

from J. Malton (Ed.) Language:  
9 Biological & Social Factors. Logos  
Russ, 1972.

## The Integrated Study of Language Behaviour\*

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- A. Why we are where we are
- B. Why some are nativists
- C. Language as a communicative system
- D. Conclusion

### A. Why we are where we are

The previous chapters in this volume have presented a mélange of dissatisfactions with many aspects of the contemporary study of language. A review of the intellectual history that has led us to our current confusion may help us understand the nature of the issues we face today. I shall start with quotations from the work of a psychologist particularly concerned with a description of language behaviour which emphasised that sentences are the natural unit of linguistic analysis:

"The sentences cannot be isolated from speech behaviour by any automatic empiricist procedures which operate solely on the 'observable facts': rather the sentence is given definition in terms of intuitions about sequences of words.

We can define the sentence as . . . *the linguistic expression of the voluntary arrangement of a whole mental image in its components, set in logical relations to one another.*" (p. 240)

This kind of definition has several consequences. The most impor-

\* Research supported by PHS 1 GM 16737. I am indebted to A. Jonch and N. S. Sutherland for advice on the manuscript.

tant is that superficial word order does not uniquely determine the internal relations.

"How is the logical structure maintained in those sentences which are not statements? . . . And furthermore, how are the main members of a statement related to one another if the sentence undergoes some kind of linguistic transformation, that nevertheless leaves its sense untouched? If I change the sentence 'Caesar crossed the Rubicon' into the form 'The Rubicon was crossed by Caesar', has the subject 'Caesar' thereby become the object and conversely has the former object, 'the Rubicon', become the subject? Or if I say 'the crossing of the Rubicon was carried out by Caesar' has the original predicate now changed into the subject?" (p. 259)

This difficulty is overcome by distinguishing between two levels of linguistic analysis:

"If one maintains that in the two sentences 'Caesar crossed the Rubicon' and 'The Rubicon was crossed by Caesar' the subject has changed, then one has thereby assuredly lost sight of the 'subject' in the Aristotelian sense as that which undertakes the predicate and has replaced it with the behavioural viewpoint, namely that the 'subject' must be the topic. The acting person in both cases naturally is Caesar. But he is the topic of the action only in the first and not in the second sentence. The first is a statement about Caesar, the second about the Rubicon." (pp. 260-261)

Finally, the 'logical' internal relations among the sentence-parts are not merely 'formal' relations, but are also taken to be psychological:

"The logical and the psychological do not constitute a union with separable components; rather the logical relations among the sentence-members are primarily psychological: logic has abstracted them from the psychological course of thought, in order to investigate their laws in their particular and most perfectly isolated form." (p. 260)

Though this analysis of the study of language is similar to recent linguistic discussions of language structure (cf Chomsky, 1965), its author was Wundt, writing at the turn of the century. Unfortunately, Wundt did not combine his insightful views on language with his well-known experimental zeal; if he had, the study of language would now be much more advanced as an experimental science. Wundt categorised the study of language as part of *social* psychology, for which experi-

mental techniques were considered to be inappropriate. One could study the nature of language only through the sort of philosophical considerations and personal introspections exemplified in the above quotations. Such structures as 'mental images' or 'voluntary expressions' were not thought of as amenable to direct study by experimenting on behavioural processes. It was necessary to study language and other higher order mental capacities primarily by means of introspective intuitions.

In the hands of Wundt's students (notably Titchener in the U.S.A.), introspection became a systematic basis for attempts to use personal intuitions as a primary source of psychological data. It was eventually realised that a general science based on introspections would always be limited: one man's 'image' of peanut butter could be another man's 'image' of horseriding. That is, introspections become so idiosyncratic that they cannot be used as the basis for a science.

Many reacted against such a '*mentalist*' enterprise and joined the ranks of operationally-obsessed behaviourist psychologists. For thirty years the psychological study of sentences lay fallow, submerged in the dogmatic behaviourist requirement of an experimental basis for all psychological data. The particular consequence of these strictures for language study was that linguists and psychologists avoided any considerations of abstract, 'logical' structure. To see the remarkable contrast to earlier views, one can compare Leonard Bloomfield's 1914 book *The Study of Language* with his 1933 book, *Language*. The former is an open exploration of Wundt's considerations, while the latter rejects such views as 'unscientific mentalism'.

The development of 'Generative Grammar' in 1957 represented a return to the earlier structuralism of Wundt, albeit with more powerful and more precise descriptive devices than were originally available (Chomsky, 1957). In Chomsky's reformulation, the possible internal 'logical' relations among words and phrases are described by a set of elementary phrase structure rules and a lexicon. This latter component generates representations of particular logical structures, such as that shown in (1).

- 1. Actor = Caesar
- Action = Cross
- Object = Rubicon
- Tense = Past

The internal structure and external form of each sentence are related

by a set of 'transformations', which organise the phrases into particular sequences (as in 2).

- 2. a. Caesar crossed the Rubicon.
- b. The Rubicon was crossed by Caesar.
- c. It's Caesar who crossed the Rubicon.
- d. It's the Rubicon that Caesar crossed.
- e. It's Caesar that the Rubicon was crossed by.
- f. What Caesar did was cross the Rubicon.
- g. What happened to the Rubicon was that it was crossed by Caesar.

Such a descriptive model accounts for the fact that superficially different sentences can have the same set of internal relations, the differences being contributed by differences in the transformations which map the internal structures onto their external forms.

This model of grammar set the scene for the difficulties and perplexities raised in many of the other chapters. The basic data which such a grammar describes are intuitions about the grammaticality of certain sequences (eg 3a is grammatical while 3b is not) and the relations between sequences (eg the structure in 3c is related internally to 3a, while that of 3d is not (even though 3c and 3d are superficially similar).

- 3. a. Caesar crossed the Rubicon.
- b. \*Caesar the Rubicon crossed.
- c. The Rubicon was crossed by Caesar.
- d. The Rubicon was crossed by midnight.

Such intuitions are assumed to be stable reflections of actual linguistic structure. The fact that the psychological nature of such introspections is totally obscure does not undercut the claim that the intuitions are valid data, so long as no claims are made about the psychological processes which they imply.

**B. Why some are nativists**

Grammarians have made the distinction between grammar and speech behaviour particularly clear by emphasising that grammars account for 'linguistic knowledge' but not for the processes which deploy that knowledge. Psycholinguists have attempted to capitalise on the insights

\*This symbol indicates that the sentence following is not an acceptable English sentence.

of linguists by incorporating grammars, unmodified, into their models of speech behaviour. However the grammarian's intention was to account only for the structural properties implied by our basic knowledge of sentence grammaticality. The interaction of grammaticality with other aspects of behaviour, for example, social function, semantics, general psychological systems, human communication, biological systems and innate structures, was explicitly left open by generative grammarians.

Of course, like the psycholinguists of the early 1960s, we all find linguistic grammar tantalising. A grammar's descriptive precision and the centrality of the facts about language which it describes encourage us to incorporate it directly into the explanation of all aspects of language behaviour. The frustration involved in such attempts is also reflected in the previous chapters.

While linguists themselves make no claims about the psychological properties of linguistic rules, they have produced detailed arguments that human infants learn language as a consequence of highly specific inborn structures, 'pretuned' to extract human language from their environment, and not to extract other kinds of communication systems. That is, the structure of human language is not learned (and presumably formed) by some 'general purpose' learning capacity in the child, but by means of highly specific innate structures (Chomsky, 1965; Katz, 1967; Lenneberg, 1967).

It is useful to consider the kinds of facts which motivate linguists and psychologists to make such strong claims. The child learns the elements of his first language by the age of three without apparent specific instruction and appears to acquire an intuitive knowledge of the internal, 'abstract' structure of sentences even though he is never presented with their explicit expression. This developmental pattern in language acquisition is incompatible with those theories of learning and cognitive structure which assume that the environment reinforces the child for particular overt acts, and which account only for the incorporation of originally overt stimuli and responses. On such a view the unreinforced appearance in the child of 'abstract' logical structures (for example, the concepts in 1) is particularly puzzling.

### 1. *Speech production*

Furthermore, the patterns of language learning do not show the steady incremental convergence towards adult language predicted by the view that language learning proceeds by the steady mastery of individual sentence constructions. There are abrupt shifts in the manifest speech

performance of the child, which imply drastic structural reorganisations of his linguistic knowledge. Firstly, there are several developments which characterise learning to speak, regardless of the language that is being acquired (the speech production data are reviewed in Slobin, 1970). The child starts out speaking individual words which appear in many instances to indicate relational interactions rather than mere naming. For example (6a) could mean any one of the full sentences in (6b-f), depending on the situation.

6.
  - a. Doggie.
  - b. There is a dog.
  - c. I want the dog.
  - d. Listen to the dog.
  - e. I'm scared of the dog.
  - f. Is that a dog?

There is clearly an early point in the child's linguistic development when a single word carries relational intention. Presumably limitations of expressive capacity restrict the pronounceable output to one-word utterances, even though relations between several words are intended.

When these limitations are overcome and the child advances to two-word utterances, several interesting characteristics appear in his speech. First, there is a universal 'actor-action', 'action-object' word order for two-word utterances containing transitive verbs. That is, utterances like (7a) always mean (7b) and utterances like (7c) mean (7d). In utterances with intransitive verbs, each child goes through a

7.
  - a. mommy kiss
  - b. 'mommy is kissing somebody' (or 'should be doing so')
  - c. kiss mommy
  - d. 'somebody is kissing mommy' (or 'should be doing so')

phase of using one characteristic word-order or the other, but the order varies from language to language and from child to child as in (8ab).

8.
  - a. glass fall
  - b. fall glass

(It is striking that these phenomena also occur in inflected languages, such as German and Russian.) Finally, when the child can produce three-word utterances his language passes through a series of sentence forms, each of which is distinct from adult constructions. For example, the way in which a child asks questions goes through several stages

(Bellugi, 1967). The stage at which the child says sentences (9a) does not represent a *gradual* convergence towards the external appearance of the adult question form (9b). Rather, the child is using a specific

9. a. What Harry said?
- b. What did Harry say?

rule (*place the WH-word first* in questions). Similarly, the development of the child's expressive mastery of the past participle of English strong verbs goes through stages like those in (10a-c) (see Cazden, 1968). At the stage when the child produces utterances like (10b) his

10. a. Harry went
- b. Harry wented
- c. Harry went

ability to talk is temporarily worse (ie, less adult-like) than at a younger age because he is *overgeneralising* the rule that past participles for weak verbs are formed by adding *-ed* to the stem. The conclusion from all these facts is that the child's early speech production is based on certain structural hypotheses. He thus acquires discrete abstract rules for talking rather than mastering his language by the steady accumulation of specific constructions.

## 2. *Speech perception*

The development of the child's ability to understand sentences has been studied less, but there are striking similarities to the development of talking ability (reviewed in Bever, 1970b). At the age of two years, the child uses a perceptual strategy that a 'noun-verb' sequence is interpreted as 'actor-action'. For example, the sentences in (11) are correctly acted out (significantly more often than chance) by two-year-old children. The child's correct performance on sentences like (11c)

11. a. *The horse kisses the cow*
- b. It's *the horse kisses* the cow
- c. It's the cow *the horse kisses*

shows that he does not merely take the first noun of a sentence to be the actor, but rather appears to analyse the 'noun-verb' sequence as a kind of primitive *gestalt* even when it does not occur first in a sentence. Further evidence for this possibility is shown by the fact that the two-year-old child performance is 50% correct on passive sentences like

(12a). Apparently the *is* in (12a) blocks the 'noun-verb' *gestalt* since, if it applied, children would always *reverse* the interpretation of passives incorrectly taking 'the cow' as actor (cf R. Bates, 1969, for further discussion). Furthermore, the fact that semantically improbable sentences (12b) are performed better than chance at age two years supports the interpretation that the child is using a structural strategy rather than a semantic one.

12. a. The cow is kissed by the horse
- b. The dog pats the mother

In the interpretation of complex sentences with more than one *noun-verb* sequence the young child takes the first such sequence as the most significant, and tends to ignore other parts of the sentence. Thus in comprehension and repetition studies young children tend to respond to the italicised portion of the sentences in (13).

13. a. The horse *the cow kissed* fell over
- b. *The horse kissed the cow* and fell over
- c. *The horse kissing the cow* fell over

At age four the child appears to have given up his dependence on the 'noun-verb' *gestalt* and now interprets sentences using the strategy that the first noun is the actor. Accordingly, his performance on sentences like (11c) and (12a) is *worse* than at age 3½, while his performance on sentences (11a) and (11b) improves (if it is not already at 100%). After this period the child's performance on complex sentences becomes much more like that of an adult: if the child ignores one of the clauses, it is usually the subordinate clause which is dropped, regardless of the order of presentation in the sentence.

In brief, the mechanism for understanding sentences appears to go through discontinuous phases without any specific training or reinforcement of the perceptual mechanisms preferred at each age. As in the case of the development of speech production, at certain ages the child's performance can deteriorate, suggesting that linguistic perceptual development involves the reformulation of perceptual rules rather than the perceptual mastery of a gradually increasing number of different constructions.

## 3. *Neurological dominance*

There are certain gross neurological developments between 2 and 5 years which suggest a structural shift in the neural organisation related

to language capacity. It is well-attested (see p. 15) that in normal adults, linguistic capacity is relatively localised in one brain hemisphere (usually the left). For example, clinical evidence shows that lesions in the left hemisphere are more likely to cause aphasia than lesions in the corresponding area of the right hemisphere. Similarly, Kimura (1967) showed that most normal adults repeat more of the digits presented to the right ear (functionally enervating the *left* hemisphere) than of those presented simultaneously to the left ear (enervating the *right* hemisphere). (See Bever, 1970c, for a review of these and related phenomena.) Lenneberg (1967) presents evidence that this neurological specialisation of linguistic function is not 'fixed' until the age of 12-13, since before that age aphasia resulting from lesions to the left hemisphere is quickly overcome, suggesting a 'transfer' of the function to the right hemisphere. The relative persistence of aphasia from left-hemisphere lesions sustained after that age suggests that the relative equipotentiality of the two hemispheres has been lost.

More recent research indicates that while there is some lability of dominance, which is perhaps not firmly developed until age 12, there is also a predisposition for the left-hemisphere to be dominant in speech even in the very young child. First, Wada (1969) has reported a greater anatomical development in neonates of left hemisphere brain areas involved in speech behaviour. Second, Teuber and Twitchell (Teuber, in press) have found that children with signs of early lesions in the left hemisphere have retarded verbal development compared with children showing signs of early right-hemisphere lesions. Such investigations suggest that the young child does not have total freedom to select which hemisphere is to be specialised for language; there is a genetic predisposition for the left hemisphere.

We have found a relation between the development of certain perceptual strategies for dealing with speech and the development of an ear-preference. Those children between three and five who show a strong ear preference also show a strong tendency to utilise the strategy that the first noun in a speech sequence is the actor. This suggests that there is an intimate relation between the differentiation of such strategies and the emergence of lateralisation (Bever, 1970c).

Some of our recent investigations show that environmental stimulation plays a critical role in the emergence and 'fixing' of the neurological predisposition for the left hemisphere (Bever, Palmer, Sumner and Moran, in preparation). We examined two socio-economically matched populations of boys at age four years, eight months (4/8) on

simple measures of hand, ear and eye dominance. The experimental group had participated in a diffuse 'cultural enrichment' programme (see Rees and Palmer, 1969, for a description of the programme) starting at 2/8 for some boys and 3/8 for others. A control group was tested (on standard measures of intellectual capacity) at the same intervals as the experimental groups but received no enrichment. At age 4/8 the experimental groups showed more hand/ear/eye consistency (ie preferring the right hand, right eye, and right ear to the same extent) and more children showed an overall preference for the right side (associated functionally with the left hemisphere, at least for the hand and ear). That is, while there may be a predisposition for the left hemisphere to be dominant, certain environmental stimuli can stimulate the emergence of its structural integration with sensory-motor processing.

In conclusion, the development of the ability to talk, and to listen, and of the neurological dominance underlying language all start out at age two with certain predispositions, either inborn or previously acquired. Shifts occur in each of these aspects of linguistic organisation as a consequence of interacting with the linguistic and cognitive environment. Such facts support the claim that language-learning depends on specific mental and physiological structures rather than on 'general intelligence'.

Some scholars have taken the linguists' claim that language is 'innate' to include the claim that inborn linguistic predispositions are not themselves derived from other general properties of human neurology and cognition, but are limited to their linguistic expression. It is not a necessary part of the claim that there are innate structures underlying linguistic universals that those structures are not reflected in other aspects of human behaviour. Of course, it is also not obvious what a 'general purpose' learning model would be like, despite the attempts of many psychologists to frame one. Insofar as a general learning theory predicts the impossibility of abstract linguistic structures, it is inadequate to account for the learning of human language. However, failure of one type of allegedly general purpose learning theory to account for language learning does not prove that some other general learning theory will not account for it.

### C. Language as a communicative system

The previous chapters discuss specific ways in which we should modify our preoccupation with the acquisition of pure grammatical structure so as to set the psychology of language in a broader perspective. Leontiev urges that we view both social structure and language

as functions of the basic 'urge' for socially motivated and organised communication. Schlesinger makes the related argument that human language is merely one example of possible human communication systems. Wales narrows the argument further by discussing specific psychological mechanisms that may underlie highly intricate grammatical structures. Hasan maintains that grammatical structure itself cannot be studied or understood in isolation either from the semantic structure of language or from the semantic properties of specific lexical items. The two chapters concerned with the biological basis of linguistic structure both suggest that we must be cautious in assuming that every universal property of languages is necessarily 'innate'. Campbell points out that many behavioural properties recruited by human language are also utilised by presumptively more primitive communication systems. Finally, McNeill attempts to distinguish between different kinds of linguistic universals as a function of the extent to which they are derived from general (non-linguistic) cognitive properties of human beings.

Viewing all of these arguments together we can see that they represent attempts at a delimitation of the role of 'syntax' in language which we should take into account when studying its universal properties in adults and its development in children. We could represent this delimitation as a kind of conceptual algebra which describes what we must factor out from language behaviour before attributing it to a specific linguistic structure rather than to a linguistic expression of a

14. (Structure of Language Behaviour) —  $(SU + HCS + PN + SS + BUC + CS) = (\text{specifically linguistic structures})$

general psychological structure (where  $SU$  = social urge;  $HCS$  = common properties of all human communications systems;  $PM$  = psychological mechanisms;  $SS$  = semantic structures;  $BUC$  = biological universals of communications systems;  $CS$  = common properties of all human cognition systems).

Of course such conceptual articulation is possible only when the items are mutually exclusive and functionally independent (ie when what is represented by one term is not affected by what is represented by any of the other terms). Unfortunately, such independence is the exception rather than the rule; we cannot add and subtract aspects of behaviour as though they were integers. Rather we must view language as an organizing communication system within which different mental and neurological mechanisms interact and modify each other. In discussions and research we may refer to each mechanism as though

it had isolable properties, but this must be viewed as a necessary idealisation and a scientific metaphor rather than a reflection of the true state of affairs.

Dissatisfaction with the current devotion to syntactic phenomena in language behaviour is a natural outgrowth of the progress and speed of the structuralist revival that has occurred within linguistics. It is indeed time to expand our horizons beyond the treatment of syntax to more inclusive treatments of language behaviour. However, we must tread carefully lest our enthusiasm to describe all available 'facts' about language leads us into the same kind of behaviourist swamp that engulfed the last structuralist period between 1920 and 1950. We can avoid this danger and bring the study of language into line with other areas of behavioural science if we recognise that language behaviour is itself a function of a variety of interacting systems, none of which is logically prior in its influence on language behaviour.

In this sense the study of language is like the study of an animal within biological science. Consider for example the description of a rabbit: it includes such items as the fact that the rabbit engages in hopping behaviour, is herbivorous, has a specific normal body temperature, has a certain kind of liver, has a unique genetic structure, lives in holes in the ground, and so forth. All of these facts are part of the description of what a 'rabbit' is; yet none of them alone is an exhaustive or sufficient description of 'rabbit'. All of the physiological and behavioural subsystems of the rabbit exist simultaneously and can modify each others' structure and function. Thus, while we can study the function of the rabbit's liver as though it existed in total isolation, there are certain points where our description of the liver must take into account other subsystems of the animal—eg. the body temperature, normal heart rate, the behavioural patterns accompanying elimination of body wastes and so on. Of course, certain aspects of the animal might appear to be so remote as to be functionally distinct from each other; for example, one might think that there is no mutual influence between the length of the rabbit's ears and the function of his liver. However, interactions between each subsystem set up for isolated description cannot be ruled out *a priori*, but must be examined empirically. For example, one might argue that the length of a rabbit's ears is involved in increasing body surface to increase control over body temperature (cf the fact that desert-rabbits' ears are particularly oversized). Thus after all, there is an interaction between ear length, and *all* internal organs via temperature regulation. An animal is a coherent whole in which no component is entirely distinct from any other.

An analogous line of argument holds for the study of language. During the past few years we have concentrated on the study of the structure and acquisition of the syntactic aspect of language; we have made the simplifying assumption that the interactions between syntax and other aspects of language behaviour are sufficiently remote so that theoretical conclusions about the structure of syntax will not turn out to be spurious when placed in a larger context. However, as we consider other subsystems of language behaviour it is becoming clear that the attempt to study syntax *in vitro* has certain limits which we may have already exceeded.

In the remainder of this discussion I shall review three aspects of the interaction of syntactic structures with other behavioural aspects of language. First, there are many sources for the unacceptability of potential sentences in addition to structural 'ungrammaticality': in some cases linguists may mistakenly construct a syntactic theory to rule out particular utterances as 'ungrammatical' which in fact are unacceptable due to non-grammatical facts about their use. Second, the role in laboratory studies of particular grammatically defined structures is greatly influenced by the subject's task: thus certain structures which are necessarily primary in linguistic descriptions play a secondary role in many other kinds of speech behaviour. Finally, the nongrammatical mechanisms of speech behaviour in the child can be seen to play a part in the formation of the child's grammar itself. As a result the linguist may claim as a structural 'grammatical universal' a property of language which is really due to extra-grammatical properties of the language-learning child.

### 1. *The multiple source of sequence unacceptability*

Linguistic grammars are descriptions of a range of structural facts about speech sequences, the most basic of which is that some are grammatical and that some are ungrammatical. The intuitions of native speakers about the acceptability of potential sentences is the main source for such facts. For example, the sequences in (15) are clearly ungrammatical, while those in (16) are clearly grammatical.

15. a. \*I believe it that John to be a Martian.  
 b. \*Paul Bunyan felled the trees as fast as J.  
     Apple seed grewed them.  
 c. \*Mc Tarzan, you Jane.  
 d. \*White man speak with forked tongue, steal land, sell  
     firewater braves.

\*This symbol indicates that the sentence following is not an acceptable English sentence.

16. a. I believe John to be a Martian.  
 b. P. Bunyan felled the trees as fast as J.  
     Appleseed grew them.  
 c. I'm Tarzan, you're Jane.  
 d. The White men spoke with a forked tongue, stole the land  
     and sold firewater to braves.

These cases are perfectly clear and will be agreed upon by all native speakers of English. Thus the factual basis of grammars can be quite solidly grounded in intuitions about acceptability of sequences.

However, there are many bases for unacceptability judgements in addition to the violation of grammatical constraints. First, there are cases in which sentences are unacceptable because they appear to place an inordinately heavy load on the system of speech perception. For example (a) is far less acceptable than the grammatically parallel (b) in each of the pairs below:

17. a. ?The horse raced past the barn fell.  
 b. The horse ridden past the barn fell.
- a. ?The pitcher tossed the ball tossed the ball<sup>1</sup>  
 b. The pitcher thrown the ball tossed the ball.
- a. ?They didn't like even considering discussing continuing  
     selling buildings.  
 b. They didn't like even considering a discussion of continu-  
     ing to sell buildings.

There are also cases in which sentences are unacceptable because they are impossible to utter (at least without special practice which allows one to circumvent the usual system of speech production):

18. a. ?Peter Piper picked a peck of pickled peppers.  
 b. Peter Johnson picked a lot of ruined peppers.
- a. ?She sells seashells by the sea shore.  
 b. She hawks mollusks by the sea shore.
- a. ?Rubber baby buggy bumpers bug Bugs Bunny.  
 b. Metal baby carriage bumpers upset Bugs Bunny.

?This symbol indicates that the acceptability of the sentence following is questionable.

Certain sentences are unacceptable because they involve inherent contradictions:

19. a. \*All bachelors are married.  
 b. No bachelors are married.
- a. \*The king isn't a king.  
 b. The king isn't a prince.

Other sentences are unacceptable because they have presuppositions which are either generically or factually false:

20. a. \*Why don't all the married bachelors get divorced?  
 b. Why don't all the married men get divorced?
- a. \*Why doesn't the present king of France abdicate?  
 b. Why doesn't the present premier of France resign?

Certain sentences are unacceptable given the conversational context in which they occur; thus, following (21c), (21a) is unacceptable while (21b) is acceptable:

21. a. \*The river is three miles south of the house.  
 b. The house is three miles north of the river.  
 c. Where is the house?

The personal context in which a sentence is uttered can influence its acceptability: (22a) is unacceptable spoken to one's sergeant but perfectly acceptable when spoken to one's psychiatrist. Conversely (22b) is unacceptable when spoken to one's grandmother (at

22. a. My eldest male sibling enjoys rhythmic relaxation in his abode.  
 b. My brudder frugs in his pad.

least for the author) but entirely acceptable when spoken to (certain of the author's) contemporaries.

Finally, there is a set of sentences which might be spoken and understood but which are felt to be unacceptable (15, 23). Unlike the previous kinds of unacceptability we may agree that such sentences

\*This symbol indicates that the sentence following is not an acceptable English sentence.

are unacceptable but we cannot find any particular aspect of speech behaviour that makes them so. It is not the case that they are hard to understand or say, that they are meaningless, or that they violate

23. a. I hope it for to be stopping raining when I am having leaving.  
 b. In English article precedes noun.

certain contextual conventions. They are simply unacceptable English sentences, no matter what the situation. It is cases like these, which have no obvious source for their unacceptability, that are classified as 'ungrammatical'. When we cannot find any other behavioural or contextual reason for the unacceptability of an utterance we conclude that it is *structurally* incorrect and modify the theoretical grammar accordingly, so that it marks such sequences as 'ungrammatical'.

Unfortunately, most of our judgements about the acceptability of a given sequence combine several features of the different systems of speech behaviour. I tried above to give examples of each kind of unacceptability that would be maximally clear; most real cases are compounded. Even if we can all agree that a particular sentence is unacceptable, it is much more difficult for us to agree *why* it is unacceptable. Yet this agreement is crucial, since a syntactic analysis of a language is intended to account for 'pure' structural acceptability judgements, and not for acceptability judgements caused by non-syntactic, semantic, psychological or contextual factors.

Although intuitions about sequence acceptability do not directly reflect the structure of the language in all cases, such intuitions are the main data the linguist can use to verify his grammar. This fact could raise serious doubts as to whether linguistic science is about anything at all since the source of the data is so obscure. However, this obscurity is characteristic of every exploration of behaviour. Rather than rejecting linguistic study, we should pursue the course typical of most psychological sciences; give up the belief in an 'absolute' intuition about the acceptability of sentences and study the laws governing the process involved in producing such intuitions.

The effect of stimulus context on the absolute judgement of the stimulus has become a part of almost every branch of psychology. One of the most basic laws governing the interaction between stimuli is the *law of contrast*; for example, the well-known phenomenon of feeling that the ocean is cold on a hot day while the same ocean at the same temperature feels warm on a cool day. One's 'absolute' judgement of a stimulus can be affected by the difference between the stimulus and



its context. This influence by contrast clearly can affect 'intuitions' about structural grammaticality. For example, in the sentence triples in (24), (b) compared with (a) may be judged 'ungrammatical', but contrasted with (c) they will probably be judged as 'grammatical'.

24. a. Who must telephone her?  
 b. ?Who need telephone her?  
 c. \*Who want telephone her?
- a. He sent money even to the girls.  
 b. ?He sent money to even the girls.  
 c. \*He sent money to the even girls.
- a. I wouldn't like John to win the race.  
 b. ?I wouldn't like for John to win the race.  
 c. \*I wouldn't force for John to win the race.

That is, not only are there several kinds of systematic bases for the unacceptability of sequences, but even the judgement of structural grammaticality is itself subject to contextual contrast.

The fact that linguistic intuitions are subject to the same kind of influences as other types of human judgement does not invalidate many results from linguistic investigations. Many intuitions about sentences appear to be strong enough to resist contextual effects. We can expect that these intuitions will remain constant even when we have developed an understanding of the intuitional process (eg, the relationship between actives and passives; the fact that 'John hit the ball' is a sentence of English, etc). However, recent linguistic theoreticians have placed increasing dependence on relatively subtle intuitions (see Lakoff, 1968; Kiparsky and Kiparsky, in press; Ross, 1968; MacCawley, 1968), whose psychological status is extremely unclear. Since there are many sources for intuitional judgements other than grammaticality, and since grammaticality judgements can themselves be influenced by context, subtle intuitions are not to be trusted until we understand the nature of their interaction with non-grammatical factors. We require a science of linguistic introspection to provide a theoretical and empirical basis for including some acceptability judgements as syntactically relevant and excluding others. If we depend too

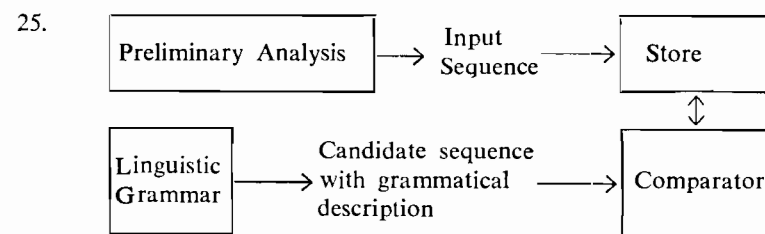
? This symbol indicates that the acceptability of the sentence following is questionable.

\* This symbol indicates that the sentence following is not an acceptable English sentence.

much on acceptability intuitions without exploring their nature, linguistic research will perpetuate the defects of introspective mentalism as well as its virtues.

## 2. *The role of theoretical linguistic structure in actual speech behaviour*

The role the structures postulated by linguistic theory actually play in behaviour is a baffling problem. A transformational grammar describes every sentence as having an internal and an external phrase structure, and a set of transformations which map the former onto the latter. There is no clear evidence, however, how the formally defined transformations are utilised in either speech perception or memory, although there is evidence that the internal and external structures are utilised directly in these processes. Nevertheless, some perceptual models have attempted to incorporate a grammar as part of the processing mechanism. For example, 'analysis-by-synthesis' models of speech perception postulate that a grammar is used to generate possible sentences as part of ongoing speech perception; when the sentence generated by the grammar matches the just-heard stimulus sentence, the perceptual mechanism marks the stimulus sentence as having that grammatical structure (see Halle and Stevens, 1963). This kind of



perceptual model predicts that sentences whose grammatical description involves many transformations should be correspondingly complex perceptually. For example, passive sentences should be more difficult to understand than active sentences. This particular prediction was borne out by many different kinds of experimental studies, and it appeared as if the 'psycholinguistics' of the 1960s was to be a period of exciting interaction between linguistic theory and psychological experimentation, in which theoretical claims from linguistics could be directly verified by experimental psychology (cf, Miller, 1962).

Unfortunately, clear success was limited only to the very first experiments, such as the study of the relative perceptual complexity

of the passive construction. Many examples appeared of sentence constructions in which more grammatical transformations resulted in sentences which were in fact *simpler* to understand, as in the examples (b) in (26).

26. (Sentence pairs in which (b) has more transformations than (a) but is perceptually simpler)
- a. The dog was called by someone.
  - b. The dog was called.
- 
- a. The cat that is small is on the mat that is made of grass.
  - b. The small cat is on the grass mat.
- 
- a. That John left the party angrily and quickly annoyed Bill.
  - b. It annoyed Bill that John left the party angrily and quickly.

While everybody was willing to agree with the claim that sentence perception involves in part the discovery of the internal, 'logical' relations inherent to each sentence, it was not at all clear how the grammatical structures used to describe intuitions about sentences are themselves deployed in actual sentence processing (Fodor and Garrett, 1968). Such an observation raises the general question: which linguistically-postulated structures are primary in actual speech behaviour and which are abstracted from behaviour?

There are three structures which are manifest in most linguistic theories (even those that are not 'generative'), the phoneme, the external phrase structure, and the internal 'logical' structure. Our current research suggests that these three structures are the residue of an internal abstraction process, rather than structures which are themselves actively used in all normal speech processing. There is strong empirical *linguistic* evidence for the 'reality' of each of the three linguistic structures: each structure is necessary for the description of certain indisputable facts about sentences. However, observational and experimental investigations indicate that the role of these structures in speech behaviour is dependent on the particular activity. In general, these linguistic structures appear in behaviour as organising concepts rather than as primary behavioural entities.

(a) THE NONPERCEPTUAL AND NONARTICULATORY REALITY OF THE PHONEME. Consider first the phoneme, the basic sound unit in language. The word *bats* is made up of four such units, which correspond (in this

case) to the individual letters in the spelling of the word. There is a great deal of intuitive confirmation of such a subdivision of the acoustic stream of speech: the presence of spoonerisms in speech, of alliterative and rhyming folk poetry, and the natural development of phonemic alphabets. In formal linguistic study the phoneme is the basic segment for analysis of the sound patterns unique to each language. In English, for example, the rule for the regular formation of the plurals is as stated in (27).

27. To the singular form add
- (a) /s/ if it ends in a voiceless consonant except those in (c)
  - (b) /z/ if it ends in a voiced consonant or vowel except those in (c)
  - (c) /əz/ if it ends in a sibilant or fricative consonant

For example, after the word *bet* (case (a)) the plural ending is pronounced '-s' as in *bets*; after the word *bed* (case (b)) it is '-z' as in *bedz*; if the singular form of the word ends in a vowel (eg. *bay*, case (b)) then the plural is also pronounced as '-z' (as in *bayz*). Finally, after the word *bush* (case (c)) the plural ending is pronounced 'əz' as in *bushəz*. ('Fricative sounds' are phonemes that involve a marked turbulence of air in their production; eg. the last sound in 'bush, butch, budge, rouge, bus, buzz'.)

These three rules account for all the regular plural forms in English in an elegant and straightforward manner. The large number of acoustic-articulatory phenomena in languages that are equally well described in terms of phonemes is the basic descriptive motivation for postulating their existence. Unfortunately, attempts to determine the acoustic (or articulatory) definition of the objective constancies associated with each phoneme have been frustrating and unsuccessful. The physical realisation of each phoneme is modified by the surrounding phonemes. The acoustic (or articulatory) definitions must take into account sequences of several phonemes at the same time so that the interdependencies can be included in the description.

A more natural unit for objective definition of the basic units of speech perception and articulation is the *syllable*. Not only do we feel that we talk in syllables (rather than stringing phonemes together) but it is also possible objectively to describe the physical properties of the articulatory and acoustic boundaries of syllables. Such boundaries are marked by changes in articulatory movements and corresponding changes in the acoustic intensity of the speech signal. The relative clarity of the objective definitiveness of the syllable is also reflected in

the fact that it is possible to speak all syllables in isolation, but impossible to speak most phonemes in isolation.

Unfortunately the description of linguistic phenomena such as plural formation cannot be naturally described in terms of unsegmented syllables, but must depend on the subdivision of the syllable into phonemes. There are approximately 5,000 unique syllables in English. The rule for plural formation would have to list the different kinds of syllables that take the different plural forms (in /-s/, /-z/ and /-ehz/) in the rule like (28).

28. To the singular form add
- (a) /s/ if it ends in '-bet, -bat, -but, . . . -sip, -sap, -sup . . .'
  - (b) /z/ if it ends in '-bed, -bod, -bud, . . . -sib, -sab, -sub . . .'
  - (c) /ehz/ if it ends in '-bef, -baf, -buf, . . . -sis, -sas, -sus . . .'

While such a representation in terms of syllables would be slightly more economical than listing all the singular words themselves, the major generalisation would be lost that it is the sound *at the end* of the syllable that determines the sound of the plural. This fact could be captured by describing syllables in terms of the sounds that they end in, and stating the rules as listed for the phonemic analysis, as above. But this description would be equivalent to the phonemic analysis itself since it would merely be a circuitous way of referring to the phoneme in question as 'the last sound of the syllable'. Of course, rule (28a) and (28b) would in fact be impossible to state in an unsegmented syllabic system: neither /s/ nor /z/ are themselves syllables, and therefore could not be used as theoretical terms. One would actually have to list separately the pluralisation process as the formation of a new plural syllable from each singular syllable as exemplified in (29). That is, using unsegmented syllables, plural formation would be a process made up of thousands of rules.

29. singular form	plural form
-bet	-bets
-bat	-bats
-bit	-bits
.	.
.	.
.	.
.	.

Thus we appear to be in a dilemma. While the syllable is the natural unit for the description of linguistic data, the phoneme is the natural unit for the description of linguistic regularities. This dilemma can be

converted into an empirical question about the relative role of the phoneme and syllable in actual speech behaviour. To examine this, Harris Savin and I (Savin and Bever, 1970) compared the amount of time it takes for a person to react discriminatively to a syllable beginning in a particular phoneme depending on whether or not he knows the entire syllable to listen for or just the first phoneme of the syllable. We found that it takes about a fifteenth of a second *longer* to identify the syllable when only the first phoneme is known than when the entire syllable is known. Yet all the responses are completed before the middle of the vowel. Listeners are conscious primarily of syllables, and secondarily of the phonemes. We take this result as an empirical reflection of the fact that phonemes are themselves entities which are abstracted out from speech perception and production. The role of such units is to 'mediate' the acoustic and articulatory regularities in the language. Phonemes are 'psychologically real', but their level of conscious reality is *derived* from the primary acoustic/articulatory speech unit, which is the syllable.

(b) THE ABSTRACTNESS OF SURFACE PHRASE STRUCTURE. Another theoretical structure postulated by all linguistic theories is the external phrase structure (or 'parsing structure') which ascribes a hierarchical analysis to the relations between adjacent words and phrases. The phrase structures in (30a) and (30b), indicated by parentheses, represent such hierarchical relations among sequences. Like the phoneme, phrase structure organisations of sentences are critical to the formulation of linguistic rules which capture generalisations about sentence organisation. The phrase structure analysis of sentences is behaviourally reflected in our perception and production of the placement of relative pauses, as well as agreeing with our intuitions about the relative closeness of the associations between adjacent words. Analyses like those in (30) represent empirical data in language behaviour. Phrase structure hierarchies are also indispensable to linguistic analysis; they represent the notion of *phrase type*, which is the theoretical term referred to in linguistic rules (eg, 'noun phrase, verb phrase, adverbial phrase', etc). Each phrase type subsumes a wide variety of distinct constructions, each of which is treated as the same by grammatical rules.

30. a. (they (fed him (dog biscuits)))  
 b. (they (fed (his dog) biscuits))

31.  $NP_1 V NP_2 \rightarrow NP_2$  be  $V + ed$  by  $NP_1$

Consider the formulation of the passive rule in English if the notion of the constituent ‘nounphrase’ (*NP* in (31)) were not a possible concept. One consequence would be that each of the passive sentences in (32) would be formed from the active structure by a separate structural rule.

32. a. *The wine was produced by a German mouse.*
- b. *The alcoholic beverage was produced by a German mouse.*
- c. *The wine was produced by a mouse of German extraction.*
- d. *The fermented juice from a bunch of grapes was produced by a German mouse.*
- e. *The wine was produced by a mouse born in Germany.*
- f. *The liquid in a bottle, made from the juice of undried raisins, was produced by a rodent born in Germany that has whiskers and is crackers about cheese.*

The notion of ‘nounphrase’ (italicised in the examples in (32)) allows a simple and intuitive statement of the linguistic regularities. In brief, there are both behavioural and formal motivations for the analysis of sentences into phrase structure hierarchies.

The question remains, however, as to the role of such hierarchies in ongoing speech behaviour. Traditional and current theories of speech perception agree that the most straightforward (and first) step in the comprehension of sentences is the analysis of the surface phrase structure. (Full comprehension of the meaning is presumed to require ‘deeper’ or ‘more abstract’ operations on the allegedly easily perceived surface structure.)

To test experimentally the claim that the first and easiest step in sentence perception is the isolation of surface phrase structure we have examined the displacements in the reported location of a single click presented during sentences (see Garrett and Bever (1970) for a review of this research). Our first studies demonstrated that the reported location of a click is attracted towards boundaries between explicitly signified clauses (Fodor and Bever, 1965; Garrett, 1965). For example, clicks objectively in the positions marked ‘S’ in the sentences in (33) were reported as having occurred in or toward the points between the clauses, marked ‘R’.

33. a. (The reporters (who were watching George)) drove to  
          the car   S     R
- b. (To catch the reporters) George drove to the car.  
  R     S

Such results demonstrate the claim that the clause units are primary segments of speech processing: a click is mislocated as occurring at the boundaries of such units, presumably reflecting their perceptual coherence or *gestalt*.

These experiments left open the question as to whether it is the external or internal organisation of sentences that is the basis for perceptual segmentation. Our studies confounded the two levels of sentence organisation, since clause boundaries like those in (33) are points at which a surface structure boundary difference coincides with a logical structure difference, as pictured in (34). (Square brackets represent the segmentation of internal structure sentences.)

34. a. [[The reporters who were watching George]     drove the car]  
          2 1   1                                 2
- Actor – reporters   Actor – reporters  
          Action – watch   Action – drove  
          Object – George   Object – car
- b. [[To catch the reporters]                     George drove the car]  
          2 1   1                                 2
- Actor – George   Actor – George  
          Action – catch   Action – drove  
          Object – reporters   Object – car

To show whether internal structure boundaries are the basis for perceptual segmentation we examined the location of clicks in sentences which differed in their internal structure segmentation without any corresponding differences in their surface phrase structure. We found that the internal phrase structure organisation differences were reflected in corresponding differences in click locations, as shown in

35. a. [The general desired     [the troops to fight the enemy]]  
          1   2   2 1
- Actor – general   Actor – troops  
          Action – desired   Action – fight  
          Object – it (S<sub>2</sub>)   Object – enemy
- b. [The general defied     [the troops]     to fight the enemy]  
          1   2   1   2
- Actor – general   Actor – troops  
          Action – defied   Action – fight  
          Object – troops   Object – enemy

(36). This demonstrated that logical structure organisation can act alone as the basis for perceptual segmentation, at least as reflected in the location of clicks.

36. a. The general  $\begin{matrix} \text{R} \\ \text{S} \end{matrix}$  desired the troops to fight the enemy.  
 b. The general  $\begin{matrix} \text{S} \\ \text{R} \end{matrix}$  defied the troops to fight the enemy.

These results left open the possibility that surface phrase structure could also act as the basis for perceptual segmentation. In cases like (33) the click-displacement effects might have been due to the internal structure organisation. To test surface structure effects separately, we have repeatedly examined the location of clicks in sentences with differences in surface structure that do not correspond to internal structure sentence boundaries. The results indicate that such phrase structure divisions within clauses do not attract clicks. For example, there was no difference in the pattern of responses to clicks in (37a) and (37b). (The phrase structure difference is indicated with the parentheses.)

37. a. Sam walked (up the highway) . . .  
 b. Sam (looked up) the address . . .

These results suggest that the first step in the conscious organisation of heard sentences is the segmentation of speech into distinct logical structures rather than the organisation of the entire surface phrase structure. Listeners are first conscious of the segmentation of sequences into structural units that correspond to the units of meaning, namely internal structure sentences.

Of course, our negative results on the effect of surface phrase structure might merely have shown that click location is not a true behavioural indicator of segmental processes. Our studies on minor phrase structure distinctions all required subjects to report the sentence and click location immediately following the stimulus sequence. One might argue that the delayed response 'washed out' any perceptual effects of surface phrase structure. If this were so one would expect no change in the effect of surface structure on click location if subjects waited even longer before reporting their responses. In a separate experiment (Bever, 1968) I required subjects to wait five seconds before writing down the sentence and indicating the click location. Contrary to the prediction, distinctions in minor phrase structure like

that in (37a) and (37b) *do* affect the location of the clicks when listeners delay their reporting (eg, the location response patterns are relatively as shown in (38a) and (38b)). That is, listeners develop a *greater* appreciation of surface phrase structure as they hold the sentence in memory.

38. a. Sam  $\begin{matrix} \text{R} \\ \text{S} \end{matrix}$  walked up the highway.  
 b. Sam  $\begin{matrix} \text{S} \\ \text{R} \end{matrix}$  looked up the address.

The conclusion from these studies is that in immediate sentence processing listeners segment together only those surface structure phrases that correspond to internal sentences. Complete surface phrase structure details are organised as part only *after* the listener has comprehended the sentence, not as the very first perceptual step. It would appear that surface phrase structure, like the phoneme, is a secondary, derived construct so far as the immediate conscious organisation of speech stimuli is concerned. This is perhaps more startling than our claim about the abstractness of the phoneme, since surface phrase structure appears to be one of the few aspects of linguistic phenomenology which traditional and modern grammarians agree as 'obviously real'

What then of the many percepts which do reflect phrase structure, such as stress and intonation? What of the 'set' experiments, in which subjects learn surface structure patterns as an aid to perceiving novel sentences which repeat those patterns? What of the studies of eye movements during reading which suggest that details of surface phrase structure guide where readers look? Is it not the case that these phenomena justify the claim that surface phrase structure is perceptually primary? It is my belief that all of these demonstrations of the 'behavioural reality' of surface phrase structure depend on giving listeners an opportunity to 'abstract out' the phrase structure analysis. Accordingly, they do not demonstrate that surface phrase structure organises immediate processing when the structure is not known beforehand. Rather, the existing phenomena show that, *once known*, the surface phrase structure of a particular sequence can interact with basic sensory processes and sensations.

The most obvious case is the formation of phrase structure set. Mehler and Carey (1968) found that subjects perceive a sentence like (39) in noise better after a series of five sentences with similar surface

structure than after five sentences with a dissimilar phrase structure like (40).

39. They are (smiling authors).  
 40. They (are fixing) airplanes.

Such a result does not demonstrate that such details of surface phrase structure are ordinarily responded to in perception. Rather, it demonstrates that listeners can isolate and expect such a particular phrase structure after repeated presentation.<sup>2</sup>

The perception of stress patterns might be taken as empirical evidence for the use of phrase structure hierarchies in immediate processing. Such percepts as in (41) have been taken as the factual basis

41. a. The <sup>1</sup>fat (<sup>2</sup>general's <sup>3</sup>wife) (the fat wife of a general).  
 b. The (<sup>1</sup>fat <sup>3</sup>general's) <sup>2</sup>wife (the wife of the fat general).

for cyclically applying stress assignment rules such as (42) in English (see Chomsky and Halle, 1969).<sup>3</sup> ('1' indicates strong stress, '2' intermediate stress and '3' weak stress.) These rules apply first to the

42. Apply stress 1 to the initial constituent of a phrase and lower other stresses. This rule applies to successively more inclusive phrase constituents.

43.           <sup>1</sup>           <sup>1</sup>           <sup>1</sup>           <sup>1</sup>           <sup>2</sup>           <sup>1</sup>  
           ((fat) ((general's) (wife))) (((fat) (general's) (wife)))  
 a.   <sup>1</sup>           <sup>1</sup>           <sup>2</sup>           <sup>1</sup>           <sup>1</sup>  
       fat        general's wife     fat general's wife  
 b.   <sup>1</sup>           <sup>2</sup>           <sup>3</sup>           <sup>1</sup>           <sup>3</sup>           <sup>2</sup>  
       fat        general's wife     fat general's wife

smallest constituent as shown in (43) and then to successively more inclusive constituents (43a, then 43b). The kind of intuitions about stress shown in (41) might be taken as empirical support for the immediate perceptual organisation of the phrase structure in (41) since, at first, stress would appear to be an aspect of speech that is perceived directly. The fact that phrase structure is required to describe the stress pattern and that stress is an immediate percept would appear to justify the claim that phrase structure is an immediate percept. However, in studying intuitions of stress as in (41) linguists require a good deal of personal introspection and reflection to decide on stress

patterns, except for the intuitions about the placement of the primary stress. This reflects the fact that only primary stress is reliably observable as an intensity variation in the acoustic analysis of speech. This was shown by Lieberman (1963), who found that if the articulatory information is removed from utterance but intensity and intonation preserved, linguists could not agree on the position of any stress levels below the primary one. The subjective assignment of stress patterns that reflect minor differences in phrase structure depends on independent knowledge of the phrase structure and reflective consideration of it.<sup>4</sup> The complete stress pattern is not itself perceived immediately and cannot be taken as evidence for the claim that all the details of surface phrase structure are perceptually primary.

Our own experimental demonstration of the role of surface phrase structure in guiding eye fixations has a similar explanation (Mehler, Bever and Carey, 1967). We found evidence that there is a rule of eye-fixation which describes the relative frequency of the part of a sentence we look at directly as a function of its phrase structure (44). This rule

44. Fixate on the initial half of a constituent.

applies to successively more inclusive phrase structure constituents. We tested the predictions made by (44) on sequences whose phrase structure was ambiguous, as in (45), with a preceding context to force the interpretation one way or another.

45. They were lecturing doctors.

The cross-subject comparisons of relative number of eye-fixations at each point were in accord with the predictions made by (44). This would appear to support the claim that surface phrase structure plays an immediate role in sentence perception; it interacts with the ongoing placement of eye-fixations, which surely implicates it in the very first stages of perception. However, the design of our experiment required that the subjects be pre-set to expect one of the interpretations of the ambiguous sequences. This presetting involved several preceding sentences containing direct presentation of the ambiguous phrase in a context which disambiguated it (eg, a preceding sentence might be 'The lecturing doctors spoke clearly . . .'). Our subjects were explicitly pretrained in each case on the critical phrase with a particular phrase structure. The influence of the phrase structure of the critical phrase on eye-fixations merely demonstrated the role of phrase structure in the recognition of pre-set structures.

The conclusion from these arguments is that the complete surface phrase structure of a sentence is not necessarily perceived as the first step of sentence perception. Rather, surface phrase structure *can* be used if listeners are pre-set for it, and it can be appreciated if listeners are encouraged to process further a sentence after first hearing it.

## (c) HOW MANY DEEP STRUCTURES ARE REALLY INSIDE THE MIND?

A third linguistic structure figuring prominently in current descriptions is the syntactic organisation of the grammatical relations between phrases, which is internal to every sentence. Like the phoneme and phrase structure, internal or 'deep' syntactic structure is used in linguistic descriptions both for empirical and theoretical reasons. Consider the sentences in (46). It is clear that the logical relations between 'the cat', 'interest' and 'the dogs' are constant despite the obvious differences in the surface form of the different sentences in (46). The

46. a. The cat interested the dogs.
- b. The dogs were interested by the cat.
- c. It's the cat that interested the dogs.
- d. It's the dogs the cat interested.
- e. It's the cat by whom the dogs were interested.
- f. The cat happened to interest the dogs.
- g. It's true that the cat interested the dogs.
- h. The dogs happened to be interested by the cat.
- i. The cat succeeded in interesting the dogs.
- j. The cat seemed to interest the dogs.
- k. The interesting of the dogs by the cat really occurred.
- l. The cat's interesting the dogs really happened.
- m. What seemed to happen was that the cat interested the dogs.
- n. It's the dogs that the cat happened to interest.
- o. Interesting the dogs was easy for the cat.
- p. It was easy for the cat to interest the dogs.
- q. The dogs were easy for the cat to interest.
- r. It's interesting the dogs that the cat did.
- s. What the cat did was interest the dogs.
- t. What interested the dogs was the cat.
- u. What the dogs were interested by was the cat.
- v. It's the cat the dogs were interested by.
- w. It's by the cat that the dogs were interested.
- x. The cat happened to seem to be able to interest the dogs.
- y. What the cat seemed to do was interest the dogs.
- z. The interesting of the dogs by the cat happened yesterday.

- aa. Being interested by the cat happened to the dogs.
- .
- .
- .
- .
- z<sup>n</sup> Fssst.

concept of grammatical relations, such as actor, action, object as in (47), is inherent to every sentence independent of the explicit construction of the sentence.

47. actor = cat
- action = interest
- object = dogs

The systematic representation of the logical relations among the phrases in each sentence could take different forms. A grammar could label the internal relations which the parts of the sentences have in relation to each other separately for each type of sentence construction. For example, (48a) and (48b) articulate the separate relations among the phrases within active and passive construction. The systematic separate representation of the logical relations for all clause construction types would appear to be impossible, since there is no known limit on the complexity of such structures which are inherently allowed

48. a. In an active sentence the first noun phrase is the actor and the last is the object.
- b. In a passive sentence the first noun phrase is the object and the last is the actor.

by a language. Consider the number of different statements of the logical relations needed just for the different sentence constructions in (46). Furthermore, statements like (48a) and (48b) fail to represent directly the fact that there are sets of *related* sentences which differ in their construction, but which share certain internal phrase relations (as do all the sentences in (46)). Finally, formulae like those in (48) *presuppose* that each sentence is independently marked as to what construction type it is. Yet this requirement makes formulae like (48) circular rather than explanatory.

These empirical failings of stating the grammatical relations with a different formula for each construction type are avoided if a grammar contains rules for relating one construction type to another. For example, the active and the passive construction could be related by a

'co-occurrence transformational' formula as in (49). The relation in (49a), stated formally in (49b), can explain the fact that (48a) and (48b)

49. a. To every transitive declarative sentence there corresponds a passive sentence in which the noun phrase order is reversed, in which the verb is placed in the past participle form and followed by the word *by*, in which a form of the verb BE follows the first noun phrase and is inflected with the tense of the original sentence.
- b.  $NP_1$  Verb + tense<sub>i</sub>  $NP_2$   $\longleftrightarrow$   
 $NP_2$  Be + tense<sub>i</sub> Verb + ed by  $NP_1$

are related. Such formulae relate sentence constructions with different surface orders of the phrases but they do not themselves change the logical relations (cf Harris, 1955).

The need to represent the logical relations inherent in every sentence is not maintained out of idle caprice, nor merely out of the desire to represent directly speakers' intuitions about such relations. The set of semantic and syntactic restrictions on possible phrase combinations are stated across such relations. For example, the sentences in (50a) and (50b) are unacceptable for the same reason, despite their superficial differences; namely no inanimate noun (eg, 'sandwich') can be the

50. a. \*The dog interested the sandwich.  
 \*The sandwich was interested by the dog.

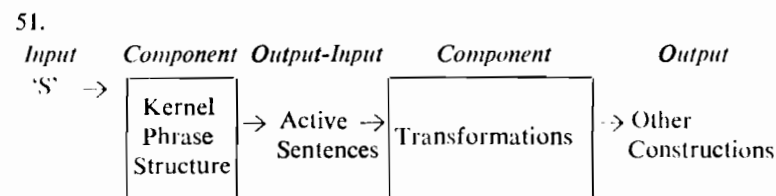
object of the action 'interest'. To state this restriction without reference to the concept 'object' one would have to refer to each of the different constructions separately, since the ordinal position of the 'object' can vary in each construction (as in (46a-z)). Clearly, the statement of such restrictions in terms of underlying logical relations is vastly simpler (and more to the point) than statements in terms of actual sentence construction (even if the latter form of description were possible).

Formulae like (47) represent in a compact manner the logical relations for all sentence constructions. The assignment of the logical relations could be stated on only one of the construction types since the transformations like (49b) do not change the logical relations. It should be noted that neither the active nor the passive sentence is the more 'basic' in the formula in (49); the formula merely states a two-way mapping which specifies how to transform one sentence construc-

\* This symbol indicates that the sentence following is not an acceptable English sentence.

tion into a corresponding sentence of the other construction. The question remains as to which construction type should be used as the 'basic' one on which the logical relations are stated. The active form is the most appropriate since all combinations of phrases can appear in an active construction, if they can be combined into a sentence at all. Certain active sentences do not have corresponding passive forms (sentences with intransitive verbs, eg, 'the dog slept', do not have corresponding passives, eg, \*'was slept by the dog'); but no (non-idiomatic) passive form fails to have a corresponding active. Thus if we assign the logical relations in a sentence with reference to the active form, as in (48a), the statement need only be made once for all the possible logical relations in the entire language. If the passive form were basic and the relations stated as in (48b), then an additional statement would be required for sentences which have no passive version at all, such as sentences with intransitive verbs. Arguments of this sort can be marshalled from all construction types showing that the simple active form of sentences is the most appropriate structure to use as the 'basic' construction representing the logical relations among the phrases.

The decision to represent the logical relations in sentences based on the active form leads to a natural ordering of the application of rules in the formation of all sentence constructions. The grammatical representation of each sentence always includes the active form to which it corresponds (if it is not an active sentence itself) as the canonical representation of its logical relations. A natural consequence of the ubiquity of the active form in every construction is to derive the other forms by means of transformations like (49b). Such transformations now have directionality, mapping the active sentence onto successively more distantly related constructions. The structure of grammar of this kind is presented in (51).



It follows from the organisation of grammar in (51) that the structure to which transformations apply is an abstraction from the simple

\* This symbol indicates that the sentence following is not an acceptable English sentence.

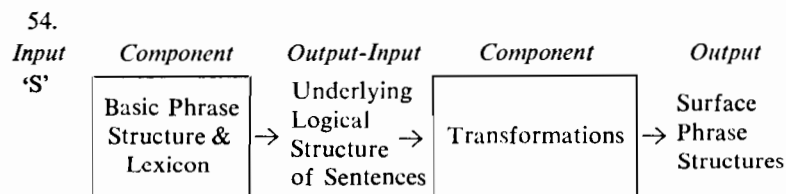


active form of the sentence rather than the active sentence itself. If the passive reordering rule applied to a fully formed declarative sentence like 'The cat interested the dogs' then an incorrect form like (52) would result, in which the verb inflection agrees in number with the *original* singular surface phrase structure subject, *cat*.

52. \*The dogs was interested by the cat.

53. The cat sg past interest the dog pl.

The generalisation that the first noun phrase determines the number of the verb inflection can be maintained only if the passive reordering rule applies *before* the inflection rule. This has the consequence that the passive reordering transformation applies to an abstract structure that has not yet had agreement inflections applied to it, as in (53). That is, the transformations do not apply to an *actual* sentence, but to an abstract schematic representation of the logical relations among the phrases of the sentence. A grammar of this kind is outlined in (54). This was the form of a transformational grammar proposed by



Chomsky in 1957 and refined in 1965. Basic phrases are generated in a schema which represents their logical interrelations. A set of transformations map such schemata onto actual sentences.

Certain transformations impose serious rearrangements on the external form of a sentence, such as the passive (55). Other transformations change specific lexical items (56) and others adjust the final form of the sentence (57).

55.  $NP_1 \text{ tense } V \ NP_2 \rightarrow NP_2 \text{ tense Be } V + \text{ed by } NP_1$  (passive)
56.  $NP \text{ tense Be } V_x + \text{ed by } NP \rightarrow NP \text{ tense Be } V_x + \text{ed preposition}_x$   
 $NP$  (preposition is 'in' if  $V$  is 'interest', 'at' if  $V$  is 'upset',  
 etc) (pseudo-passive)
57.  $NP + no_i \text{ tense } V \dots \rightarrow NP + no_i \ V + \text{tense} + no_i \dots$   
 (number and tense agreement)

Sample derivations with these transformations are presented in (58)-(60).<sup>5</sup>

58. The cat sg. past interest the dog pl.  
 The cat sg. interest sg. past the dog pl. (number agreement)
59. The cat sg. past interest the dog pl.  
 The dog pl. past Be interest + pp. by the cat sg. (passive)  
 The dog pl. Be + past + pl. interest + pp. by the cat. (number and tense agreement)
60. The cat sg. past interest the dog pl.  
 The dog pl. past Be interest + pp. by the cat sg. (passive)  
 The dog pl. past Be interest + pp. in the cat sg. ('pseudo-passive')
- The dog pl. Be + past + pl. interest + pp. in the dog sg. (number and tense agreement)

One of the first studies of the 'psychological reality' of such a grammar centred on the role of the underlying phrase structures of sentences as the active schemata used in sentence memorisation. A series of experiments suggested that, in memorising lists of sentences, we tend to encode them in terms of their individual internal structures, with additional information specifying the transformations that must apply to yield their surface structure (Miller, 1962; Mehler, 1963). One demonstration of this was the fact that passive sentences are harder to remember than active sentences. This was allegedly due to the passive sentence (eg (48b)) having one additional fact to be memorised over active sentences, namely the information that the passive transformation applies as well as the (obligatory) number and tense agreement transformation.

In a recent experiment we examined the validity of the behavioural claim that the active (58), the passive (59) and the 'pseudo-passive' (60) require an increasing amount of space in memory, corresponding to the relative number of transformations involved in their derivation, as summarised in (61) (Bever and Hurtig, forthcoming). Subjects were asked to examine each sentence in a heterogenous set of nine for five seconds, and to write out all the sentences after each of five trials. We found that active sentences (58) were the best recalled, passive (59) the

next best and pseudo-passives (60) were the worst recalled, just as predicted.

- |        |                                     |  |
|--------|-------------------------------------|--|
| 61. a. | The cat interested the dogs         | <i>transformations</i><br>(number and tense) |
| b.     | The dogs were interested by the cat | (passive, number and tense)                  |
| c.     | The dogs were interested in the cat | (passive, pseudo-passive, number and tense)  |

This kind of evidence, obtained by many researchers, widely supports the claim that the encoded form of sentences corresponds at least in part to an analysis of the logical relations on the one hand, and informations about transformations used to derive the surface form of the sentence on the other hand. These experiments verified analyses made by syntactic theory, using a straightforward interpretation of the interaction of memory and syntax. The notions of 'internal structure' and 'transformation' became psychologically respectable, and we all looked forward to further experimental studies of the role of these structures in behaviour.

Developments in syntactic theory, however, suggested that the internal representation of most sentences was far more abstract than had first been thought. For example, further consideration of a 'pseudo-passive' sentence like (61c) indicated that to derive it from the passive form of the sentence fails to capture many linguistic regularities (Postal, 1968).<sup>6</sup> First, certain syntactic forms can exist in the 'pseudo-passive' construction which cannot exist with the passive itself. For example (62a) is perfectly grammatical while (62b) is not (on the interpretation that John is the actor and there is no contrastive stress). Yet how could (62a) exist as a derivative of a *non-existent* form like (62b)?

62. a. John was interested in himself.  
b. \*John was interested by himself.

In addition to such formal difficulties it was noted that there is a strong intuitive feeling that the first noun phrase of such 'pseudo-passives' (*dogs* in (61c)) is an actor, while this is not characteristic of

\* This symbol indicates that the sentence following is not an acceptable English sentence.

passive constructions themselves. Furthermore, the second noun phrase of the corresponding 'active' sentences (*dogs* in (61a)) also appears to be an actor, which is not characteristic of ordinary actives. Compare (63a) with (61a). In (63a) *dogs* is the object of an action carried out by *cat*, while in (61a) *dogs* is not an obvious object of the same kind and *cat* certainly does not 'carry out' an action 'upon' *the dogs*. This difference can be seen in sentences (63b) and (63a). Clearly (63b) is unacceptable because *rock* cannot be an actor, while its initial position in (63c) does not imply that it is an actor. Thus the generalisation in (48a) would appear not to be correct if sentences like (61a) are interpreted as closest to the active form.

63. a. The cat bit the dogs.  
b. \*The cat interested the rock.  
c. The rock interested the cat.

In sum, there are formal and intuitive reasons for considering that 'pseudo-passives' (61c) rather than 'pseudo-actives' (61a) most closely represent in external form the internal relations, according to which the first appearing noun phrase is an actor, as in (48a). In this analysis the apparent 'active' form of such constructions (61a) is itself derived from the abstract structure closest to 'pseudo-passive'. That is, the deep phrase structure generates a form like (64), and an exchange transformation (66) would form the 'pseudo-active' structure as in (65).

64. The dog plural past interest in the cat singular.  
65. The cat singular past interest the dog plural.  
66.  $NP_1 V_x \text{ prep}_x NP_2 \rightarrow NP_2 V_x NP_1$  (where  $V_x \text{ prep}_x$  is 'interest in, upset at, . . .' etc.) (*exchange*)

There are other cases in which actor and object are exchanged by a transformation like (66) to produce apparent active sentences that are in fact derived from other forms. For example, (67b) is derived from a form like (67a) and (67d) from one like (67c), (67f) from (67e) and so on (note that for these examples one does not need to argue which form is the basic one; in either case they motivate the existence of a non-passive rule which exchanges actors and objects). That is, in addi-

\* This symbol indicates that the sentence following is not an acceptable English sentence.

tion to the passive rule there is a general subject/object exchange rule, like (66) which applies with verbs like *interest*, *upset*, *dry*, etc.

- 67. a. Everyone teases her easily.
- b. She teases easily (for everyone).
- c. The raisins dried in the sun.
- d. The sun dried the raisins.
- e. We suggest from graph three that . . .
- f. Graph three suggests (to us) that . . .

Thus there are many reasons to include a rule in English grammar which can explain the relation between the 'pseudo-passive' and the corresponding active. Both would appear to have the order of logical relations reversed from the general case. If one analyses the 'pseudo-passive' as closest to the basic form and derives the corresponding 'active' from it by the exchange rule, then this anomaly is avoided, since the 'pseudo-passive' orders the phrase relations in an order most closely corresponding to the canonical order assumed in (48a). The relative transformational complexity of the sentences in (61) on this analysis is presented in (68).<sup>7</sup>

- |        |                                      |  |
|--------|--------------------------------------|--|
| 68. a. | The dogs were interested in the cat. | <i>transformations</i><br>(number and tense) |
| b.     | The cat interested the dogs.         | (exchange,<br>number and tense)              |
| c.     | The dogs were interested by the cat. | (exchange,<br>passive, number<br>and tense)  |

In the light of these arguments what are we to make of the earlier experimental demonstrations that *the* underlying syntactic structure as presented in (61) is the basis on which sentences are memorised? We are now faced with two competing linguistic analyses, both of which have certain formal and empirical arguments in their favour, but which mark different sentence constructions as the closest to the underlying logical structure. One way of resolving this conflict would be to take the memory experiments as evidence for claims about which analysis is correct. On this criterion the analysis in (61) rather than (68) would be considered correct since it best predicts the sentence memory results. However, the motivations for both of the above analyses are also empirical, albeit non-experimental since they are based on intuitions

about linguistic facts. Our dilemma is not one that can be resolved by trying to ignore some of these facts merely because they are not 'substantiated' by results. We must instead specify the circumstances under which the different analyses are behaviourally relevant.

It might be argued that the analysis in (68) is relevant only to the most reflective aspect of linguistic behaviour, namely the behaviour of producing linguistically relevant intuitions. In this sense one might wish to argue that the analysis in (68) is an artefact of linguistic technique. However, this is not the only kind of behaviour in which the structural analysis in (68) appears. In a separate experiment with the same sentence materials as above, we asked subjects to recall the sentences after a relatively long period of time, from an hour to several days. Under those circumstances we found that the order of recall success was predicted better by the analysis in (68) than in the previous experiment (combined with the hypothesis that the smaller number of transformations makes a sentence easier to recall). Given a long period of time subjects apparently shift from using the analysis of sentences in (61) to one more like that in (68). We have also found that this shift can be triggered in part by giving each subject prior experience with a range of sentence constructions for each individual sentence like those in (68), before he is asked to pick out one of them to memorise. That is, anything which encourages the subject to place the sentences that he is memorising in a broader linguistic context stimulates him to use a 'deeper' linguistic analysis for the representation of those sentences.

This is analogous to the differences between the linguistic considerations which underlie the two analyses. The first analysis in (61) was based on a relatively narrow range of facts, while the later analysis in (68) was based on attempts to take into account more sentence relations and uses transformational rules needed for entirely different kinds of sentence constructions, eg (66). If our view is correct, subjects can implicitly carry out such linguistic analysis on sentences they are given to learn and develop 'more abstract' organisations of the sentences as they reflect on the sentences or put them into a broader perspective. That is, subjects can intuitively recapitulate the stages of linguistic arguments that I reviewed above, first motivating an abstract organisation among sentences (as in (61)) and then a more abstract organisation (as in (68)). Under the right circumstances (having more time or more experience with the range of sentence types) both subjects and linguists make use of a deeper analysis of the logical forms internal to the sentences.

(d) GRAMMARS, LEVELS OF ABSTRACTION AND THE ACQUISITION OF STRUCTURE. This result poses a problem for our understanding of the relation between the structure of a language and the individual speaker's knowledge of that structure. The halcyon days are gone when one could speak of the extent to which a given speaker/listener was using *the* grammar of his language in his behaviour. Rather, we find that different (and sometimes incompatible) structural hypotheses about sentence structure are brought out by different sorts of behavioural tasks. This changes the original goal of discovering *the* grammar of English, to discovering the set of possible (ie *natural*) grammars which speakers (and linguists) invent. This set is itself primary data for the study of the human processes of abstraction. That is, we can consider linguistic investigations as providing a range of possible grammatical organisations of sentences. If we find that more than one such organisation has behavioural validity (as (61) and (68)), then we have a central problem for psychological explanation: what is the nature of human abstraction which makes certain structural organisations of sentences natural, and what are the laws governing which natural organisation appears in different tasks?

The moral from the studies of the behavioural reality of the phoneme, phrase structure and underlying structure is clear. The descriptive role of such linguistic constructs justifies their use, and is alone sufficient evidence for their 'psychological reality'. But the behavioural manifestation of such constructs depends on the task and the way in which speakers approach the task. Just as we must develop a science of the phenomenology of sentence intuitions, we must also develop a theory of the interactions of internal structures with actual behaviours, if we are to progress in our understanding of language. In this sense we are indeed returning to experimental mentalism. But our position is somewhat stronger than that of the mentalists at the turn of the century. Unlike them we have a detailed theory of the set of possible internal structures of language and a range of techniques for their study. Rather than having to concentrate on individual personal images and introspections, we can study experimentally the interrelations between sentences and behavioural effects of sentence structures held in common by many speakers and analysed by a general linguistic theory.

The existence of different behavioural organisations of relations among sentences in adults raises a parallel question about the acquisition of grammar in children. The facts reviewed earlier suggest that there are certain structural universals which appear in the early

development of patterns of talking and listening. However, it is quite possible that the structure of the grammar that mediates between these systems is initially less abstract than the most abstract adult grammar. This would be consistent with our finding that the range of sentence constructions considered and the amount of time spent considering them increase the 'abstractness' of the organisational schema applied to them. Thus, as the child increases his range of perceptual and productive mastery, the grammatical structure he uses to organise his implicit knowledge may also become more abstract. To investigate this possibility we must apply various techniques to ferret out the structural organisation that children maintain as the basis for their linguistic skill. Merely to study the development of the skill itself is not sufficient since, as I have argued, the same manifest skill can reflect quite distinct internal organisations.

### 3. *The influence of the child's speech behaviour on universals of linguistic structure*

Each system of speech behaviour discussed above plays a role in language as a whole, and therefore constrains the form of the other systems. For example, it is often noted that the perceptual mechanism for speech comprehension must comply with the syntactic structure of the language. Obviously, many specific perceptual rules reflect structural properties unique to each language. For example, we can show experimentally that English listeners search implicitly for a noun when they hear a determiner (words like 'the, a, some . . .', etc) and clearly such a strategy would play no role in the listening habits of speakers in a language without prenominal determiners. There are also universal structural constraints which are reflected in universal properties of the mechanism for speech perception. For example, the perceptual mechanism is not required to decode sentences with backwards word order.

It is equally true (although less often recognised) that the form of the syntactic system is itself constrained by the limitations of human perception. Clearly the child does not learn grammatical constructions which he cannot understand; in this way perceptually incomprehensible constructions are weeded out of the grammar of a language as they arise. In some cases, structural universal constraints on syntax might allow specific constructions to exist in a language which are ruled out because they are nevertheless hard for a child to understand.

The interplay between perceptual and grammatical complexity is most strikingly revealed in the history of language, in which we can

observe cases where a change in one part of a grammar makes certain constructions harder to understand; these constructions are then ruled out of the language by further developments in the grammar. An example of the effect of this kind of interaction on the structure of language appears in the evolution of the constraints on the presence of relative pronouns introducing subordinate clauses in English. Consider the sentences in (69a, b).

69. a. The boy who likes the girls fell down.  
b. \*The boy likes the girls fell down.

Sentences like (69b) are ungrammatical, in which the subject relative pronoun is deleted in a relative clause modifying an initial noun. We can find a plausible explanation for this in the child's early strategy of interpreting any 'noun/verb' sequence as 'actor-action' and his tendency to take the first such sequence as the most important part of the sentence. If the relative clause introducer ('who, that') were deleted as in (69b) the child would be misled into concentrating his attention on what is in fact the *subordinate* clause of the sentence since the first 'noun/verb' sequence is not marked as subordinate. Furthermore, there would be complete ambiguity of a sentence like (69b) with one like (70b), derived from (70a).

70. a. The boy likes the girls who fell down.  
b. \*The boy likes the girls fell down.

While a certain amount of derivational ambiguity appears in most languages it is plausible that ambiguity as to which clause is the main clause and which the subordinate is particularly difficult for the perceptual mechanism to deal with. Most ambiguities can be resolved by the context in which they occur; nevertheless there would be many instances in which the ambiguity between sentences like (69b) and (70b) would be particularly hard to resolve from conversational context, since one of the basic logical propositions is shared ('The boy likes the girls'). We found that children go through a period of interpreting sentences with the most obvious interpretation even to the point of misinterpreting sentences like 'The dog pats the mother'. Accordingly, ambiguous sentences that are not uniquely biased to a particular interpretation by the context would be particularly hard for the child since there would be no contextually 'obvious' interpretation.

\* This symbol indicates that the sentence following is not an acceptable English sentence.

Such constructions would tend to be blocked from occurring in the language if there were an available grammatical mechanism that could block them.

Thus there are two perceptual reasons that one could suggest for the restrictions on the deletion of subject relative pronouns on initial nouns, as in (69b). The first sequence would be misinterpreted as an independent main clause, and the construction would also be highly confusable with the sentences derived from deletion of subject relative on non-initial nouns as in (70b). The restriction against subject relative pronoun deletion on non-initial nouns (70b) has a weaker perceptual motivation—namely that the sequence created by that deletion, although not initial, would itself be a plausible independent clause (eg, 'the girls fell down') and produce a confusing sentence.

At first these arguments may appear hopelessly *post hoc*—we have merely rationalised a perceptual system around the grammatical phenomenon as its explanation. There are several counters to the claim that our explanation is circular. First we are using *independent* evidence from perception in adults and the acquisition of perceptual mechanisms in children to show that such constructions are perceptually difficult. Second, there are other grammatical structural constraints on optional rules in English which can be directly interpreted as maintaining an initial subordinate clause marked as distinct from an initial main clause. For example, there are no restrictions on subject relative pronoun deletion if the form of the verb in the relative clause is itself not confusable with the main verb of a sentence. While (71b) is not an allowed derivation from (71a), (71c) is. On our interpretation (71c) is allowed because in it, the relative clause verb form is uniquely marked (by the '... ing') as in a subordinate construction.

71. a. The boy who is running down the street is happy.  
b. \*The boy is running down the street is happy.  
c. The boy running down the street is happy.

There are similar restrictions on the deletion of complement particles, 'the fact' and 'that' in English. These are freely deleted from many constructions when the subordinate clause does not appear first in the sentence (72a-d). However, *at least one* of these markers must appear when the subordinate clause is in initial position (72e-h). This is not merely a restriction that the subordinate marker must always appear at the beginning of initial subordinate clauses, as is shown by

\* This symbol indicates that the sentence following is not an acceptable English sentence.

## THE STUDY OF LANGUAGE BEHAVIOUR

72. a. I know the fact that John is here.  
 b. I know that John is here.  
 c. I know the fact John is here.  
 d. I know John is here.  
 e. The fact that John is here is known to me.  
 f. That John is here is known to me.  
 g. The fact John is here is known to me.  
 h. \*John is here is known to me.
73. a. I am bothered by the mere fact of John's being present.  
 b. I am bothered by John's being present.  
 c. The mere fact of John's being present bothered me.  
 d. John's being present bothered me.
74. a. I heard the claim of the fact that John is present.  
 b. I heard the claim that John is present.  
 c. I heard the claim John is present.  
 d. The claim that John is present was heard by me.  
 e. The claim John is present was heard by me.

the examples in (73d) and (74e). In these cases there are other markers that the initial clause is subordinate (the '...ing' on the verb in (73d) and the presence of the deverbal complementising noun 'claim' in (74e)). The complementising particles 'that' and 'the fact' may be deleted on initial subordinate clauses *only* if there is *some other basis* for uniquely recovering the fact that the initial clause is a subordinate clause. The generalisation underlying all these restrictions is that an initial subordinate clause must be marked as distinct from an initial main clause. Accordingly, the restriction on subject relative pronoun deletion on initial nouns is simply a particular rule operating within the general restriction on the form of English sentences.

The final independent evidence for our interpretation is drawn from the history of English. The modern English restriction on deleting subject relative pronouns on non-initial nouns is less strongly motivated perceptually than the restrictions on deletion following initial nouns. This is reflected in the fact that there was a long period in English when sentences like (70b) *could* occur. (Of course, in Old and Middle English, the form of the relative and demonstrative pronouns used to introduce relative clauses was quite different; the examples given here are merely to illustrate the structural properties of the sen-

\* This symbol indicates that the sentence following is not an acceptable English sentence.

tences. See Bever and Langendoen (in press) for a collection of historical examples, and a more detailed discussion of the phenomenon.) That is, the relative pronoun was deletable when it modified non-initial nouns: before the 12-13th Century, sentences like (75b) were optional versions of sentences like (75a). It was only around the 14th Century that such sentences became completely inadmissible.

75. a. Alle mæhtign þæm be gelefes.  
 b. Alle mæhtign þæm gelefes.  
 (All power to him (who) believes).

Why should this have happened? Why should sentences like (75b) ever have been admissible if they are inconsistent with the perceptual strategies, and why did they then become ungrammatical when they did? In our view, such sentences were acceptable before the 14th Century because the object noun (eg, 'the girl' in (70b) or 'þæm' in (75b)) was often uniquely inflected in a non-subject case ('accusative' in (70b), 'dative' in (75b)). That is, there could have been no confusion that the noun-verb sequence created by deleting the subject relative pronoun was a *subject-verb* sequence, since the noun phrase was often uniquely and explicitly inflected as a *non-subject* noun. Sentences like (70a) were not allowed at this time because in them the modified initial noun was also inflected in subject case and the perceptual confusion would have been as strong as in modern English.

By the end of the 14th Century nominal and adjectival declensions had largely disappeared so that all sentences like (70b, 75b) were now themselves perceptually confusing as in modern English. It was at this time that the restriction against deleting any subject relative pronoun appeared. In our view this development occurred simply as a way of resolving the perceptual difficulty occasioned by the loss of the nominal inflection system. As children learned the language, they gradually constrained admissible deletions of relative pronouns to the modern system, because of the newly developed difficulty in understanding sentences which violated that system.

In brief, the history of the language reveals an interplay between the organisation of the grammatical rules and the perceptual complexity of the sentences generated by those rules. The deletion of subject relative pronouns on *initial* nouns has always been inadmissible as part of the general system of restrictions that guarantee that initial subordinate clauses are distinct from initial main clauses. In Old English subject relative pronouns could be deleted on non-initial nouns because such nouns were often explicitly marked by inflections

as non-subject; such a 'noun' could not be misinterpreted as an independent clause subject of the following subordinate verb. When noun inflections were lost from the language this confusion could arise: such sentences became perceptually complex and the restriction on subject relative pronoun deletion was extended to relative pronouns modifying nouns in all positions.<sup>8</sup>

In this example the scope of the particular optional (or 'stylistic') rule that deletes relative pronoun modifiers was modified according to the perceptual habits of the child. This exemplifies how the relative dependence of the child on perceptual strategies of speech constrains the form of structural grammars which are learned. It is obvious that a grammar could not be learned in which every sentence is ambiguous with respect to its internal structure. Similarly, a grammar in which every sentence violated universal perceptual principles could not be learned. But existing grammars do contain sentences *some* of which are ambiguous, and *some* of which strain general perceptual principles. We cannot restrict the universal form of a possible grammar in any way except to say that sentences which it predicts must be, *in general, perceptually analysable*. Surely the notion of relative perceptibility must be measured *vis-à-vis* the actual use of the language and the properties of the child's cognitive structure rather than be reference to 'structural universals of the grammar of a language'. Accordingly, certain universal features of linguistic grammars are due to laws governing their actual use by young children and adults. The fact that the child is simultaneously acquiring a structural grammar and systems for speech production and perception leads to a view of language learning and corresponding principles of linguistic change and linguistic universals which emphasises an interaction between the different systems of language use. Since language learning includes the simultaneous acquisition of perceptual and grammatical structures, the ultimate structure of the grammatical system is partially a function of two kinds of simplicity: simplicity of the structural system itself, and simplicity of the systems for speech perception and production.

It remains for further research to show what perceptual constraints interact with the syntax of non-Indo-European languages. The mechanisms of speech production and, even more important, of structural learning will undoubtedly be shown to have profound effects on the kinds of structures which languages exhibit. I have concentrated on English because we have done little work with other languages. I have concentrated on the effects of the *perceptual* mechanism in syntax because we understand nothing about the mechanisms of language

acquisition and speech production. Since we are at the beginning of our investigations I urge the reader to take our examples with a dose of salt; future research will indicate most of the specific claims made here to be superficial and incorrect. But there is no doubt that such interaction between speech behaviour and linguistic structure occurs continuously and is the main source for the life and evolution of every language.

#### D. Conclusion

One common thread in this volume is a wariness of the monolithic tendencies of the recent revolution in the study of language: each author discusses some particular way in which structural properties of language should be embedded within other systems of language and cognition. I have argued that the concept of language behaviour is like the concept of a particular species—a complex of interacting systems, primarily the systems of speech perception, speech production and speech structure. Such subsystems *mutually* influence each other's internal structure; accordingly, *no* system is more central or explanatory than any other. In this chapter I have presented a sample of theoretical, experimental and historical approaches that can be used to explore the interactions of these behavioural subsystems of language.

There are two conclusions from this view of the study of language. First we must be much more careful than in the recent past to study the nature of our intuitions about sentences. It will not do to multiply formal 'levels' or apocalyptically to attack each others' theories every time a new kind of intuition appears on the horizon. We must first make sure that we understand its nature and its interaction with other sets of intuitions. Not only will this solidify the factual basis of linguistic description, it may offer some understanding of how further to develop experimental phenomenology.

The final point bears on the question of nativism in language and the relation of human language to more primitive communication systems. Nobody in command of his faculties can deny that language is innate in some sense, just as it is innate to a monkey to have digital opposition. But the study of homologues in allegedly primitive forms of advanced behaviour only confuses the problem. Consider the uselessness of comparing the monkey's capacity to hang by his fingers, with his capacity to hang by his elbow and by his prehensile tail. Similarly, evolutionary analogues are equally spurious: one does not seek the explanation of what is uniquely innate in a modern horse by 'subtracting out' what was innate to an *eohippus*. Each species is a

coherent organism with its own interacting organisational systems; these interactions necessarily modify and mutate whatever innate structures are shared with earlier related species. Given that all behavioural systems naturally interact within a species it is not clear that one can compare two intact species to isolate what structure is unique to one of them (see Campbell, Chapter 1). Nor can one treat 'structure of language' as independent of the 'structure of cognition' (see McNeill, Chapter 3) since both structures determine certain aspects of each other.

Accordingly, it is not at all clear that homologues of communicative behaviour in non-human animals constitute a basic behavioural substrate on which human language rests. Nor is it clear how the basic perceptual, cognitive and social mechanisms internal to humans independent of language are organised by language behaviour itself. We do not face a problem of describing *what* is innate in human language, either by reference to related dumb species or to the linguistic role of non-linguistic aspects of human cognition. Rather, our problem is to specify *how* the child's desire to communicate recruits and organises human capacities into the species of behaviour that we know has 'language'.

#### Footnotes

<sup>1</sup> I am indebted to J. Limber for calling my attention to this particular construction.

<sup>2</sup> Notice also that the surface phrase structure difference in these cases is also reflected in an internal structural difference. Mehler and Carey found that such differences did not form an effective perceptual set if they were not also reflected in surface structure differences.

<sup>3</sup> These examples are only intended to give the reader an idea of the *kind* of processes involved in English stress assignment. The reader should consult Chomsky and Halle for a full treatment of the problem.

<sup>4</sup> Note that the finding that phrase structure is not ordinarily assigned as an initial step in sentence perception is further evidence against the

standard "analysis-by-synthesis" model of speech perception. According to that model, the goal of the synthetic component of perception is to generate a "match" of the surface phrase structure of the sentence which is allegedly already computed. The evidence reviewed here suggests that the surface phrase structure is often never fully computed in perception either as the first *or* the final step.

<sup>5</sup> The pseudo-passive transformation (56) was not discussed in print by Chomsky, to my knowledge. However, the analysis of sentences such as (61c) as derived from passives by a rule like (56) is consistent with the syntactic theory as presented in *Syntactic Structures* (and was discussed in classes by Chomsky in 1961). This analysis was later rejected because of the meaning differences between sentences like (61b) and (61c), on the view that sentences with different meanings cannot have different underlying internal structures. However, Chomsky's current arguments (1970) that certain aspects of semantic interpretation depend on surface structure would allow for deriving (61c) from (61b), with meaning differences accounted for by surface structure interpretive rules.

<sup>6</sup> The arguments against the analysis in (61) presented here are stimulated by Postal's work, although the reader should credit Postal with the correct arguments and the author with the incorrect arguments. The main point of the present discussion is to explore the kinds of linguistic arguments there are against the analysis in (61) and in favour of an analysis like that of (68).

<sup>7</sup> At least for the interpretation of (61a) which is synonymous with (61c). The difficulty with these cases is that (61a) is ambiguous, meaning either the same as (61b) or the same as (61c). This suggests that there are two possible analyses of sentences like (61a, ba c).

(61a)—Base <sub>i</sub> , number and tense	(61a)—Base <sub>i</sub> , exchange, number and tense
(61b)—Base <sub>j</sub> , passive, number and tense	(61b)—Base <sub>i</sub> , exchange, passive number and tense
(61c)—Base <sub>j</sub> , number and tense	(61c)—Base <sub>j</sub> , number and tense

On either analysis 'pseudo-passives' (61c) are simpler transformationally than passives (61b), which directly conflicts with the analysis in (61). In the reported experiments the verbs used were not 'cognitive' like *interest* but impersonal like *dry*. A sample set of sentences corresponding to 61a, b, c is: (a) the sun dried the raisins; (b) the raisins were dried by the sun; (c) the raisins dried in the sun.

<sup>8</sup> For the purposes of the present discussion the loss of inflections is left unexplained. See Bever and Langendoen (1970) for further discussion.



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