The Nature of Cerebral Dominance in Speech Behaviour of the Child and Adult[1]

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INTRODUCTION AND SUMMARY

A CORRECT understanding of the relation between human behaviour and brain function requires a theory of human brain function and a theory of human behaviour. Since neither theory is available today, it is futile to attempt a strict account of even a limited area of the problem, such as the relation between speech behaviour and anatomical specificity of neurological functioning. Consequently such terms as "speech perception" or "neurological locus of function" are only conceptual representations of behavioural and neuro-physiological structures which await real analysis and explanation.

Given these limitations, this paper presents a taxonomy of human cognition, as exemplified in language, which separates actual language behaviour (or language "performance") from primitive characteristics of language and from sensitivity to language structure. On the basis of evidence from functional ear asymmetries in adult speech behaviour and their development in children, I suggest that cerebral dominance for speech is specifically related to the behavioural strategies we use in actually listening to sentences. Since the development of these behavioural strategies appears to be responsive to actual experience, their close relation to dominance suggests that cerebral dominance develops (at least in part) in response to external experiences.

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THREE ASPECTS OF HUMAN THOUGHT

In our research we have distinguished three aspects of cognition for separate study: basic capacities, behavioural strategies and epistemological structures (see Mehler and Bever, 1968b; Bever, 1970). First, we investigate the *basic capacities* which appear in young children without obvious specific environmental training. Consider, for example, the 2-year-old's capacity to judge numerical inequalities (Mehler and Bever, 1968a; Bever *et al.*, 1968; Mehler, this volume), or his ability to predicate actions in speech. Second, in both perceptual and productive behaviour, children and adults utilize many systems of *behavioural strategies* to shortcut the internal structure implied by the regularities in their behaviour. For example, to make relative judgements of large numbers, we may suspend our knowledge in integers and counting, and simply use the perceptual rule that an array that "looks" larger has more components; or if we hear a series of words with only one reasonable semantic connection (e.g., "dog bite cracker"), then we may suspend any further perceptual analysis of the speech signal and assume that the sentence follows the usual semantic constraints on "dog", "bite", "cracker". Finally, as adults, we have a set of *epistemological structures* —systematic generalizations of our intuitions about the regularities in our own behaviour. Consider, for example, the concept of an integer and counting which we use in justifying our judgements of quantities; or the intuition of relative "grammaticality" that a parent uses to guide a child's speech and a linguist depends on for the isolation of linguistically relevant data.

PREVIOUS STUDIES

In this paper I follow a century of research in making certain assumptions about the nature of cerebral dominance in speech function. While each ear has direct neurological connections with each hemisphere, the contralateral connections (right ear to left hemisphere, left ear to right hemisphere) are taken to be the functionally relevant neurological connections. (It has been shown that almost all right-handed adults have a dominant right-ear/left-hemisphere, as do many left-handed subjects. In general, most investigations of auditory asymmetry are confined to "right-handed" subjects, so the right ear is generally the dominant ear.) One hemisphere of the adult brain is normally primary in speech activity. Much of the evidence for this hemispheric dominance derives from clinical studies of the relative effect of lesions in the right or left hemispheres on language ability (reviewed in Teuber, Battersby and Bender, 1960; Mountcastle, 1962; Hecaen and Ajuriaguerra, 1964; Geschwind, 1965). These clinical studies indicate that more severe aphasia results from insult to the dominant hemisphere.

Recent work with normal subjects has expanded the basic clinical findings (reviewed by Zangwill, 1960; Milner, 1962; Kimura, 1967). Experiments by Bryden (1965), and by Kimura and Milner and others have shown that the perception of digits and words is superior when the stimuli are presented to the dominant ear. Recently, Shankweiler and Studdert-Kennedy (1967) have shown that consonants presented to the right ear are identified better than those simultaneously presented to the left ear. Using relative ease of perception of different digits presented simultaneously to both ears as a criterion, Kimura (1963) found that auditory cerebral dominance is tentatively established by 6 years of age. Lenneberg (1967) has concluded that cerebral dominance is permanently established by the age of ten, since aphasia caused by brain injury after that age is relatively difficult to overcome.

These clinical and experimental findings are generally quantitative: the dominant hemisphere is *better* than the non-dominant hemisphere at processing speech stimuli. Other findings indicate that there are basic qualitative differences as well. (In all our studies we use monolingual right-handed subjects whose close relatives are all right-handed, in order to be as sure as possible that all subjects are dominant in the right-ear/left-hemisphere.) The amplitude of the GSR in response to mild shocks, administered while Ss are listening to sentences, varied depending on the structure of the sentence. The interaction between linguistic structure and GSR is stronger if the sentences are heard in the right ear than if they are heard in the left (Bever *et al.*, 1968). We also found that if a click is presented to one ear while a sentence is presented to the other ear, the click is reported as occurring earlier in the sentence if the click is heard in the left ear than if it is heard in the right ear (Fodor and Bever, 1965, replicated in Bever *et al.*, 1969a; Bever *et al.*, 1969b). In a small pilot experiment we found that this effect obtains only if the speech is in the form of a sentence; random word sequences of the same length do not show the ear asymmetry. On the basis of this preliminary evidence, I suggested that certain perceptual mechanisms in the dominant ear-hemisphere system are selectively sensitive to more abstract aspects of syntactic organization than the internal structure of words.

This suggestion left unexplained the nature and source of those perceptual processes asymmetrically devoted to syntax. However, several authors suggest that functional cerebral asymmetry may be related to learning strategies. Milner (1962, pp. 177–178) reports: "Perhaps the most clear-cut result to emerge from the study of human temporal lobe function is the disturbance in the recall of verbal material, which regularly accompanies lesions of the left temporal lobe when speech is represented in the left hemisphere. This has been shown both for verbal associative learning (Meyer and Yates, 1955) and for story recall." Teuber (Teuber *et al.*, 1960) reported that brain damage in one hemisphere results in deficits of the contralateral hand in the learning of tactile discriminations (i.e., tactile discrimination does not improve in successive trials). Recently, Liberman *et al.* (1967) have claimed that consonant perception is better in the dominant ear while vowel perception is not, because consonant perception is relatively dependent on learned acoustic patterns. Finally, Kimura (1963, 1967) suggested that the early development of speech lateralization is facilitated by enriched cultural experience. Extrapolating from these observations we can argue that lateralization is, in part, a function of learning, not just an internal physiological development.

I shall explore a possibility suggested by the observations of these authors and by our analysis of cognition as three systems: *the dominant hemisphere is the locus for behavioural strategies of speech comprehension*; these strategies are acquired by the young child as functional lateralization develops and persevere as components of adult perceptual mechanisms. I must emphasize again that these strategies of speech processing are not directly related either to universal properties of speech (e.g., the fact that words have reference) nor to sophisticated adult knowledge of grammar. That is, the processing strategies constitute an inductive, non-grammatical system of speech comprehension, that of immediate apprehension of the internal, "logical" structure of actual verbal sequences. Thus, I am not claiming that either basic linguistic capacities or grammatically defined adult knowledge of linguistic structure is asymmetrically represented in the brain. Rather, I am claiming that the learned processes of *utilization* of language structure in actual comprehension are functionally "located" in the dominant hemisphere.

There are three kinds of recent findings which support this thesis. (1) There are qualitative differences between the ears in simple perceptual and memory tasks and monaural stimulation. (2) There is a particular syntactic strategy of speech-processing which is utilized most strongly in the dominant ear in adults. (3) Young children who have developed auditory asymmetry utilize this perceptual strategy much more than children of the same age who have not developed auditory asymmetry.

QUALITATIVE MONAURAL DIFFERENCES

It has been a canon of the investigation of speech lateralization that perceptual differences between the ears are quantitative and appear only under conditions of dichotic stimulation (different stimuli presented simultaneously to the two ears). For example, more digits are recalled of those presented to the right ear than of those presented simultaneously to the left ear; but subjects perform equally well if digits are presented to the left ear or right ear alone (Kimura, 1963). If this claim were general it would suggest that asymmetries in auditory functioning are due to qualitative differences which appear only if the dominant ear "inhibits" perception in the other ear. Recently, we investigated whether differences can appear without simultaneous stimulation. We used a task that allows both quantitative and qualitative differences to appear, namely the location of a brief tone in a sentence.

Our previous research has shown that if a tone is presented in one ear and a sentence in the other, subjects who hear the tone in the left ear report it as having occurred earlier than subjects who hear the tone in the right ear (Fodor and Bever, 1965). (Note that this effect only obtains if both ears do not receive the same stimuli; a binaural click is not heard as preceding in the left ear.) That is, there is a relative facilitation of the tone in the left ear and/or a relative delay of the tone in the right ear. This finding was perplexing to us, since we had expected the reverse difference (if any) to appear on functional-anatomical neurological grounds. Because the right ear functionally enervates the left hemisphere it should therefore produce a relative temporal facilitation of the tone rather than a relative delay.

To investigate this finding further, we had subjects locate short tones presented during sentences heard in the same ear, with nothing presented to the other ear. After each sentence-tone combination, the subject wrote down the sentence and indicated with a slash where in the sentence he thought the tone had occurred (Bever and Stein, in press). Fifty right-handed college students (25 male and 25 female) heard 25 sentence-tone combinations in the right ear and 50 (25 male and 25 female) heard the stimuli in the left ear. Each sentence was 12 words long and had two major clauses. There was one 35 msec. 1000 Hz sine wave tone located within each sentence, adjusted in intensity to be equal to the most intense vowel sound in the sentences. If a subject thought that his response was highly unreliable he indicated it as a "guess"; such responses were excluded from the overall analysis, as were a few responses in which the sentence was so badly recalled that the tone location

TABLE I. RESULTS OF LOCATING SINGLE TONES IN SENTENCES

	Tone location absolute error (syllables)	*Tone location relative error (syllables)*	*Percentage locations correct*	*Percentage reported location guesses*
Sentences and tones heard in . . .				
Left ear	1·00	−0·63	32	4·8
Right ear	0·95	−0·57	32	6·5

could not be assessed. The results scored to the nearest half syllable for each response are summarized in Table I according to the ear in which the stimuli were heard (Bever *et al.*, 1968; Bever *et al.*, 1969a).

There were no striking differences in the overall pattern of response between the two ears; most subjects preposed the actual location of the tone (i.e., subjects generally located the tone as having occurred at a point in the sentence preceding its objective location). Subjects who heard the stimuli in the left ear responded with a slightly larger magnitude of error. However, the subjects who heard the stimuli in the right ear produced a larger number of "guesses" and more responses in which the sentence was badly recalled.

Subjects who heard the stimuli in the left ear tended to prepose the location of the tone more than subjects who heard the stimuli in the right ear. However, there was a large range of average error magnitudes and of overall relative position of subjective location across subjects: some subjects in both conditions responded with a very small average error magnitude, and some subjects in both conditions responded with a very small average tendency to prepose the location of tones.

There was a positive correlation between a subject's mean accuracy of tone location and his overall tendency to prepose; subjects who responded accurately showed a relatively small tendency to prepose (Fig. 1). However, the correlation between average error size and average tendency to prepose was much higher across subjects who heard the stimuli in the left ear (Pearson $r=0{\cdot}71$) than across subjects who heard the stimuli in the right ear (Pearson $r=0{\cdot}43$). Most of the difference in the error-magnitude/subjective-preposition correlation between the right and left ears is due to subjects whose mean error was larger than one syllable: a small group of subjects who heard the stimuli in the right ear and who had a large average error systematically *reversed* this correlation. Conversely the correlations between mean error size and tending to prepose tones for the 25 most accurate subjects in each condition are nearly identical (0·56 across the left-ear subjects and 0·52 across the right-ear subjects).

There are various specific perceptual mechanisms which might account for these ear differences. A consistent interpretation of them is the following: there is a tendency subjectively to prepose the position of single tones in sentences; thus, the larger the average location error of a subject the larger is his average tendency to prepose. This correlation is weaker when the sentence (and tone) is heard in the dominant ear. That is, immediate speech-processing interferes more with other perceptual activities when speech is presented to the right ear (e.g., the locating of a tone) than it does when the speech is heard in the left ear. (The proposal that hearing speech in the dominant ear interacts more with other tasks also accounts for the fact that there were more reported guesses of tone locations and failures to record the sentence correctly among those subjects who heard the stimuli in the right ear.)

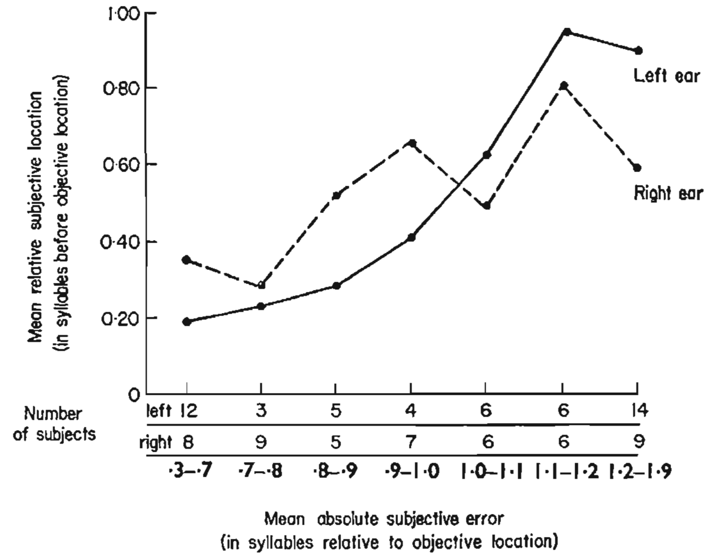

FIG. 1. The relation of absolute error size in the location of clicks and tendency to prepose the clicks.

We have also found a difference between the ears in immediate processing of sentences which does not appear for lists of random words. The paradigm is outlined in Fig. 2. Subjects heard ten seven-word sequences

Hear	Silent	Hear	Count	Say
Sentence	Interval	Number	Backwards	Sentence

FIG. 2. Paradigm of Experimental Sequence in Studies of Immediate Recall.

in one ear. Each sequence was followed by a two-second silence, which was followed by a two-digit number. Subjects counted backwards by threes from that number for five seconds (to block rehearsal) and then reported the original verbal sequence.

The verbal strings were either randomly ordered words (1*a*), or those same words ordered into a sentence (1*b*):

1*a*. Nice in seem did fact very they.
b. They in fact did seem very nice.

Both the random word strings and the sentences were constructed by splicing together the words read originally in a random list. Thus, there were no acoustic cues (other than the order of the words) which differentiated the sentences from the random strings. Sixteen subjects heard the random strings and 16 subjects heard the sentences (eight in the left ear and eight in the right ear for each type of stimulus material). The results are presented in Table II. More sentences were responded to correctly by subjects who heard them in the right ear ($p < 0{\cdot}05$ by Wilcoxon matched pairs signed ranks two-tail across the ten sentences). Also, more words in the sentences were correctly recalled for subjects who heard the sentences in the right ear ($p < 0{\cdot}06$ Wilcoxon, two-tail). No differences between the ears appeared for subjects who heard the random word sequences. Thus, it would appear that the difference in performance associated with the ear in which the sentence is heard is due to the

TABLE II. RESULTS OF IMMEDIATE RECALL OF WORDS IN ARRANGED SENTENCE ORDER (1*a*) AND RANDOM ORDER (1*b*)
(see Fig. 2 for experimental paradigm)

	Words in sentence order		*Words in random order*	
	% sequences totally correct	*% words correct*	*% sequences totally correct*	*% words correct*
Sequence heard in . . .				
Left ear	54	94	4	57
Right ear	65	96	4	57

higher order syntactic organization of a sentence, not to the fact that the stimulus material is composed of words.

We used the same experimental paradigm in Fig. 2 to bring out a qualitative difference in the immediate recall of sentences presented to the right and left ears. (This research is being conducted with J. Mehler as part of a larger investigation of the differences between short- and long-term memory of sentences. The data in Table III are based on 56 subjects for each ear, with varying intervals between the end of the stimulus sentence and the presentation of the number, from 0 to 5 seconds.) In this study, each subject heard (*a*) one active sentence; (*b*) one passive; (*c*) one negative; (*d*) one question; (*e*) one passive negative; (*f*) one passive question; (*g*) one negative question; and (*h*) one negative passive question:

2*a*. The bug bit the dog. (active)
b. The dog was bitten by the bug. (passive)
c. The bug didn't bite the dog. (negative)
d. Did the bug bite the dog? (question)
e. The dog wasn't bitten by the bug. (negative passive)
f. Was the dog bitten by the bug? (passive question)
g. Didn't the bug bite the dog? (negative question)
h. Wasn't the dog bitten by the bug? (negative passive question)

Quite often subjects reported the correct words but the wrong syntax. For example, a stimulus passive sentence like (2*b*) was often recalled as the corresponding active (2*a*). The erroneous responses, which changed syntax but maintained the words and meaning relations between them, (i.e. "the actor and the object of the action"), fall into two types, *meaning-preserving* syntactic errors (e.g., passive to active; question to negative question, etc.) or *meaning-changing* syntactic errors (e.g. passive to negative passive, active to question, etc.). Sentences presented to the right ear were recalled with fewer meaning-changing syntactic errors than sentences presented to the left ear, while the number of meaning-preserving errors was the same (Table III).

TABLE III. MEAN PERCENTAGE OF SYNTACTIC ERRORS/SUBJECT IN IMMEDIATE RECALL OF SYNTACTICALLY VARYING SENTENCES

	Left ear	*Right ear*
Meaning-preserving syntactic errors	16	19
Meaning-changing syntactic errors	16	5
Total	32	24

These studies indicate that the dominant ear is more directly involved in the processing of the syntactic and semantic aspects of speech and that its involvement qualitatively affects perceptual judgements and immediate recall. While this phenomenon requires further study, it indicates that listening to speech affects the dominant ear differently from the non-dominant ear, *even with monaural stimulation.* The next sections argue that this difference is in part due to the relative availability to the dominant ear-hemisphere system of immediate processing strategies which organize the incoming speech signal.

STRATEGIES OF SPEECH PERCEPTION

The three aspects of cognition (basic capacities, behavioural strategies and epistemological structures) are simultaneously present in adult functioning. For example, in their use of language, adults predicate actions and (at least in the case of parents and linguists) can produce conscious intuitions about the acceptability in their dialect of particular speech sequences. But while we can observe these two aspects of adult capacity in actual direct behavioural expressions, we depend on experiments to demonstrate the presence of the behavioural strategies of speech perception. For example, recent experimental evidence demonstrates that there is a sequential, functional labelling strategy which applies to the apparent order of words in a sentence (in the absence of specific semantic information):

> Strategy (A). Any *Noun-Verb-Noun* (NVN) sequence in the actual sequence within a potential underlying syntactic structure unit corresponds to *actor-action-object.*

Notice that strategy (A) is probably valid for most utterances, since the passive order is relatively infrequent in speech. Thus, as a processing *strategy* it allows listeners to shortcut the use of full linguistic rules and structure in comprehension. Of course, on this view, utterances which do not conform to (A) are relatively complex psychologically.

The primary finding which verifies the existence of this strategy is that the passive construction is harder to understand than the active (in the absence of semantic constraints). The following seven experiments have shown this.

(i) McMahon (1963; replicated by Gough, 1966) found that generically true (3*b*) or false (3*d*) passives are harder to verify than the corresponding actives (3*a*, 3*c*):

3*a*. 5 precedes 13 *c*. 13 precedes 5
b. 13 is preceded by 5 *d*. 5 is preceded by 13

Notice that the functional relations among the major segments in passive sentences are the reverse of the assumptions of strategy (A), that the first noun is the logical subject (actor) and the last noun is the logical object.

(ii) Slobin (1966) found that children verify pictures which correspond to active sentences more quickly than pictures corresponding to passive sentences.

(iii) Savin and Perchonock (1965; replicated by Wright, 1968, and by Epstein, 1969) showed that the number of unrelated words which can be recalled immediately following a passive sentence is smaller than the number recalled following an active sentence.

The fact that the passive is relatively complex perceptually and in immediate memory might be due to its increased length, to its increased transformational complexity, or to its failure to preserve the "*NVN*= *actor-action-object*" property in the surface structure. Only the last explanation is consistent with all the following experiments.

(iv) Mehler and Carey (1968) found that the time needed to verify pictures accompanying sentences with the progressive tense construction (4*a*) is shorter than superficially identical sentences with a participial construction (4*b*). This would be predicted by the fact that progressive tense constructions preserve the "actor-action-object" order in the surface sequence.

4*a*. they are fixing benches.
b. they are performing monkeys.

(v) Blumenthal (1967) analysed the errors subjects make in attempting immediate recall of centre-embedded sentences (5*a*). His conclusion was that the main strategy which subjects use is to assume that the first three nouns are a compound subject and that the three verbs are a compound action (as in 5*b*). That is, they impose a general "actor-action" schema on to what they hear.

5*a*. the man the girl the boy met believed laughed.
b. the man the girl and the boy met believed and laughed.

(vi) In immediate comprehension I found that subjects cannot avoid assuming that an apparent *NVN* sequence corresponds to "actor-action-object" even after training on these sequences (Bever, 1967). Subjects gave immediate paraphrases of centre-embedded sentences with apparent *NVN* sequences, e.g., underlined in (6*a*). Even after eight trials (with different sentences) the subjects understood the sentences with this property less well than the sentences without it, e.g. (6*b*).

6*a*. *the editor authors the newspaper* hired liked laughed.
b. the editor the authors newspapers hired liked laughed.

That is, the "NVN" sequence in (*a*) is so compelling, that it can take on the status of a "linguistic illusion" which training cannot overcome.

(vii) J. Mehler and I studied the immediate recall of simple sentences and found that subjects have a strong tendency to reconstruct a sentence to conform maximally to an "NVN" sequence. For example, in (7*a*) the *NVN* sequence is maintained while in (7*b*) it is interrupted. Subjects heard an equal number of sentences like (7*a*) and (7*b*) for immediate recall in the paradigm presented in Fig. 2.

7*a*. quickly *the waiter sent the order* back.
b. *the waiter* quickly *sent* back *the order.*

In immediate recall, 87 per cent of the syntactic order errors were from stimulus sentences like (7*b*) to response sentences like (7*a*), rather than the reverse.

NVN STRATEGY AND AUDITORY DOMINANCE IN ADULTS

The "NVN" processing strategy is clearly not part either of basic linguistic capacity or of adult linguistic intuitions. On the one hand, the processing strategy appears to be related specifically to the probabilities in linguistic experience and so may not be a basic capacity of human cognition. On the other hand, such a strategy for the mapping of a lexical sequence on to a functional interpretation is not derived from a linguistic rule or any set of linguistic rules. Therefore, it is not a component of the adult epistemological structure which is implied by our ability to make judgements about grammaticality. Rather, it is part of a system of non-grammatical strategies of immediate speech processing. These strategies guide our comprehension of the functional relations which are internal to each actual utterance.

Elaborations of two of the above experiments give preliminary evidence that this organizing strategy is directly associated with the dominant ear-hemisphere system. First, we investigated the immediate recall of sentences with adverbs and participles (as in experiment (vii) above) with monaural stimulation. When a subject is given 2 seconds to process the sentence, relatively more syntactic errors are made by subjects who hear the sentence in the right ear than by subjects who hear the sentence in the left ear (Table IV). Recall that the tendency of syntactic errors is to segregate the *NVN* cluster, as in (7*a*). Thus, more sentences presented to the right ear tended to be recalled, as in (7*a*), even when the original stimulus was (7*b*); this effect was less strong for subjects who heard the sentences in the left ear. However, the ear differences in this immediate recall experiment appear only for those subjects who are given a 2-second interval following the sentence. Thus, this experiment is not a direct test of *immediate* perceptual processing; rather it demonstrates an ear asymmetry in the organization of a sentence in immediate memory.

TABLE IV. PERCENTAGE OF ERRORS WHICH ARE SYNTACTIC IN IMMEDIATE RECALL OF SENTENCES WITH ADVERBS AND PARTICIPLES
(See Fig. 2 for Experimental Paradigm. Each subject heard 16 sentences)

Empty interval after sentence (seconds)	*No. of seconds counting backwards*	*Left ear*		*Right ear*	
		Absolute no. error/subject	*% Syntactic errors*	*Absolute no. error/subject*	*% Syntactic errors*
2	5	2·6	52	2·9	77
0	7	3·8	71	4·4	69
0	5	3·4	70	3·3	55

In an attempt to test perceptual differences between the ear-hemisphere systems, Carey *et al.* (1970) have studied picture verification time (as in study (iv) above) in which 20 subjects heard five sentences of each construction type monaurally. They found that, without experience, the progressive form (4*a*) is responded to faster than the participial construction (4*b*) by subjects who heard the sentences in the right ear ($p < 0{\cdot}005$ by *t*-test); there is no difference in latency between the two sentence constructions for inexperienced subjects who heard the stimuli in the left ear (see the "without experience" data in Fig. 3). That is, the latency to sentences heard in the right ear is longest for the construction which does not conform to the *NVN=actor-action-object* pattern, (4*b*), and shortest for the construction that does conform to this pattern, (4*a*). Of course, the fact that adjectival sentences are responded to more slowly when presented to the right ear might only show that the right ear is more sensitive to syntactic complexity, rather than that the right ear utilizes the *NVN* strategy in particular. The adjectival construction is more complex syntactically than the progressive construction, since it has a recursion in the deep syntactic structure (underlying the participial adjectival use of the verb) and it involves at least one more transformation in the linguistic analysis of the derivation from the deep structure to the surface structure (to permute the participle and the noun it modifies in the surface structure). However, the relative complexity of the adjectival construction does not explain why the latency to the progressive construction is *shorter* when presented to the right ear than it is when presented to the left ear, without experience ($p < 0{\cdot}01$). There is no reason why *absence* of structural complexity should affect the right ear more than the left ear. Rather, the progressive construction must exhibit a construction that *actively* conforms to a perceptual pattern for which the right ear is preset.

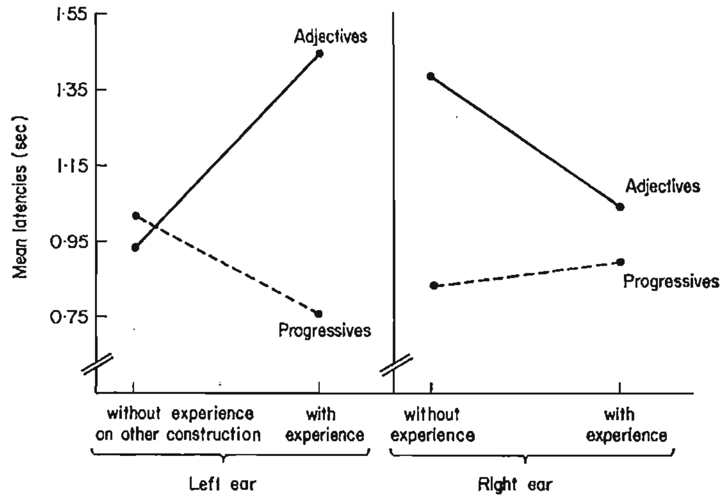

FIG. 3. Latencies to decide that the pictures are appropriate to adjective and progressive constructions.

Subjects heard two groups of five sentences each in the same ear; if a subject heard five progressive sentences in the first group then he heard five adjectival sentences in the second group (in the same ear) and vice versa. Subjects who heard the sentences in the right ear responded faster in the second group; but adjectival constructions still received longer latencies than progressive constructions. (Adjective latencies are longer than progressive, $p < 0{\cdot}005$ in first group, $p < 0{\cdot}07$ in the second group for right-ear subjects; see "with experience" data in Fig. 3.) However, subjects who heard the sentences in the left ear reversed the pattern of responses in the second group; adjectival constructions received the shortest latencies in the first group (not significant) and the longest latencies in the second group ($p < 0{\cdot}005$). Indeed, the pattern and absolute

size of response latencies of subjects who heard the second group of sentences in the left ear is nearly identical to that of the responses to the first group of sentences for subjects who heard the sentences in the right ear. That is, *with experience* the non-dominant ear can utilize the same strategies as those indigenous to the dominant ear.

These studies support the view that the dominant ear-hemisphere system in adults involves a strategy of immediate speech-processing which organizes speech-input sequence as actor-action-object if at all possible; this organizing principle is not immediately available to the non-dominant ear-hemisphere, but can be acquired with some experience.

DEVELOPMENT OF THE NVN STRATEGY AND CEREBRAL DOMINANCE

We have some evidence that the perceptual strategy (A) is acquired at about the end of the fourth year. We have been investigating the development of the child's capacity to understand simple passive sentences, which do not have semantic constraints, e.g., (8):

8. The horse is kissed by the cow.

The child's task is to "act out the story" described by the sentence with toy animals. The performance of children from 2 to 5 years on reversible passive sentences like (8) is presented in Fig. 4. (Each child acted out six sentences, one of which was a reversible passive like (8).) The relevant feature of the child's development is the steady improvement until about the age of four; at this age, there is a temporary increase in the tendency to interpret the first noun as the actor and the last noun as the object. This temporary decrease in comprehension was also found in another experiment (run by different research assistants) in which each child acted out 12 sentences, three of which were reversible passives like (8). In other research we have found that at the age of four, children are particularly dependent on superficial perceptual strategies which they have just developed (Bever, in press; and Mehler, this volume). Accordingly, we interpret the temporary decrease in performance on reversible passives as due to development and the *over*-generalization of the perceptual heuristic, *NVN = actor-action-object*. (Further research indicates that this strategy may primarily be the following: "the first noun is the actor".) Note also that from the standpoint of the present paper it is irrelevant whether this strategy is learned entirely by "passive" induction across some characteristics of external linguistic experience, or whether it is developed from internal causes.

We noticed in the first of the experiments on passive comprehension that the perceptual strategy developed earlier in girls than in boys. Since Kimura's research had suggested that auditory dominance develops earlier in girls than in boys, it appeared that the relationship between the acquisition of the perceptual strategy and auditory dominance could be used as a critical test of the hypothesis that there is a general relation

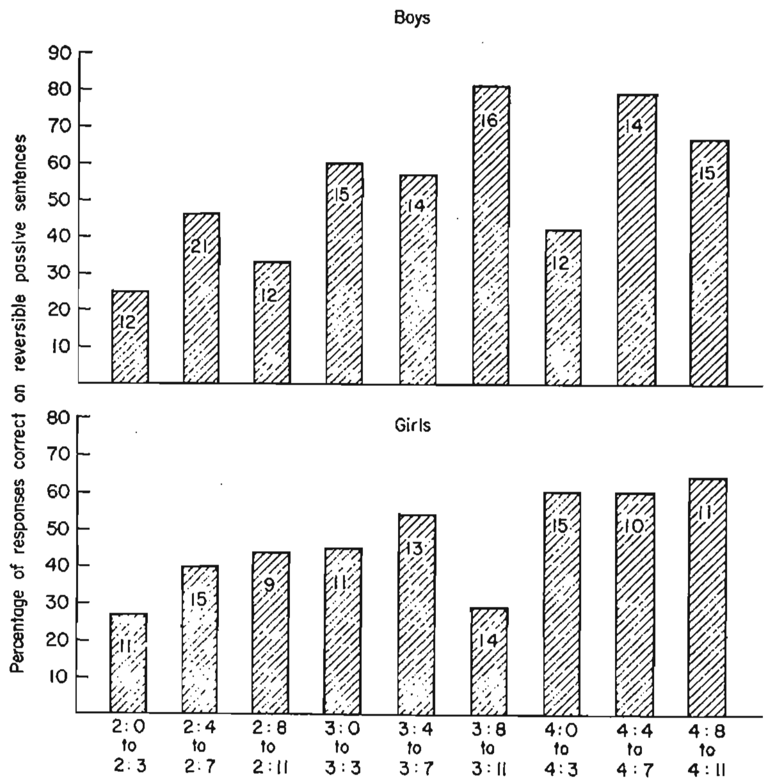

FIG. 4. Comprehension of passives in boys and girls from 2 to 5 years of age.

between cerebral dominance and the utilization of perceptual strategies. Accordingly, in a separate experiment on sentence perception each child (who was willing) was tested for ear-dominance during the same experimental session in which he acted out the 12 sentences. This study showed that those children with a preference for stimuli presented to the right ear have a greater dependence on the linguistic perceptual strategy than children without such an ear preference.

To test the ear dominance of each child I modified Kimura's dichotic-digit technique so that it could be used with young children. Each child was shown a set of inverted paper cups with toy animals glued on to them. Each animal was discussed by the experimenter and the child until the child agreed to its generic name (e.g., "giraffe", "doggie", "bird", etc.). Then the child put on stereophonic earphones and was told that if he picked up the animal(s) which he "heard the lady say on the earphones" he would find an M & M candy (Smartie) under the animal(s). The child heard a pair of animal names, one in each ear; after each trial he was allowed to pick up some animals (but not all) to get the M & M's. In this way we could observe which ear the child attended to most closely, simply by recording which animal he picked up (or which animal he picked up first if he picked up both).

	Trial	*Left ear*	*Right ear*
Phase (1)	1	horsie	horsie
	2	bird	bird
	3	cow	cow
	4	bear	bear
	5	doggie	doggie
Phase (2)	6	giraffe	horsie
	7	cow	bear
	8	lion	giraffe
Phase (3)	9	monkey	doggie
		bear	bird
	10	giraffe	horsie
		bird	cow
	etc.		

FIG. 5. Paradigm of the experimental sequence in auditory dominance studies of children.

The experimental sequence of trials had three phases (see Fig. 5): (1) the child hears the same animal name in both ears; (2) the child hears a single pair of different names in each ear (the stereo pairs being matched for intensity and duration); (3) the child hears two pairs of different animal names in quick succession. The response to the double trials in (3) were scored for the relative attention given to the animal names presented to the right ear. Figure 6 presents the distribution of relative preference for the animal heard in the right ear in phase 3 for the 195 children between $2\frac{1}{2}$ and $5\frac{1}{2}$ we have tested to date (October 1968). We classified the children according to their position in this distribution, as predominantly left-ear dominant, no-dominance and predominantly right-ear dominant. (The brackets in Fig. 6 indicate where the category divisions were made.)

Of the children who were studied for ear dominance, 129 between 3 and 5 years also participated in the separate sentence comprehension experiment outlined above (in which each child heard three reversible

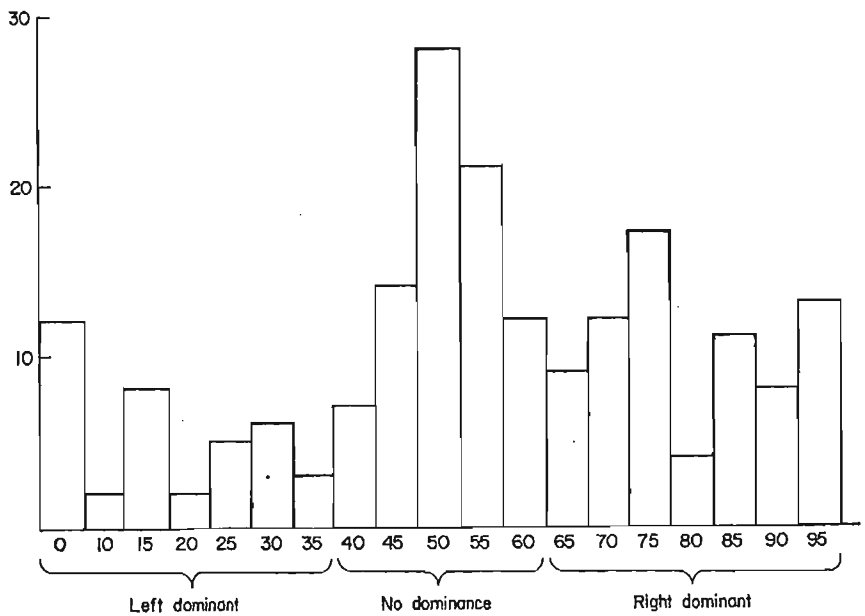

FIG. 6. Histogram of relative tendency to choose animals presented to right ear in Auditory Dominance Test with children.

actives and three reversible passives). The performance on the reversible active and passive sentence tasks for those children is given by the graph in Fig. 7, according to their relative right-ear dominance, shown by the histogram in the same figure. The size of the active-passive difference corresponds to the use of strategy (A), since that strategy leads to good performance on active sentences and bad performance on passive sentences. Inspection of this difference for children with each amount of right-ear dominance shows that there is a relative increase in the perceptual dependence on strategy (A) correlated with the amount of right or left dominance shown by each group of children. Conversely, children with no preference for either ear use strategy (A) very little. To test the significance of these findings, each child was scored for his relative ten-

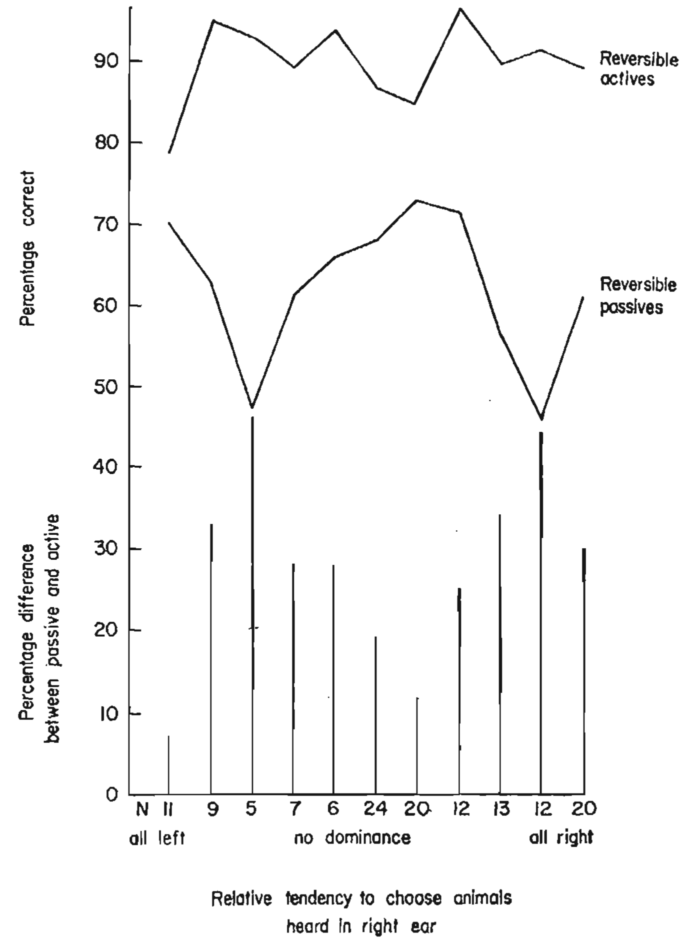

FIG. 7. Performance on acting out sentences presented to the right ear, by children with varying ear preferences.

dency to reverse the interpretation of reversible passive sentences. This was done by taking the number of passive sentences that he reversed and subtracting the number of simple reversible active sentences that he reversed. The latter subtraction was to control for the few subjects who reversed the interpretation of some passives *and* actives. The means in the first row of Table 5 and all of Table 6 exclude subjects who make no reversing errors on reversible actives and passives; since roughly the same proportion of subjects (24 per cent overall) in each ear-dominance

TABLE V. COMPARATIVE ANALYSIS OF SENTENCE COMPREHENSION AND EAR PREFERENCE IN CHILDREN AGED FROM 3 TO 5

Preferred ear	*Left*	*No dominance*	*Right*
Average relative tendency to reverse passives (see text)	40%	23%	43%
Average percentage of reversible actives and passives correct	75%	78%	75%
Percentage of children without any sentence errors	34%	26%	23%
Average correct animal choices	48·6%	53·5%	49·4%
Median age	3 yr. 11 mo.	4 yr. ½ mo.	4 yr.
Number of children	32	50	47
Percentage of right ear animals chosen	0–37·4	37·5–62·4	62·5–100

category made no errors, the inclusion of these subjects simply decreases the clarity of the data (Fig. 7 includes all children). The mean relative tendency to reverse reversible passives for children in each of the dominance categories is presented in Table V. The tendency is much higher among children who are categorized as having an ear preference. ($\chi^2 = 5{\cdot}49$, $p < 0{\cdot}02$ for right-dominant *vs.* no-dominance subjects; $\chi^2 = 2{\cdot}84$ for left-dominant *vs.* no-dominance subjects.) That is, children with a dominant right ear tend more than non-ear-dominant children to utilize strategy (A) of speech perception, *NVN = actor-action-object*.

There are several difficulties with these data which force me to be cautious in claiming that they demonstrate a direct association between the development of auditory dominance and the development of strategy (A). First, it might be the case that the correlation between ear-preference in the dichotic-listening task and the tendency to reverse passive sentences is simply a function of age: that is, as children get older, they pass through a period in which they reverse reversible passive sentences, and (perhaps independently) they develop auditory asymmetry. However, in our data ear-dominance is not strongly related to age among the children younger than 5. Furthermore, the relative tendency to reverse passive sentences is *higher* for right-ear dominant children at the age of 3 than at the age of four considered separately (see Table VI). Thus, while the development of auditory asymmetry and the linguistic perceptual strategy might still be independent functions of some other aspect of maturation, there is no obvious direct relation between this sort of maturation and age.

An additional problem is raised by the fact that subjects who show no ear asymmetry tend to make fewer errors on the sentence perception tasks. Thus, the fact that more passive reversals are made by children with ear asymmetry than by those without asymmetry could be due to the fact that such children make more errors overall and that reversing passive sentences is always a relatively more frequent error. However, Table VI shows that, among the children who make a given number of errors on the reversible sentences overall, there is a higher tendency for right-ear and left-ear dominant subjects to make errors which reverse passive sentences than for non-dominant children.[1]

TABLE VI. RELATIVE TENDENCY TO REVERSE PASSIVE SENTENCES FOR CHILDREN WITH DIFFERENT EAR DOMINANCE, ANALYSED BY AGE OF THE CHILD AND BY THE NUMBER OF ERRORS A CHILD MAKES OVERALL

(a)

Age	*N* (*that produce errors*)	*Left* (%)	*No dominance* (%)	*Right* (%)
3 yr.	51	30	27	50
4 yr.	46	53	17	40

(b)

No. of errors	*Left* (%)	*No dominance* (%)	*Right* (%)
1	20	17	23
2	27	10	60
3 or more	54	37	63

[1] The performance of subjects who show left-ear dominance is puzzling to me at the moment. First, a third of the subjects in the dichotic listening experiment who showed any dominance showed it in the left ear, which is a much larger proportion than that reported for adults. Second, left-ear dominant subjects showed almost the same tendency as right-ear dominant subjects to use the syntactic strategy on passive sentences. These facts might be true for one of three reasons: (a) some children pass through a phase of right-hemisphere dominance (associated functionally with the left ear). Evidence for this interpretation is suggested by Lenneberg's observation that about 30 per cent of young children show aphasia after injury to the right hemisphere; (b) ear dominance and the use of the linguistic strategy are associated with either right- or left-ear dominance; or (c) some of the "left-ear" dominant subjects are actually right-ear dominant, but happen to respond to the ear competition elicited in the dichotic listening tasks by focusing on the left ear input; that is, these subjects may be sensitive to the difference between the input to the two ears as a function of having a dominant ear, but the dominance may not be so strong as to preclude conscious focusing on the *non*-dominant ear.

These results support the hypothesis that the development of auditory dominance is associated with the development of the strategy of speech perception, *NVN = actor-action-object*. We have corroborated this result for the first part of the strategy, *N = actor*, with cleft-sentences that have their subject first (9*a*) or object first (9*b*). Significantly more right-dominant children reverse sentences like (9*b*) than do children with no dominance.

9*a*. It's the horse that kisses the alligator.
b. It's the alligator that the horse kisses.

CONCLUSION

I have presented the following arguments in support of the thesis that the dominant hemisphere is the locus for the acquired strategies of speech perception. (1) It is possible to elicit qualitative behavioural differences between the right and left ear in right-handed (and presumably right-eared) subjects, without explicit auditory competition between the ears. These differences indicate a greater involvement of the right ear in the immediate processing of the speech stimulus. (2) Studies of immediate speech-processing in right-handed adults indicate the activity of an immediate processing strategy, *NVN corresponds to actor-action-object*. This strategy of speech-processing is directly available to the dominant ear and is not immediately available to the non-dominant ear. (3) This strategy emerges in the perceptual behaviour of the child at the beginning of the fourth year. Those children between 3 and 5 who show an auditory ear-preference also have a relatively large tendency to utilize this strategy in speech perception.

I mentioned above that the investigators at Haskins Laboratory (Liberman *et al.*, 1967) interpret the superiority of the right ear in consonant perception as a function of the fact that consonant perception is relatively dependent on perceptual learning.[1] This interpretation is the phonetic analogue of my interpretation of the cerebral asymmetries in the utilization of syntactic perceptual strategies. Thus, the dominant hemisphere may be the locus for acquired perceptual strategies of speech at all levels of linguistic capacity.

[1] There are alternative explanations of this phenomenon. For example, consonants have been shown to be relatively high in "information" content (e.g., most of a written message can be decoded if only the consonants are presented and a spoken message can be understood even if all the vowels are pronounced "uh", so long as the consonants are pronounced correctly). Consequently, if the right ear is dominant for speech in general we could expect that it would be relatively more dominant for those aspects of speech which are relatively informative and relatively more attended, namely consonants. Such an explanation does not draw directly on the relative dependence of consonant perception on learned patterns.

It is important to notice that in both syntax and phonology the strategies of speech behaviour are not obviously related to basic properties of language or to sophisticated grammatical knowledge. The grammatical rules which describe the derivation of lexical and phonetic sequences from their "logical" syntactic organization, and from their "abstract" phonemic sequence, have no immediately apparent reflection in the behavioural processing system, although the processing strategies are part of a behavioural system for the deployment in actual comprehension of knowledge which is grammatically defined. I refer to the strategies as part of the speech "processing" system in order to leave open the question whether this system is immediately "perceptual" or a system of the organization of "short-term memory" (if there is a real difference between the two). The investigations reported in this paper suggest only that one component of speech behaviour is functionally and neurologically asymmetric. I must emphasize that this conclusion leaves open the possibility that the basic linguistic capacities (e.g., the capacity for reference or predication), as well as the sophisticated knowledge of linguistic structure, are neurologically reflected equally in the "dominant" and "non-dominant" hemispheres. Indeed, some recent work by Sperry and Gazzaniga (1967) on the performance of subjects with neuro-anatomically disconnected cerebral hemispheres suggests that both hemispheres have the capacity to understand the basic referential properties of some words. But it is not yet clear how general this phenomenon is, nor is it clear how to understand the implication for normal adults of research on people whose cerebral hemispheres have been physically disconnected. Notice that our results show that there are distinct *qualitative* differences between the processing habits of the two ears, as opposed to straightforward *quantitative* differences, for example, reduced attention to the non-dominant ear (suggested by Treisman and Geffon, 1968). However, the distinction between interpreting a behavioural effect as qualitative and as quantitative is inextricably muddled; an apparent qualitative difference between two behaviours can always be reinterpreted as a quantitative difference along a conceptual dimension which subsumes both behaviours. For example, one could reinterpret our apparently qualitative findings as due to the quantitative lack of attention initially paid to the non-dominant ear by the central speech-processing mechanism.

Our experiment on picture-verification time showed that, after some monaural experience, the left ear operates like the right ear with processing strategies. Such lability is puzzling if the functional auditory asymmetries are due to a structural difference (for example, the lack of relevant neurological connections to the non-dominant ear). However, a neuro-anatomically sound adult human has both higher and lower connections between the cerebral hemispheres so that experience and behavioural habits can be transmitted from one hemisphere to the other (assuming that neuro-anatomical connections are relevant in such a direct way). Thus, the functional dominance we are studying in speech is a matter of the initial localization of acquired perceptual *habits*. The ability of the non-dominant ear to mimic the performance (at least qualitatively) of the dominant ear, after experience, is not surprising whatever the neurophysiological basis for cerebral asymmetry may be. Consider your own behaviour when you use your non-dominant hand for some complicated manual skill that is usually carried out by your dominant hand (e.g., throwing a ball, eating soup with a spoon, striking a match and lighting a cigarette). At first, your manual motions are awkward and jerky; your manual improvement may appear to recapitulate the original motor learning of your dominant hand. But with enough experience some of the same integrative motor strategies used in the dominant hand appear to smooth out the activity of the non-dominant hand (although your performance may always be less good than with the dominant hand).

The ability of the non-dominant behavioural system to acquire the patterns of skill of the dominant system when given unilateral experience may explain why many behavioural ear differences depend on simultaneous stimulation of the two ears. Presumably, the non-dominant ear cannot acquire the skill of the dominant ear when they are in direct competition, but when the non-dominant ear is on its own it can quickly acquire the performance strategies of the dominant ear, thus masking many initial qualitative differences between the ears.

I should like to add a general speculation about the relative role of external experience and of internal neurophysiological maturation in the normal development of cerebral lateralization of function. It has been noted by others (e.g., Zangwill, 1960) that lack of clear cerebral dominance is often associated with learning problems in children who otherwise appear to be intelligent. This would support an hypothesis that the ability to learn from experience and cerebral lateralization are related, but does not clarify whether certain critical experiences (presumably before the age of 6) are necessary to stimulate the development of lateralization. The form of the lateralized perceptual strategies in the adults and children we have studied appears to be responsive to the actual probabilities in stimuli recognized by the child as part of his own experience. The fact that functional dominance appears to develop simultaneously with the perceptual strategies raises the possibility that cerebral lateralization is itself critically dependent on certain kinds of experience. For example, I noted that Kimura found that children from a "lower middle class" school showed less auditory dominance than children from a wealthier community. We could take this as support for the claim that cerebral lateralization is in part a function of certain kinds of intellectual experience.[1]

Of course, we can (and should) study the functional nature of cerebral dominance independent of its physiological basis and its individual ontogenesis. I have reviewed a series of scattered arguments that the dominant hemisphere and behavioural strategies of speech-processing are uniquely associated, not because the arguments *should* convince you, but because they convince me that we must pursue this possibility.

Discussion

BEVER: It seems to me, that we are all to some extent burdened with a particular notion of structure, and I want to try to modify this notion. There is a classical conflict within biological fields between analyses in terms of structures and in terms of processes. In the past 10 years of linguistics and psycholinguistics we have emphasized structure over process. This was a reaction to the preoccupation with learning processes that went on before that, when the only process that anyone could think of was free-floating association, which didn't seem to work out very well. I think now that we could try to develop an enriched concept of the kinds of psychological processes which we might find in organisms. Up till now we have taken the view that the language structure is given; that we can discover the structure by teasing out little facts here and there and then assembling them in phrase structure "trees"; and then we state the relations between trees by transformations, and only after that is done can we come to the problem of seeing how all this structure is utilized in behaviour.

Perhaps the time has come to look upon this in a different way. We

[1] It is intriguing to notice that the relation of localization of brain function and the variety of early experience has been demonstrated for rats (Smith, 1959). Smith found that rats reared in an undifferentiated environment follow Lashley's law of mass action and do not show functional cerebral specificity, while rats reared in an intricate environment do show cerebral localization and differentiation of functions in various learning tasks. (I am indebted to Dr. J. Church for calling my attention to this research.)

might look upon linguistic structure as the distillation, as a by-product, of active language processes. The question we should now ask is something like this: given that we know the nature of linguistic structures, what do they tell us about the linguistic processes, about the processes that result in language behaviour? One area that I have been particularly interested in lately has been concerned with the constraints that the general principles of perception might bring to bear on some of the intricate and internal linguistic structures that we find. I am arguing that these structures are the way they are because certain general perceptual constraints are present.

One example is the constraints on pronominalization in English. The general rule about pronominalization is that it *proceeds from left to right.* If you want to say:

*"Bill$_i$ talks to Bill$_i$"

and you mean the two "Bills" to be co-referential, you must say:

"Bill$_i$ talks to himself$_i$."

You can't say:

*"He$_i$ talks to Bill$_i$"

if you are talking about only one person. If you say:

"He$_i$ talks to Bill$_j$,"

you have to mean somebody else, you cannot mean *Bill was talking to himself.* However, this general left-right rule may be broken when the pronominalization is from a main clause into a subordinate clause. You can say both:

"Although Mary spoke to Bill$_i$, he$_i$ stayed late;"

and

"Although Mary spoke to him$_i$, Bill$_i$ stayed late."

"Bill stayed late" is the main clause and "although Mary spoke to him" is the subordinate clause. That is, there is a second rule of pronominalization, that it proceeds from main clause to subordinate clause. What you can't say is:

*"He$_i$ stayed late although Mary spoke to Bill$_i$."

Here the pronominalization does not satisfy the left-to-right rule and it doesn't satisfy the subordinate-clause/main-clause rule either. Several people (Postal, Ross and Langacker) discovered these two general principles about the same time. Actually, there are other difficulties

about pronominalization; but let's assume for the moment that these two rules might be true and then let's look at what kind of general cognitive principle would provide the basis for them.

What seems to happen is that the pronominalization is allowed to occur whenever you know already what the pronoun refers to—as in the left-to-right rule—or when you are given a promissory note that you are about to be told what the pronominalization refers to, as in the cases with subordinate clauses. Bob Kirk, of M.I.T., argues that by the time you come to a verb in a clause, you already know whether it is a verb in a subordinate clause or the verb in a main clause of a sentence. This is because there is always some marker of subordination like *although, with, if,* and so on, or the *-ing* suffix, or the infinitive marker *to.* If Kirk is right that the subordinate clause is always marked as such when it comes first in a sentence, that means that the listener is given the promissory note that the main clause is coming. This seems to me to be the basis for a very reasonable perceptual strategy, given that what we do when we're hearing sentences is trying to sort out what the main thought is and what the qualifying thoughts are. The strategy here is that when we hear a subordinate clause we know there is more to come, and we put it aside and wait for the main clause. Since we know more is to come, a pronoun in an initial subordinate clause is acceptable. It is in this way that the structural constraints on pronominalization rules interact with perceptual strategies.

Another example has to do with the ordering of adjectives. Vendler (1967) has argued that the more noun-like an adjective is, the further away it must be from the determiner (e.g. "the") or the closer it must be to the noun. For instance, we say a *nice metal ball,* but not a *metal nice ball. Metal* has much more "nounness" than *nice* has, so it goes next to *ball.* Now it seems to me that a very reasonable perceptual strategy would be that, when you hear a determiner *a, the,* perhaps *any,* numbers and so on, there is a perceptual strategy to look for the first thing that *can* be a noun and that gives you the opportunity to establish closure at least provisionally. If we had an order which allowed *the metal nice ball,* it would incorrectly apply closure prematurely after *metal* since it can be a noun. So the constraints on the neutral, conjunctive order of adjectives can be viewed as a structural accommodation to our perceptual system.

SINCLAIR: I wonder how much this question of subordinate and main clauses has to do with topic and comment. I believe you can say in English:

"The time Bill stayed late Mary had spoken to him", and that you can also say:

"The time he stayed late, Mary had spoken to Bill."

BEVER: Perhaps you can, but the second sentence is a surface structure in which the first clause is marked as subordinate.
KLIMA: Yes, but sentences are presumably processed via surface structure.
BEVER: O.K. it may be that the rules don't handle this, although I think they do. I did say that we hadn't yet licked all the problems of pronominalization. However, the structural constraints I mentioned handle a large number of problems.
SCHLESINGER: I would like to suggest an alternative explanation to the phenomenon of order of adjectives. Your explanation can't account for *the good old man*, for instance, or *the tough old man*, or *the stingy old man*. This seems to involve a distinction between secondary and primary qualifiers. *Old* belongs to the man, he can't help being old, but he can help being stingy.
BEVER: In certain cases that might be true, although the adjective order you give is not the neutral conjoined order in my dialect. But if we try to deal with the problem in this way, it is going to be extremely messy in any case because it allows any kind of perceptual strategies and inductive strategies which people might develop on the basis of their experience. There are going to be all kinds of intersecting types of experience which will range from such structural variables that I've been talking about here, to the richest source of induction, which is context, which we don't know how to study. There is another point here, about counter examples; what we're dealing with are perceptual *strategies*, not exceptionless rules; 20 per cent of the cases could be counter-examples and it would still be an effective perceptual mechanism to have this as a strategy.
ERVIN-TRIPP: You have been talking about a strategy for receiving other people's speech. Presumably a child develops his perceptual strategies before he learns to control his speech in the same way, and we might expect to find that some of these strategies affect speech output too. Basil Bernstein and his colleagues found that 5-year-old working-class children do not follow these rules for pronominal usage and do not use pronouns the way middle-class children do, with verbally specified antecedents. We also have some evidence that working-class children, on the input side, have learned their language more often from other children than from adults.
BEVER: Yes, clearly what we are talking about are partially induced strategies, although the perceptual system must also start with some built-in mechanisms. I'm talking about the kinds of perceptual inductions that the child develops, once his memory attains the quality or the quantity which allows him to form such inductions. He is critically dependent on getting enough cases over which to make his induction.

ROBINSON: It is quite true that, in working-class speech, they let out lots of pronouns without giving any referents, so that when they say *him*, *it*, *he*, you have no idea what they are talking about unless you are also with them; even then you might not. So, their failure to follow the rules leads to failure in communication as well.
CAZDEN: I think we need to distinguish between what is ungrammatical and what is referentially unclear. For instance:

"He kicked it and broke the window"

is not ungrammatical, but you won't understand it unless you know the context.
ROBINSON: You're right. The problem is: you get 14 pronouns in a small paragraph and three nouns for these to refer to. This is not a matter of clever violations of rules, it is just a series of pronouns.
T. INGRAM: Perhaps it's just that we don't understand it. You often find that other children from the same group understand what one of them is saying, even if what is said doesn't refer to the immediate situation.
ERVIN-TRIPP: Well, there have been a number of "back to back" communication experiments. One child is supposed to tell another child about how a number of objects are arranged, so that the second child can reproduce the arrangement. Working-class children succeed less well at this game, even with working-class hearers. These experiments normally don't pair close friends nor refer to shared experience, and these are the normal conditions under which working-class children learn the amount of specificity required for successful communication. They have not been trained to over-specify, and without feedback here may take up a style of communication that has normally worked for them, where a lot of pronouns can be used.
ROBINSON: I don't think it's a matter of familiarity with the group, as much as familiarity with the environment in which the events are occurring. I think there is a distinction here between speaking in a restricted in-group code, so that everyone knows the allusions, as against speaking egocentrically where you simply fail to provide the necessary information.
SINCLAIR: It seems to me that ability to use pronouns is something which develops with age as a cognitive function. When you first have children playing at talking on the telephone, every child, working-class

or middle-class, will act as if the other child can see what he is talking about. To take your earlier example, it is as if you have an adult seeing Mary and Bill looking at each other, he can very well say to somebody else:

"Although she spoke to him he is still staying late."

You have nothing but pronouns, but it's O.K. because you can see the persons involved. When we have working-class children and middle-class children, if there is any difference in their ability, it might be that working class children don't catch on to the game that you're playing. Once you get them to understand that the game is to specify objects that are invisible to the listener, then we have never been able to find any differences between working-class children and middle-class children, except that the middle-class children catch on to this kind of game much more quickly.

ROBINSON: You may be right, it may be a perceptual problem of what the situation is about, rather than a problem of what their command of the language is. If what you're talking about turns out to be a violation of the pronominal rules, then I could argue that children that don't get the chance to learn the strategy also violate the rules.

SCHLESINGER: You could look at this in a slightly different way. It seems to me you're saying that the strategies originate in the child. Now you could say that this is a strategy which the adult adopts when he communicates with others, so that the listener is not overburdened. In other words, the child learns it from the adult, who has learnt it because he wants to help the child.

BEVER: This sounds kind of circular to me.

MEHLER: I think you could be interpreted as being circular too; because you take a structure in the language and then you say that this is due to a certain strategy, and then you say that because that structure exists that proves that your strategy is right. But the strategy of looking for the nearest nounlike word might have resulted in a language where you had determiner always followed by noun, and then all the adjectives could be piled up afterwards. Or, given that adjectives precede nouns, you could invent other strategies to account for that.

BEVER: I'm not trying to say that it is only these perceptual constraints that determine the form of the language or that all perceptual strategies are induced. As regards word order, I think it is just in those cases where the syntactic structure allows free order, that the perceptual constraints play a role in determining the preferred order.

HYMES: There's a problem here. What with the variety of conceptual

constraints and the number of different languages, how would you preserve any sort of general all-over principles? The question is very difficult, but I can think of one general constraint: language-users tolerate only a very small amount of ambiguity. For instance, you generally need to know where the deep structure subject, verb and object are, and languages will have a necessary amount of case markings, or the necessary amount of ordering constraints to let you know. Of course every language has a certain amount of ambiguity which is tolerated. In English we have sentences like "John is quick to please", which is ambiguous with respect to its deep-structure relations. But no language allows itself to be totally chaotic, to allow an arbitrarily large number of such ambiguous derivations. Terry Langendoen argues that linguistic pressure is in the direction of resolving ambiguity. Whenever the ambiguity gets too bad, you stick in a function word to clear things up.