants a drink

ANIMALS: nil

BODY PARTS: nil

G. 1;6 1/5 - 1;8 5/6, inclusive

ARTEFACTS:

choo choo Q: his toy train, pr P toy train

shoes Q: shoes, pr P child's red lace-up shoes x5

car Q: cars x3, pr toy blue VW car x5, pr P two-tone drophead coupé, wanting to see P car in pr picture book x4, *pr toy London bus

bus Q: bus

door Q: door

flowers Q: flowers, Q: *trees

[ʃ:, ingressive] pr microphone

birdie *aircraft heard overhead

PEOPLE:

Lee Q: his sister

G. 1;6 1/5 - 1;8 5/6, inclusive (cont.)

PEOPLE: (cont.):

Santa

Grandad

Terry Q: a friend of his

Jean Q: Jean

Andrew Q: Andrew

Mummy Q: his mother x6, his mother x52

Lesley Q: his cousin

Malcolm Q: his uncle

Daddy Q: his father x3

baby Q: said when he sees a pram x2

girl Q: girls generally

FOOD:

juice Q: pointing to bottles

cheese Q: cheese x2

tea Q: *drinks and food

ANIMALS:

Susie Q: a friend's dog

teddy pr P yellow teddy bear, *pr P toy panda x2, *pr P yellow plastic duck x6

[lateral clicks] pr plastic horse, *pr plastic bull

BODY PARTS:

toes Q: his own toes

G. 1;9 1/6 - 2;1, inclusive

ARTEFACTS:

choo choo pr toy bricks pushed along in a line x5, pr toy train x24, wanting to see pr toy train x2, pr P toy train x 24, *pr toy jeep x2, *pr P toy ocean liner. After 1;11 2/5 G had a distinct noise to accompany play with toy trains.

train Q: train, pr toy train x11

shoes Q: shoes in shops x2, pr P child's red strap and button shoes x3, Martin Atkinson's boot x3, his sister's new shoes x7, pr doll's shoes x3, Q: his father's shoes

car Q: his toy car, Q: a friend's toy car, Q: his grandfather's car, Q: car x2, pr toy jeep x7, pr toy blue VW car x11, rummaging through pr toys wanting a car, pr P car in relief outline on plastic beaker x19, hunting through pr plastic beakers for one with P car x18, pr P two-tone drophead coupé x13, pr P red saloon in street scene x6, unidentified P cars, leafing through pr picture books in search of P car x43, *pr P younger child's tricycle, *pr P toy ocean liner, *pr P yellow lorry x2

lorry Q: lorry

bike pr P bicycle with rider in street scene x5, pr P older child's tricycle

bus pr toy London bus x60, Q: bus, toy minibus

door evoked by hearing knock on the front door

flower pr P flower in relief outline on plastic beaker, pr P schematic flowerheads on eaves of a toy house, pr P yellow flowerhead with butterfly on it

[ʃ:, ingressive] pr microphone

birdie

trees Q: trees, pr P trees in park

tractor Q: tractor, pr P large toy tractor being driven by a little boy x6

bath Q: ?object or event x2

tea pr P teacup and saucer in relief outline on plastic beaker x3, empty teacup x3, *pr P empty saucepan with lid leaning against it. Cf. FOOD.

G. 1;9 1/6 - 2;1, inclusive (cont.)

ARTEFACTS (cont.):

spoon Q: spoon, pr P top view of teaspoon x3, pr P almost side view of teaspoon x5, real teaspoon x7, wanting and receiving teaspoon to prise open pr animal tin x25

bib Q: bib

cup Q: cup

clock Q: clock, pr P alarm clock x2, pr P wall clock in a nursery school scene

bed Q: his sister's bunk bed, Q: his own bunk bed

cot pr P cot x3

ball pr P bright beach ball, another pr P bright beach ball, pr yellow ball with holes

jug Q: jug

daa Q: ceiling lights

bubble Q: hot soapy water in a bucket

book Q: book, pr phonetician's notebook, pr picture books x6

pillow Q: pillow

dress Q: dress

cover Q: his personal comforter blanket

cigarette Q: cigarette

gun Q: toy gun

cook pr doll's cook x5

garage Q: his new toy service station

top tops of pr skittles x5

sponge Q: bathroom sponge

towel Q: towel

soap Q: soap

stick pr plastic cookcoper's meatstick

G. 1;9 1/6 - 2;1, inclusive (cont.)

ARTEFACTS (cont.):

bobbles Q: his sister's elasticised hair-retainer

PEOPLE:

Lee his sister x7, Q: his sister x2

Santa

Grandad Q: his grandfather

Terry

Jean

Andrew

Mummy his mother x166, Q: his mother x4

Lesley

Malcolm his uncle

Daddy Q: his father x2, *pr P man, ?

baby pr P little girl looking at a book, minute and blurred pr P baby in pram in background of a street scene, Q: baby x3, pr P little girl, pr doll x5

girl Q: *big boys and girls, Q: girl

Helen Q: Helen

Lorna Q: a friend of his

Ella Q: his grandmother, *exclamation of pleasure x6

Irene Q: Irene

Derek *Patrick Griffiths, a friend of his called Derek

G. Q: his own name x2

Ralston Q: a friend of his

man pr plastic zookeeper x12

G. 1;9 1/6 - 2;1, inclusive (cont.)

FOOD:

juice pr P red liquid being drunk through straws from glasses by two children x2, *pr P water jars being used to dip brushes by children painting x2, *pr orange coloured plastic beaker, *Martin Atkinson's mug of coffee x3

cheese Q: cheese

tea *pr P red enamel mug of milk x5, pr P white mug containing tea-coloured liquid x3, Q: tea. Cf. ARTEFACTS.

tatoes Q: potatoes being prepared for cooking

nana pr P partly-peeled banana on a plate

cream Q: ice cream

egg pr P egg in egg-cup on plate x10

soup Q: soup

cake Q: cake

sweeties Q: sweets

syrup Q: wanting syrup on his bread

jam Q: wanting jam on his bread

ANIMALS:

Sunie

teddy pr P teddy bear in relief outline on plastic beaker x2, pr P yellow teddy bear x4, looking through the book for this P teddy bear, *pr P toy panda, *pr P floppy rag doll, *pr P baby doll in a pram, *pr plastic chimpanzee x3

/lateral clicks/ two pr plastic horses x5, *pr P plastic cow x3

dog Q: dog, pr P white Scottish terrier, *pr plastic horse x4, *pr plastic bull x3, *pr plastic sheep x2, *pr plastic cow x8, *pr P toy panda, *pr P front half of a cat, pr P beagle's head

cow Q: cow x2, pr plastic cow x16, *pr plastic horses x5

pussy pr P cat in relief outline on plastic beaker x5

sheep pr plastic sheep x16

G. 1;9 1/6 - 2;1, inclusive (cont.)

ANIMALS (cont.):

duck pr P yellow plastic duck x7

BODY PARTS:

toes

teeth Q: teeth

tum belly of plastic horse

G. 2;1½ - 2;2 5/6, inclusive

ARTEFACTS:

choo choo stationary line of pr toy bricks, pr toy trains

train pr toy trains x7

shoes pr P shoe in relief outline on plastic beakers x4, Q: his father's shoes, pr doll's shoes x3, pr P child's red lace-up shoes

car pr toy jeep x19, pr P car in relief outline on plastic beaker x19; hunting through pr beakers for one with P car x6, P car drawn by Martin Atkinson x3, his own toy limousine x8, another of his own toy cars, *pr toy train

lorry

bike

bus P bus drawn by Martin Atkinson, pr toy London bus x4, looking through toys for this bus

door Q: door

flowers *pr P tree in relief outline on plastic beaker, pr P daisies

[ʃ:, ingressive]

birdie Cf. ANIMALS.

trees

tractor

C. 2;1½ - 2;2 5/6, inclusive (cont.)

ARTEFACTS (cont.):

bath Q: bath

tea Cf. FOOD.

cup

spoon pr P top view of teaspoon

bib Q: bib

clock pr P clock in relief outline on plastic beaker, pr P alarm clock, *his father's watch

bed Q: bed

cot

ball Q: ball

jug

light Q: light, Q: lights on Christmas tree

bubble

book

pillow

dress

cover Q: his personal comforter blanket

cigarette

gun

sock pr doll's sock x2

garage pr tin on its side used as garage for toy cars x3, *pr plastic beaker with P car used to hide plastic zookeeper, garage built of pr toy bricks for toy cars x12, wanting a garage built of pr toy bricks x4, *pr P house in relief outline on plastic beaker x6, as he runs pr toy jeep / perhaps wanting a garage / x3

top

sponge

G. 2;11 - 2;2 5/6, inclusive (cont.)

ARTEFACTS (cont.):

towel

soap

stick

bobbles

phone Q: his parents' telephone x2, pr white toy telephone x6, pr P light blue telephone, telephone heard ringing in adjacent room

coat Q: coat

pennies Q: pennies, coin used to prise open pr animal tin, pr plastic pennies x2

pram Q: pram, Q: his sister's toy pram

brush pr plastic zookeeper's broom x2

scooter Q: his sister's toy scooter

pens Q: his mother's pens

cooker Q: cooker in the kitchen

taps Q: taps on the kitchen sink

house pr P house in relief outline on plastic beaker, pr P stately American colonial chamferboard house

box Q: box

fridge Q: fridge

fire Q: lounge fire

keys pr P bunch of keys

boat pr P toy ocean liner

looms pr P several inflated balloons

stairs pr P flight of steps leading to a domestic front door

G. 2;1½ - 2;2 5/6, inclusive (cont.)

PEOPLE:

Lee Q: his sister x2

Santa

Grandad

Terry

Joan

Andrew

Mummy Q: his mother x3, his mother x18

Lesley

Malcolm Q: his uncle

Daddy Q: his father x8, his father x2

baby Q: baby, smallest of a family of Russian 'babushka' nesting dolls, Q: his sister's doll, *pr P top third of a little girl looking through a large window

girl

Helen

Lorna

Ella

Irene

Derek

G. his own name x4, Q: his own name

Ralston

cream man Q: ice cream seller

man pr plastic sockeoper x4, pr 'chairoplane' figure x2

Anne Q: Anne

G. 2;1½ - 2;2 5/6, inclusive (cont.)

FOOD:

juice

cheese

tea Q: tea

tatoes Q: potatoes

nana

cream

eggs pointing at one in pr P three eggs

soup Q: soup

cake

sweeties

syrup

jam

chips Q: potato chips

[dada] [considerable vocalic variation] biscuit x11

orange Q: orange

playpiece Q: snack packed for his sister to take to nursery school

chicken Q: cooked chicken

apple pr P large red apple

ANIMALS:

Suzie

teddy pr P teddy bear in relief outline on plastic beaker, *pr dog glove-puppet

[lateral clicks] as he walks various pr plastic animals

doggy *pr P elephant in relief outline on plastic beaker

G. 2;1½ - 2;2 5/6, inclusive (cont.)

ANIMALS (cont.):

cow pr plastic cows x9, *pr plastic bull x2, *pr plastic horse x2

puss pr P fluffy white rabbit seen from the front and above

sheep pr plastic sheep x5

duck

horse pr plastic horse x5, *pr plastic cow

hippo Q: P hippopotamus

birdie pr P parrot

BODY PARTS:

toes

teeth Q: teeth

tum

knee Q: knee

nose pr plastic elephant's trunk

G. 2;3 1/6 - 2;6 1/6, inclusive

ARTEFACTS:

choo choo pr P toy train x2

train line of pr bricks x2, pr P toy train x3

shoes Q: his own shoes x2, pr P shoe in relief outline on plastic beaker, pr P child's red lace-up shoes x3, pr P child's red strap and button shoes x2

car pr P car in relief outline on plastic beaker x14, sorting through beakers to find one with car x4, pr toy jeep x6, pr P two-tone drophead coupé, pr P car in street scene

lorry pr P - rough painting - toy lorry on cupboard shelf in a nursery school scene

bike pr P child riding a tricycle x3, pr P man on bicycle in street scene, *pr P parked motor scooter, pr P older child's tricycle x2

G. 2;3 1/6 - 2;6 1/6, inclusive (cont.)

ARTEFACTS (cont.):

bus pr toy London bus x18

door

flowers pr P daisies

/ʃ:, ingressive/

birdie

trees

tractor pr P large toy tractor being driven by a little boy x3

bath

tea

cup pr P teacup and saucer in relief outline on plastic beaker

spoon pr P almost side view of teaspoon x3

bib

clock Q: *his father's watch, pr P wall clock in nursery school scene, pr P clock in relief outline on plastic beaker x4, pr P alarm clock x2

bed Q: bed x3

bunk Q: bunk bed

cot pr P cot

ball pr P bright beach ball x4, *pr P red apple on a plate, pr yellow ball with holes

jug

lights Q: ceiling lights x4

bubble

book

pillow

dress

G. 2;3 1/6 - 2;6 1/6, inclusive (cont.)

ARTEFACTS (cont.):

cover Q: his personal comforter blanket

cigarette

gun

cook

garage garage built of pr toy bricks x19, towers built with pr toy bricks x13, wanting a garage to be built of pr toy bricks x7

top

sponge

towel

soap

stick

bobbles

phone pr red toy telephone, pr P light blue telephone, pr white toy telephone x4

coat Q: his own coat

penny pr plastic pennies x24, wanting and receiving coins to prise open animal tin and base of pr toy telephone x6

pram Q: pram x2

brush pr plastic zookeeper's broom x11, pr P broad paintbrush beside paint tin

scooter

pens

cooker

house pr P house in relief outline on plastic beaker x5, pr P stately American colonial chamferboard house

box pr P wooden box containing a rabbit, pr cardboard box for pr toy bricks x2

C. 2;3 1/6 - 2;6 1/6, inclusive (cont.)

ARTEFACTS (cont.):

fridge

fire Q: lounge fire

key pr P bunch of keys, real bunch of keys

boat

loons pr P several inflated balloons

stairs

dishes Q: dishes

anorak Q: his sister's anorak

toilet Q: lavatory bowl x2

toys Q: his own toys x2

tin pr animal tin x3

road Q: road

pants Q: pants x2

ambulance Q: ambulance x2

paper Q: paper

bricks pr P stack of toy plastic bricks embossed with letters

window window holes in pr toy London bus

washing machine Q: washing machine

party Q: children's party

taxi Q: taxi

crane roughly painted pr P toy crane on cupboard shelf in nursery school scene

nursery Q: his sister's nursery school

hat Ronira Huxley's hat x2, pr plastic zookeeper's cap

candle Q: candles used during power cuts x3

G. 2;3 1/6 - 2;6 1/6, inclusive (cont.)

ARTEFACTS (cont.):

case Q: ?suitcase

glove pr P pair of red mittens x2

scissors pr P shears hanging on wall in workshop scene

brolla pr P open umbrella

spade pr P beech spade lying in sand beside a child's bucket

stone Q: stone

shirt Q: shirt

PEOPLE:

Lee Q: his sister x10

Santa

Grandad

Terry

Jean

Andrew

Mummy Q: his mother x6, his mother x80, *pr 'chairoplane' figure x2

baby

Malcolm

Daddy Q: his father x8, his father x19, *pr P man, *pr 'chairoplane' figure x4

baby his sister's doll, pr P baby in a crib, *pr 'chairoplane' figure

girl pr P little girl sitting on a nursery school chute, pr P of 2 girls and a boy playing, Q: girl, pr P top third of a little girl looking through a large window

Helen

Lorna

G. 2;3 1/6 - 2;6 1/6, inclusive (cont.)

PEOPLE (cont.):

Ella

Irene

Derek

G. Q: his own name x14, his own name x12

Ralston

cream man

man pr plastic zookeeper x14, pr 'chairoplane' figure x3, pr P milkman

Anne

dollies his sister's dolls, roughly painted pr P dolls on cupboard shelf in a nursery school scene, pr doll x2

uncle Q: ?his uncle Malcolm

Yvonne Q: a friend of his

Pauline *Renira Huxley. Pauline Ford was the pr phonetician

Alan Q: a friend of his x2

Alan's Mummy Q: Alan's mother

Martin Martin Atkinson

Bunty his sister's doll x4

FOOD:

juice pr P liquid being drunk through straws from glasses by two children x2

cheese

tea

tatoes

nana pr P partly-peeled banana on a plate

cream

G. 2;3 1/6 - 2;6 1/6, inclusive (cont.)

FOOD (cont.):

egg Q: egg, pr P egg in egg-cup on plate x3

soup Q: soup

cake

sweeties

syrup

jam

chips

biscuit

orange pr P partly-sliced orange on a plate

playpiece

chicken

apple pr P red apple on a plate, Q: apple

coffee Q: coffee x2

dinner Q: plates of food at table x2

medicine Q: medicine x3

toast Q: toast x3

bread Q: bread

bridie Q: Cornish pasty

marmalade Q: marmalade

water Q: water

ANIMALS:

Susie

teddy pr P yellow teddy bear, *pr P toy panda x2, *pr P yellow plastic duck, pr P teddy bear in relief outline on plastic beaker x5, pr P teddy bear in a bedroom scene

G. 2;3 1/6 - 2;6 1/6, inclusive (cont.)

ANIMALS (cont.):

[lateral clicks] as he walks pr plastic cow and sheep and horse and calf

doggy

cow *pr plastic animals, pr plastic cows x18, *pr plastic bull, *pr plastic calf

puss pr P red spotted upside-down cat drawn by child in nursery school scene, pr P cat in relief outline on plastic beaker x4, *pr P rabbit in relief outline on plastic beakers x3, *pr P fluffy white rabbit seen from front and above x2, *pr P top half of snowy owl, pr P cat in domestic scene, P cat

puss cat pr P cat in relief outline on plastic beaker

cat pr P cat in relief outline on plastic beaker

sheep pr plastic sheep x7

duck pr P yellow plastic duck x4, Q: duck x2

horse various pr plastic horses x9

hippo

birdie

monkey pr plastic chimpanzee x17

calf pr plastic calf x15

[tandʌd]~[datʰant] pr P elephant in relief outline on plastic beaker x2

fish Q: fish

BODY PARTS:

toes

tum

knee

nose

hair Q: his own

G. 2;3 1/6 - 2;6 1/6, inclusive (cont.)

BODY PARTS (cont.)

head pr plastic zookeeper's head x4

tongue Q: tongue

J. 1;9 - 1;10 2/5, inclusive

ARTEFACTS:

car Q: car

book Q: book

keys Q: keys

shoes Q: shoes

door Q: door *

hot Q: used of oven and food etc.

bye bye Q: his toy telephone

PEOPLE:

Mummy Q: his mother x2

Aunty Q: Aunt Dilys

baby Q: baby

Daddy Q: his father x2

Pippa Q: his sister

boy Q: boy x3

FOOD:

marmite Q: 'marmite', Q: *peanut butter

sweets Q: sweets

J. 1;9 - 1;10 2/5, inclusive (cont.)

ANIMALS:

Olly Q: name of family cat, Q: *dogs, Q: *sheep, Q: *birds

miaow Q: P cat

woof Q: battery-powered walking and woofing toy dog, Q: dogs

BODY PARTS: nil

J. 1;10 2/3 - 2;0, inclusive

ARTEFACTS:

car Q: cars x2, pr P two-tone drophead coupé

book pr picture books x11, pr drawing pad, Q: book x2

keys

shoes shoes on boy in P boy x7, *kitten's feet in P kitten x4, pr P child's red strap and button shoes x4, Q: doll's shoes on a doll, Q: his own shoes

door

door Q: drawing-pins

bin Q: drawing pin

hot *pr microphone after holding it to his face like an electric shaver x2, *bung in base of pr toy telephone, *pr microphone mixer x3

bye bye pr microphone after being shown that it is for talking into x3, pr toy telephone x12

box Q: large cardboard box

boat Q: what he is pretending large cardboard box to be

bed Q: bed

sweeties *pile of matches which he has dropped from a matchbox x4, *pr crayons strewn on floor, *pr P bright multi-coloured toy train x4. Cf. FOOD.

knekit Q: musical box

J. 1;10 2/3 - 2;0, inclusive (cont.)

ARTEFACTS (cont.):

mess Q: mess on his highchair after lunch

money Q: money, pr plastic pennies x8

bell Q: doorbell button

spoon Q: spoon

paper Q: writing paper and letters

watch Q: wristwatch

gate Q: gate x2

coat Q: coat x4

cup pr P white china mug with cartoon P ducks containing brown liquid x2

chair pr armchair minus seat and back cushions x4, Q: chair

water Q: water

clock Q: clock

light Q: the moon

PEOPLE:

Mummy Q: his mother x6

Andie Q: Aunt Dilys

baby Q: P baby on talcum powder container, Q: baby

Daddy Q: his father

Pippa Q: his sister x4

boy Q: boy x3, P little boy x4, ?himself x3

Alasdair Q: his brother x3

Stephen Q: Stephen

Michael Q: a colleague of his mother's

man pr plastic zookeeper

J. 1;10 2/3 - 2;0, inclusive (cont.)

FOOD:

marmite Q: 'marmito'

sweeties Q: sweets. Cf. ARTEFACTS

toast Q: toast

cake Q: cake x2

milk Q: milk, Q: *any drink, Q: *sugar

apple pr P large red apple x4, *pr P two halves of an orange on a plate x2, pr P apple on a plate

juice Q: juice x2

baccy Q: coffee

tea Q: tea

biscuit Q: biscuit

ANIMALS:

Olly

miaov

woof dog drawn by Martin Atkinson, Q: dogs (live and P dogs), Q: *sheep in Holyrood Park, Q: *penguin-shaped moneybox

bear Q: koala bear, Q: *birds etc.

pussies P cats

dog P dog, Q: dog

bird Q: bird, cartoon P ducks on pr P mug x3

horse what he claims to be drawing x5, pr plastic horse x13, *pr plastic bull, looking for horse in pr animal tin x3

duck ducks on Duddingston Loch

bull *pr plastic horse

cat Q: cat

sheep Q: sheep

J. 1;10 2/3 - 2;0, inclusive (cont.)

BODY PARTS:

nose Q: nose x2

head Q: head, response to pr P child's brush and comb set, response to another pr P child's brush and comb set x4

mouth Q: mouth

eyes Q: eyes

knee Q: wanting to sit on his mother's knee

J. 2;0 1/6 - 2;2, inclusive

ARTEFACTS:

car Q: toy cars x2, pr blue toy VW car x3, pr P child's very rough painting of car in a nursery school scene x2, pr P car in relief outline on plastic beaker

book various pr picture books x31, pr drawing pad x2

keys wanting a winding key for pr toy telephone x4, bunch of door keys accepted for winding pr toy telephone x4

shoes his own shoe x6, pr P child's red strap and button shoes x7, pr doll's shoes x11, Q: his own shoe x2, red shoes on pr P cut-out paper man in a nursery school scene

door pr P open door of nursery school with children looking out x2, Q: doors in his home x3, driver's door on pr toy London bus

door/bin

hot pr P lit candle x3, *pr microphone x3. For the latter he says "It's hot".

bye bye pr red toy telephone x17, pr white toy telephone x11, pr P light blue telephone x24, pr P red telephone x6

telephone pr P red telephone x3, pr white toy telephone

box *pr animal tin, lid of cardboard box for pr toy bricks

boat Q: boat, Q: *toy crane [He saw derricks on a boat trip to Shetland.], pr P toy ocean liner x5

ship pr P toy ocean liner x3

J. 2;0 1/6 - 2;2, inclusive (cont.)

ARTEFACTS (cont.):

bed pr P cot x3 [Actually, he called it "baby bed".], Q: doll's bed, Q: *pillow

sweeties Q: *set of counting beads

wikik box Q: musical box x2

moss

money wanting and receiving coin to open pr animal tin x10, pr plastic pennies x10, Q: money x2

bell

spoon pr P almost side view teaspoon x5

paper ?, sheet of drawing paper x8

watch Q: wristwatch x2, *pr red toy telephone as he tries to wind it with door keys x4, *pr P alarm clock, *another pr P alarm clock x2, *pr P clock in relief outline on plastic beaker

gate

coat

cup

chair pr P yellow wooden upright chair with raffia seat

water response aroused by his seeing and naming pr P fish

clock *pr red toy telephone as he tries to wind it with door keys

light

house Q: his home x3, Q: drawing of a house, faint and small pr P child's painting of a house in a nursery school scene x3, pr P house in relief outline on plastic beaker

teapot Q: teapot

garage Q: garage

nose Q: *paper tissues, Q: *handkerchief. Cf. BODY PARTS.

face Q: *face-cloth. Cf. BODY PARTS.

bag Q: bag x3

J. 2;0 1/6 - 2;2, inclusive (cont.)

ARTEFACTS (cont.):

aeroplane Q: aeroplane

toys Q: toys

bricks pr P wooden toy bricks x2

garden Q: garden

anorak Q: anorak

soap Q: soap x3. Cf. FOOD.

brush pr P child's hairbrush x3, pr P toothbrush x5, *pr P comb

train Q: P railway engine, pr toy train

window Q: window

paint Q: *pens and pencils

shop Q: shop

apple *pr P bright multi-coloured beach ball, *pr P balloons, *pr P marbles. Cf. FOOD.

top Q: lid

sock pr doll's socks x6

hammer Q: hammer x2

vision Q: P TV set, Q: TV set

toilet Q: bathroom furniture for a doll's house

pencil Q: pencils, Q: *pens

rug Q: blanket

downstairs pr P flight of steps leading to a front door x5, Q: step on which he is standing

bouncy ball Q: bouncy ball

camera Q: camera

cream Q: medicinal cream

weights *pr P toy wooden bricks. There is a toy grocer's balance with weights in a nursery school he often visits.

J. 2;0 1/6 - 2;2, inclusive (cont.)

ARTEFACTS (cont.):

lorry pr P yellow lorry

bus pr toy London bus x6

drawings pr P crayons and scribbles

bin Q: wastebin

dress Q: his mother's dress

thing Q: pins for hair-curlers

church Q: church buildings

marbles pr P marbles x2

PEOPLE:

Mummy Q: his mother x3, his mother x39

Andie Q: Aunt Dilys, *face of little girl in pr P nursery school scene x2

baby *pr P little girl looking at a picture book, pr doll x2, Q: doll

Daddy *pr plastic zookeeper

Pippa *pr P little girl peering from a doorway, Q: his sister x3, *pr doll, *pr P little girl in nursery school scene x2, *pr P little girl in bed, *pr P little girl looking at a picture book

boy Q: boy x3

Alasdair Q: his brother x8, *pr P little boy running, *pr P little boy in nursery school scene x2

Stephen

Michael *Martin Atkinson x8, *Patrick Griffiths x11

Star Trek man Q: character in a TV serial programme

man pr 'chairoplane' figures x6, pr plastic zookeeper x8, pr plastic zookeeper's dismembered head, pr P cut-out paper man in a nursery school scene, pr stocking doll with sombrero

Patrick Q: Patrick Griffiths, Patrick Griffiths x2

J. 2;0 1/6 - 2;2, inclusive (cont.)

PEOPLE:

Bruce Q: surname of nursery nurse at a nursery school he often visits

Derek Q: Derek

David Q: David

Kate Q: a colleague of his mother's

Mrs Innes Q: Mrs Innes x2

doll pr doll

Donald Q: Donald

Mary Hopkins Q: Mary Hopkins

FOOD:

marmite

sweeties Cf. ARTEFACTS.

toast Q: toast

cake

milk Q: milk, pr P red mug containing milk x2

apple *pr P two halves of an orange on a plate, pr P red apple on a plate. Cf. ARTEFACTS.

juice Q: juice, "orange juice" as a response to being told that a pr plastic beaker is orange [in colour]

bacey

tea

biscuit biscuit x10, wanting a biscuit x3, *pr P two halves of an orange on a plate

jelly Q: jelly

minckie Q: potato crisps

orange Q: orange, pr P orange and a slice cut from it on a plate x3, *pr P red apple on a plate, pr P two halves of an orange on a plate x7

J. 2;0 1/6 - 2;2, inclusive (cont.)

FOOD (cont.):

nana Q: banana

egg pr P egg in egg-cup x4

bacon Q: bacon

soup Q: soup

sausage Q: sausage x2

soap Q: *salt. Cf. ARTEFACTS.

chips Q: chips

dick Q: raisins

lunch Q: *any meal

honey Q: honey

pudding Q: pudding

bread Q: bread

marmalade Q: marmalade

ANIMALS:

Olly

miaow

woof

baar

pussy pr P front half of cat

dog pr P beagle's head x2, Q: real dog, *pr P side view of lion, *pr plastic chimpanzee

birds pr P parrot x2, *pr P two fish in murky water, hunting through the book in which he saw P parrot and P fish the week before x3, stylised S on pr microphone

horsies pr plastic horse x7, *pr plastic cow x5, response re empty pr animal tin x3, response re pr animal tin which he wants opened x4

J. 2;0 1/6 - 2;2, inclusive (cont.)

ANIMALS (cont.):

duck pr P yellow plastic duck x4

bull pr plastic bull

cat pr P front half of cat x19, pr P cat in relief outline on plastic beaker

sheep pr plastic sheep x17, *pr plastic cow, wanting pr plastic sheep x2, P sheep, *pr plastic elephant, *pr P elephant in relief outline on plastic beaker

tiger Q: tiger

swan Q: swan

cow pr plastic cow x3, *pr plastic bull, *pr plastic elephant x2

fish pr P two fish in murky water

rabbit pr P fluffy white rabbit seen from front and above x2, *pr P snowy owl, pr P rabbit in relief outline on plastic beaker x3

monkey pr plastic chimpanzee x3

pig Q: pig

BODY PARTS:

nose Q: his own nose, his own nose. Cf. ARTEFACTS: head

mouth his own mouth

eyes eyes on cat drawn by his mother

knee Q: wanting to sit on his mother's knee

Alasdair's face Q: P two choir boys playing cellos. Cf. ARTEFACTS.

hand Q: his own hand x4

beep pr doll's navel

hair Q: hair

feet Q: his own foot

J. 2;2¼ - 2;6 1/6, inclusive

ARTEFACTS:

car Q: toy car, Q: real car x3, pr P child's very rough painting of car in a nursery school scene x3, *pr P younger child's tricycle, pr P green sports-car in street scene, what he wants to have built with pr toy bricks x2, Q: *child's scooter in a tree, pr P car in relief outline on plastic beaker x2

book Q: book x2, *pr P children's paintings hung on wall in a nursery school scene, pr picture books x3

keys bunch of keys x10

shoe his own sandal x6, pr P child's red lace-up shoes, pr P shoe in relief outline on plastic beaker x2

door Q: doors in his home, pr P open church doors seen from inside with children entering, pr P inside view of house front door with letter falling through letterbox x2, door on house drawn by Martin Atkinson, door on house drawn by his mother x2, P door with a woman beside it

door/bin

hot Q: 'Hoover' vacuum cleaner

bye bye pr P light blue telephone x9, pr toy telephone x5, pr P red telephone being used by a little girl x3

telephone as he picks up pr picture book which contains a P telephone, pr white toy telephone, pr red toy telephone x10, pr P red telephone being used by a little girl, Q: real telephone

box Q: box for a tortoise, *pulpit containing a vicar in pr P church interior, *pr animal tin x2, pr toy-box, *two pr plastic beakers held mouth-to-mouth to conceal a smaller one, *pr P open envelope in a little girl's hand. The envelope looks rather like a wrapped parcel

boat pr P toy ocean liner x8, Q: real boat

ship

bed pr P cot x2 [He called it "baby bed" in one of these instances.], P bed in which a boy is sleeping

sweeties Cf. FOOD

music box Q: musical box

J. 2;2½ - 2;6 1/6, inclusive (cont.)

ARTEFACTS (cont.):

moss

money Q: money x2, *pr P pink letter held by a postman, wanting a coin to open pr animal tin x2

half one Q: coins

bell

spoon pr P top view of teaspoon

paper pr P twisted scrap of cut paper beside scissors x2, Q: paper

watch *wanting to see the P clock in a pr picture book x4, *pr P clock on mantelpiece x2, *pr P alarm clock x3

gate pr P open wrought-iron double gate, *pr P open church doors seen from inside with children entering x2, flat pr toy brick beside house of pr toy bricks, Q: gate

coat Q: coat x2, Q: *said "coat on" when he found a belt lying around

cup Q: his sister's cup, pr P teacup and saucer in relief outline on plastic beaker

chair Q: chair x2, *pr P backless four-legged stools in front of a table in an empty nursery school room, pr P child's low feeding chair with attached tray x4, seats in pr toy London bus

water Q: water in bath x2, Q: P water in P seaside, surf in pr P seaside x3, what surrounds duck pr P mallard x4. Cf. FOOD.

clock pr P faint outline of clock on mantelpiece in a living-room scene x2, Q: *wristwatch, P grandfather clock with a mouse running up it x5, pr P clock in relief outline on plastic beaker

light Q: light

house faint and small pr P child's painting of a house in a nursery school scene, Q: his own home x5, Q: a house passed on the street, pr P suburban bungalow, what he wants to build with pr toy bricks x2, house drawn by Martin Atkinson x3, house drawn by Renira Hurley x3, house drawn by his mother x3, pr P top two-thirds of large house projecting above trees

teapot what he says he wants to see in a pr picture book

J. 2;2½ - 2;6 1/6, inclusive (cont.)

ARTEFACTS (cont.):

garage

nose *paper tissue x2, *handkerchief. These observations were based on written notes, not on tape-recordings. Cf. BODY PARTS.

face

bag

aeroplane

toys

bricks pr toy bricks x2

garden Q: garden at his home

anorak

soap faint pr P pink bar of soap with nailbrush and other toiletries x2

brush pr P nailbrush with soap and other toiletries, pr P child's hairbrush

train pr toy train x2, pr P bright multi-coloured toy train. He also says "choo choo" on seeing this picture.

window pr P window of suburban bungalow with children looking out of it, window on house drawn by his mother x2

paint

shop Q: any shop x2

apple Cf. FOOD.

top lids of pr animal tins x3, Q: *plugs for baths and basins, flat pr toy brick which has been put on to three parallel pr crayons to make a vehicle, *pr P traffic lights at red in a street scene / He might have been saying "stop". /, * says "top all gone" in response to headless pr plastic zookeeper

sock Q: *his mother's tights x2

hammer pr P hammer being used by a man

television Q: TV set, P TV set being watched by a cartoon pig

J. 2;2½ - 2;6 1/6, inclusive (cont.)

ARTEFACTS (cont.):

toilet

pencil *pr P crayons and scribbles x3, *pr crayon

rug

upstairs *pr P single step in aisle in interior of a church, pr P foot of domestic staircase with children coming down it x3, stairs in pr toy London bus x3

ball pr P large spotted ball on floor in a nursery school scene, pr P bright beach ball, pr ping pong ball x5

camera

cream

weights

lorry

bus Q: real bus, pr toy London bus x3, Q: his own toy bus x2

drawing *wrapper off pr crayon

bin

dress Q: his mother's dress

things

church *pr P Norman-style church window seen from inside in church scene

marbles

shelf Q: shelf

scissors Q: scissors, pr P scissors held by a little boy in a nursery school scene, pr P scissors with twisted scrap of paper x2, pr P shears on wall in a workshop scene x2, *pr P tinsnips on wall in a workshop scene, *pr P pliers on wall in a workshop scene

knitting 'chine Q: sewing machine

Peter Rabbit Q: Peter Rabbit book

see-saw Q: *swing x2, *pr P playground swings, *pr 'chairoplane'

J. 2;2½ - 2;6 1/6, inclusive (cont.)

ARTEFACTS (cont.):

steady go pr P nursery chute being used by children, Q: see-saw, pr P see-saw being ridden by two children

nappy Q: his nappy, Q: *nappy pin

bottle pr P gluepot in a nursery school scene, pr P water jars being used for dipping of brushes by children painting, Q: bottle

ambulance Q: ambulance

calendar Q: calendar

glasses Q: spectacles x2

sandals Q: his sandals, his sandal

tin empty pr animal tin x5

nut threaded nut for pr 'chairoplane' x2

sand pr P toy bucket and spade in beach sand x2

swing pr P playground swings x10

writing manufacturer's label on pr 'chairoplane'

tree pr P trees in a park, Q: real tree, pr P tree in relief outline on plastic beaker

[pipe] pr P toothbrush with soap and other toiletries

plasticine Q: plasticine

pillow Q: *loose pillowcase

trousers Q: trousers

nursery Q: creche he attended for a while x5

bike Q: his sister's bicycle, Q: his brother's bicycle x3 [He recognises it as "Alasdair's bike" even when someone else is riding it.], pr P older child's tricycle, P bicycle being ridden by a cartoon pig

flowers Q: *bits of hay on floor indoors, *pr P load of garden refuse - no flowers obvious - in barrow being pushed by a man, *another pr P same load of refuse in barrow, *pr plastic zookeeper's meatstick with 'meat' on it, pr P flower in relief outline on plastic beaker

J. 2;2¼ - 2;6 1/6, inclusive (cont.)

ARTEFACTS (cont.):

room Q: room

flute Q: penny whistles and recorders

pram Q: pram

floor Q: floor

umbrella Q: umbrella

Borneo Q: where his father is working

letter pr P pink letter seen floating down from letter-slit inside front door of a house, pr P pink letter held by a postman, pr P pink letter being read by a woman

fork *pr P bottle being held by a woman x2. She has a spoon in the other hand.

kettle pr P steaming kettle on cooker in a kitchen scene.

tea pr P electric kettle. Cf. FOOD

roof flat pr toy brick being put on to a 'house' he is building

stool Q: stool at dining-room table at home x2

cupboard Q: kitchen cupboard at home

table P table

drawer where he says missing pr 'chairoplane' figure is

beaker various pr plastic beakers

sleeve Q: sleeve of his mother's dress

petrol pr plastic beaker doubling as a petrol pump in game with pr plastic bus

ring small brass ring on pr plastic elephant's trunk

PEOPLE:

Mummy Q: his mother x14, his mother x29

Auntie Q: Aunt Dilys

J. 2;2¾ - 2;6 1/6, inclusive (cont.)

PEOPLE (cont.):

baby ?pr P doll in a pram or little girl crying in the same picture x4, Q: real baby, P baby

Daddy Q: *P man bathing in the sea, Q: *male stranger, Q: talking about his father who is working abroad x3, *pr P man pushing a barrow, *another pr P of the same man and barrow x2, *pr P postman, *pr P man with two children, *P man

Pippa *pr P children in a street scene x2, *faces of two ladies in the same pr P street scene, *pr P top half of a little girl standing in a cot x4, *pr P child's head looking out of a window, *pr P little girl, Q: his sister

boy says boy after imitating girl in connection with a pr P little girl, Q: voices of boys out of sight, Q: a predicate applied to his brother, Q: *Susan - a girl

Alasdair *pr P head and shoulders of a Panda beside a cot x3, Q: his brother x10, *pr P child's head looking out of a window, *pr P little boy, *pr P little boy walking down a street dressed as a matchbox x2

Stephen

Michael

Star Trek man

man pr 'chairoplane' figures x8, pr P dim figure of a man with only legs clearly visible swimming from otherwise deserted beach x2, Q: pr 'funny man' x2, pr plastic zookeepers x3, P boy jumping over a candlestick, pr P postman

baking man P baker with chef's hat

Patrick Patrick Griffiths x5

Bruce

Derek

David

Kate *Renira Huxley x2

Mrs Innes Q: Mrs Innes

doll

J. 2;2½ - 2;6 1/6, inclusive (cont.)

PEOPLE (cont.):

Donald

Mary Hopkins

J. Q: his own name x2, his own name x3

Granny Q: his grandmother

Aunty Maila Q: Aunt Maila x3

soldiers Q: soldiers

Ruth Q: Ruth

Lila Q: Lila

Paul Q: Paul

Bucket Q: Achit

Judy Q: Judy

Peter Q: Peter

girl Q: girl, *pr P woman operating record player at children's party, pr P little girl tugging at a man's hand

lady P little girl holding a baby x2

Susan Q: Susan

FOOD:

marmite

smeetie Q: a sweet, *pr P ornate green jelly on table at children's party

toast Q: toast

cake pr P party fare on table at children's party, P cake, pr P currant loaf in baker's window

milk pr P milk in red mug x6, Q: milk x4, *pr P brown liquid in white mug x3

apple looking through a pr picture book for P apple, pr P red apple on plate, pr P rounded brick-red things in a saucepan on cooker in a kitchen scene x3, Personal communication from his mother: *potatoes

J. 2;2¼ - 2;6 1/6, inclusive (cont.)

FOOD (cont.):

juice pr P red liquid being drunk through straws from glasses by two children, Q: bottle of medicine, Q: juice he is drinking, Q: wanting juice from the cupboard where it is kept

baccy

tea Q: evening meal. Cf. ARTEFACTS.

biscuit pr P biscuits in a bowl, Q: biscuit, pr P assorted biscuits on and near a plate x2, biscuit found on the floor

jelly Q: jelly

minskin

orange looking through a pr picture book for P orange x3, pr P three oranges in vegetable rack in kitchen scene, looking through another pr picture book for P orange x7. In the latter case he rejects P banana even though Martin Atkinson tells him it is an orange.

nana pr P partly-peeled banana on a plate x3, pr P three bananas in vegetable rack in kitchen scene, *pr P carrot with part of its green top on a tray

egg *pr P top half of burning candle with trickles of wax down its side, pr P egg in egg-cup on plate x2

bacon

soup

sausage

soap Cf. ARTEFACTS.

chips

raisin Q: raisin

lunch Q: midday meal, what cartoon pig is eating off a plate in P pig eating x2

honey

pudding

bread Q: sandwich

J. 2;2½ - 2;6 1/6, inclusive (cont.)

FOOD (cont.):

marmalade

bovril Q: 'bovril'

meat Q: meat

sugar Q: sugar

water Q: drink or water. Cf. ARTEFACTS.

chocolate spread Q: chocolate spread

breakfast Q: breakfast

food pr P lettuce and carrot being eaten off a plate by a rabbit, pr P loaves and cakes in a baker's window, pr P 'Vienna' loaf in a baker's window

butter Q: butter in butter-dish

lolly *pr P plastic cookeeper's meatstick with 'meat' on it

ANIMALS:

Olly

miaow

woof

bear

pussy cat pr P cat in relief outline on plastic beaker x2

dog pr P mongrel in suburban garden, Q: unseen dog barking

dogsation Q: Alsatian dog

bird pr P parrot, pr P bird in relief outline on plastic beaker

horsies pr plastic animals in pr animal tin, *pr P zebra, *pr P outline drawing of a donkey in a children's party scene, pr plastic horse

duck pr P mallard drake x2, pr P ducklings in a pond x6 [In four cases he actually calls them "baby duck".], dressed cartoon duck on side of mug in pr P mug

ducklings Q: ducklings

J. 2;2¼ - 2;6 1/6, inclusive (cont.)

ANIMALS (cont.):

bull

cat pr P front half of cat x2, Q: cat-shaped badge, pr P cat in entrance hall of a house, P cat in a girl's arms x2

sheep pr plastic sheep x4, P sheep in company of a Victorian girl

tiger

swan

cow pr plastic cows x6, pr plastic animals in pr animal tin

fish

rabbit three small crouched ceramic rabbits - red, green and brown - on mantelpiece in pr P nursery scene, *front half of ceramic elephant on mantelpiece in same pr P nursery scene, pr P front half of black and white rabbit x4, another pr P front half of same black and white rabbit x5, pr P rabbit in relief outline on plastic beaker

monkey pr plastic chimpanzee x7

pig P cartoon pig x2

elephant pr plastic elephant x6, pr jigsaw puzzle elephant

hen *pr P parrot, *P rooster

tortoise Q: tortoise x2

swaff Q: wasp x2

mouse P mouse running up side of a grandfather clock x4

teddy bear pr P teddy bear in relief outline on plastic beaker x2

BODY PARTS:

nose Patrick Griffiths' nose, his own nose [These observations were based on written notes, not on tape-recordings.], trunk of pr plastic elephant. Cf. ARTEFACTS.

head Q: head on a coin

mouth

J. 2;2½ - 2;6 1/6, inclusive (cont.)

BODY PARTS (cont.):

eyes Q: his own eyes, eyes of pr plastic cow x2, Remira Hurley's eyes x5

knee Q: wanting to sit on his mother's knee x2, wanting to sit on his mother's knee x4, wanting to sit on Patrick Griffiths' knee x2

face

hand Q: his own hand, his own hand, *dismembered pr doll's arm. He says [anz] - a blend of hands and arms - once re pr plastic chimpanzee's arms.

beep

hair Q: *hair and head, Q: hair x3

feet

ear pr plastic elephant's ear x2

arm pr plastic chimpanzee's arms x9. Once he called these [ans] - a blend of hands and arms.

teeth part of an explanation of the use of toothbrushes

tummy Q: said re a male stranger without a shirt, Q: his own abdomen x2

legs Q: legs

shoulders Q: wanting to be carried on someone's shoulders

finger Q: finger

K. 1;9½ - 1;11, inclusive

ARTEFACTS:

ball Q: ball

cup Q: cup

bus Q: toy bus, Q: real bus

shoe Q: shoes

PEOPLE:

Mummy Q: his mother x2

Daddy Q: his father x2

Alan Q: his brother

Gordon Q: a friend of his

boy Q: P boy

FOOD:

tea Q: wanting a drink x2

dinner Q: said at a meal

juice Q: wanting a drink

ANIMALS:

Scooty Q: a character in a comic book

BODY PARTS: nil.

K. 1;11 2/3 - 2;2 1/3, inclusive

ARTEFACTS:

ball pr P bright beach ball, *pr P three eggs x3

cup

bus *pr P older child's tricycle x2, pr toy London bus x3, *pr toy jeep

K. 1;11 2/3 - 2;2 1/3, inclusive (cont.)

ARTEFACTS (cont.):

shoe pr P child's red button and strap shoes x2, pr doll's shoe x13, Q: his own shoes

slipper pr P shoe in relief outline on plastic beaker x2

sock Q: wanting socks on

bath Q: ?object or event

trousers Q: wanting trousers on, *pr doll's briefs

pants Q: putting on rubber pants, pr doll's briefs x3

brush pr P child's blue brush and comb set

car Q: his toy car, pr toy jeep x4, pr P two-tone drophead coupé. He also makes 'car noises' at the sight of the coupé.

fire Q: lounge gas fire

purse Q: purse

clock pr P alarm clock x2, *Renira Huxley's watch x2

house Q: house which always appears on TV programme - Play School

potty Q: toilet

toilet Q: toilet

flower Q: flower

PEOPLE:

Mummy Q: his mother, his mother x12

Daddy his father x5, Q: his father

Alan Q: his brother

Gordon

boy

Santa Q: Advent calendar in shape of Father Christmas

Marty Q: Martin Atkinson, Martin Atkinson

baby pr doll, pr doll's head x4

K. 1;11 2/3 - 2;2 1/3, inclusive (cont.)

FOOD:

tea

dinner

juice

apple pr P large red apple, Q: apple

biscuit Q: biscuit

orange Q: orange

ANIMALS:

Scotty

duck Q: P duck

panda Q: toy panda

teddy Q: teddy bear

horse *pr plastic bull x2

dog Q: dog

BODY PARTS: nil

K. 2;2 2/3 - 2;5 1/3, inclusive

ARTEFACTS:

ball pr yellow ball with holes x3, pr P bright beach ball

cup pr P teacup and saucer in relief outline on plastic beaker x6

bus pr toy London bus x12, *P pullman railway carriage x2

shoes pr P shoe in relief outline on plastic beaker x4, Q: shoes x2, *pr doll's socks. The doll was wearing socks but not shoes.

slipper

sandals Q: his own sandals x2

sock pr doll's socks x2

K. 2:2 2/3 - 2:5 1/3, inclusive (cont.)

ARTEFACTS (cont.):

bath used to explain splashing noises emanating from the kitchen: "Mummy bath" x2

trousers

pants

brush

car pr toy jeep x3, pr blue toy VW car x2, pr P car in relief outline on plastic beaker x3, pr P two-tone drophead coupé, Q: car

fire lounge gas fire

purse

clock pr P clock relief outline on plastic beaker x3

house ?x3

Hector's House Q: name of a TV programme

door Q: a shut door, * pr P house in relief outline on plastic beaker, flat pr toy brick in front of pillars x4, says "shut door" as he closes Russian 'babushka' nesting doll and as he closes pr animal tin, reply when asked of a bunch of keys he has just named "Whose keys?"

potty

toilet

flower pr P flower in relief outline on plastic beaker x2

wall Q: wall at the back of drying green behind his home

bike a pr 'tinkertoy' structure with wheels x2

see saw crossbar of pr 'chairoplane' on which 'chairoplane' figures are being made to slide

swing pr 'chairoplane' x3

powder Q: talcum powder

sheets Q: said as he goes into bed

bed pr microphone box being used as a bed for Russian 'babushka' doll x2

K. 2;2 2/3 - 2;5 1/3, inclusive (cont.)

ARTEFACTS (cont.):

clothes Q: said as he gets dressed

pennies pr plastic penny x10, wanting a coin to insert in slot of pr toy telephone x4, *pr 'tinkertoy' rod as he tries to insert it in slot of pr toy telephone x2

choo choo P steam railway engine

goggles Q: piece of an egg box used as goggles by his brother

glasses Q: spectacles

some Q: ?

sticks centre-pole of pr 'chairoplane', pr 'tinkertoy' rods x2

box cardboard box for pr toy bricks, *small closed pr tin containing pr plastic pennies, *pr animal tin x4, *base of white pr toy telephone x2, cardboard box for pr 'chairoplane', ?pr toy London bus or pr tape recorder case or pr animal tin, ?x3, cardboard drum for pr 'tinkertoy' x6

bricks pr toy bricks x3

garage what he says he wants to have built with pr toy bricks x2

wheel ?, *structure of pr 'tinkertoy', *pr small blue handled screwdriver being used to prise things open x8, *?as he builds a structure of pr bricks x3, wheels on pr toy London bus, *threaded nut on pr 'chairoplane', *small silver screw on pr microphone mixer case

[tatʌv] pr P light blue telephone

bubbles Q: putting washing up liquid into water

window lounge window

strap Q: watchstrap

coat Q: coat

picnic Q: Sunday school picnic

noise Q: noise from squeaking washing machine

garden Q: the drying green behind his house

button Q: as he buttons up his cardigan

K. 2;2 2/3 - 2;5 1/3, inclusive (cont.)

ARTEFACTS (cont.):

cardigan Q: his own cardigan

key bunch of keys

lights lounge chandelier x2

toys pr 'chairoplane' in its box, looking at illustrated instruction sheet for pr 'tinkertoy' x6, *pr 'tinkertoy' flat cardboard vane

PEOPLE:

Mummy his mother x6, Q: his mother x3

Daddy his father x3, Q: his father

Alan his brother, ?x3

Gordon

boy

Santa

Martin Martin Atkinson x16, *Patrick Griffiths x5

baby middle-sized member of Russian 'babushka' family of nesting dolls x23, smallest member of Russian 'babushka' family of nesting dolls x8, looking for these two x3 / In general baby seems to denote the smallest doll of any two present. /, pr P floppy rag doll, another pr P rag doll, *pr plastic zookeeper x2

Pat Q: his aunt

Anne Q: girl who lives in the flat above

soldier pr plastic zookeeper x13, what he is trying to make with pr 'tinkertoy' x2. He has a wheel on the end of a rod.

man pr plastic zookeeper x4

FOOD:

tea

dinner

juice

K. 2;2 2/3 - 2;5 1/3, inclusive (cont.)

FOOD (cont.):

apple

biscuit

orange *pr P large red apple x3, pr P two halves of an orange on a plate x2

water Q: wanting to fill cup with water

nana *pr P large red apple, pr P partly-peeled banana on a plate

ANIMALS:

Scotty

duck

panda

teddy pr P teddy bear in relief outline on plastic beaker x3

horse various pr plastic horses x13, 'horse' made of two pr 'funny men' and walked to 'horse noises' by Patrick Griffiths x2, *pr plastic cow

dog

cow *various pr plastic horses x7, *'horse' made of two pr 'funny men' and walked to 'horse noises' by Patrick Griffiths, *pr plastic elephant, *pr P elephant in relief outline on plastic beaker x2, *Russian 'babushka' nesting doll, *pr plastic zookeeper x2, pr plastic cow x6

mouse P Mickey Mouse

monkey Q: P monkey on a cup

cats *pr plastic sheep, pr P cat in relief outline on plastic beaker x5, Q: cat, *pr P rabbit in relief outline on plastic beaker

[gadi]~[gala2]~[2ɛlə] pr P elephant in relief outline on plastic beaker x5

rabbit pr P rabbit in relief outline on plastic beaker x3

bird pr P bird in relief outline on plastic beaker

K. 2;2 2/3 - 2;5 1/3, inclusive (cont.)

BODY PARTS:

hair Q: as he touches his head

nose Martin Atkinson's nose emphasized by his wearing a pr cardboard cylinder on it

face faces of Russian 'babushka' nesting doll family x3

K. 2;5 3/5 - 2;6½, inclusive

ARTEFACTS:

ball pr ping pong ball x2

cup

bus what he wants made with pr 'tinkertoy'

shoes shoes worn by man in P man, Q: his own shoes, Q: his brother's shoes, pr doll's shoes being put on to pr plastic elephant x3

rubbers Q: his wellington boots x2

slipper

sandals

sock

bath

trousers

pants

brush

car Q: car x2, *pr P parked motor scooter in a street scene

fire

purse

clock

K. 2;5 3/5 - 2;6¼, inclusive (cont.)

ARTEFACTS (cont.):

house Q: he said "car in house", = out x49 [phonetic identity/similarity/confusion?], says "in house" as he puts a pr 'tinkertoy' rod into pr microphone case, says "go in house" as he tries to get Martin Atkinson to do the same, a suggested use for Renira Hurley's keys which he has just named

home Q: his home

Hector's House

door

potty

toilet

flower

wall

bike

motorbike Q: motorcycle

see saw

swing pr 'chairoplane' x3

sheets

bed

clothes

penny pr plastic penny, real coin x3

choo choo

goggles

glasses

song

stick pr 'tinkertoy' rods x5

box carrying box for pr toys x2, *pr animal tin x2, response to "Where do you keep your money?" x2, pr microphone case x2, cardboard drum for pr 'tinkertoy', unidentified box x2

K. 2;5 3/5 - 2;6½, inclusive (cont.)

ARTEFACTS (cont.):

bricks pr toy bricks x3

garage

wheel pr 'tinkertoy' wheel

telephone

bubbles

window

strap

coat

picnic

seaside Q: wanting to go to the beach, reminiscing after the visit x2

noise Q: noise x2, said when the doorbell rang, said when a car started up outside

bell said when the doorbell rang

garden

back green the drying green behind his house

button

cardigan

jersey Q: his own jersey

keys a bunch of keys x2

lights

toys

nursery Q: going to fetch his brother from nursery school

aeroplane Q: a real aeroplane in the sky

whistle Q: ?object or action

pencil Q: pencil

K. 2;5 3/5 - 2;6½, inclusive (cont.)

ARTEFACTS (cont.):

pocket his shirt pocket

water pr P family washing dishes x2, recounting what he saw at the seaside

bag unidentified pr P bag, *pr dog glove-puppet

teeth pr P toothbrushes

digger lorry Q: toy digger lorry

peg Q: clothes pegs

record Q: gramophone record x2

hammer pr 'tinkertoy' rod fitted transversely into a rod-connector to make a hammer x7

PEOPLE:

Mummy Q: his mother

Daddy his guess as to who rang the doorbell x2

Alan his brother x4

Gordon

boy

Santa

Martin Martin Atkinson

baby pr 'chairoplane' figures

Aunty Maureen's baby Q: Aunty Maureen's baby

Pat

Anne

soldier

man pr headless zookeeper, pr zookeeper x5

K. Q: his own name, his own name

K. 2;5 3/5 - 2;6½, inclusive (cont.)

FOOD:

tea

dinner

juice

apple

biscuit

orange

water Cf. ARTEFACTS.

nana

cake Q: wanting cake

ANIMALS:

Scoty

duck

panda

teddy

horse as he picks up animal tin, *pr plastic cow x4, *pr plastic elephant, pr plastic horse x2

Dougal *pr plastic cow

dog Q: dog x2

cow

mouse

monkey pr plastic chimpanzee x2

cat *pr plastic sheep x2

sheep *pr plastic cow x2

elly pr plastic elephant x2

rabbit

K. 2;5 3/5 - 2;6½, inclusive (cont.)

ANIMALS (cont.):

bird

BODY PARTS:

hair pr P little boy. The little boy, of course, had hair.

nose nose of pr dog glove puppet

face

(man) head pr plastic zookeeper's head x6, headless body of pr plastic zookeeper x2

eyes P little boy on which the artist neglected to add eyes