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Listening to Speech While Retaining Music: What Happens to the Right-Ear Advantage?

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On each trial, subjects were played a dichotic pair of syllables differing in the consonant (/ba/, /da/, /ga/) or in the vowel (/ba/, /bɛ/, /bi/). The pair of syllables was preceded by a melody, or a sentence, and followed by the same or a different melody, or sentence. Subjects either had to retain the first piece of additional material or were free to ignore it. The different combinations of phonemic contrast, additional material, and instruction concerning the additional material were used in different sessions. In each case, the main task of the subjects was to respond to the presence or the absence of the target /ba/ on the ear previously indicated. There was no effect of context on relative ear accuracy, but the right-ear advantage observed for consonants in response latency when subjects retained a sentence gave way to a small nonsignificant left-ear advantage when subjects retained a melody. Right-ear advantage in response latencies was also observed for vowels in the verbal context, but the contextual effect, although in the same direction as for consonants, was very slight. The implications of contextual effects for a theory of the determinants of the auditory laterality effects are discussed.

Kimura (1961) found that subjects, listening dichotically to lists of digits, recall stimuli arriving at the ear contralateral to the language-dominant hemisphere more efficiently than stimuli arriving at the ipsilateral ear. Since in most people the language-dominant hemisphere is the left, that effect is usually known as the right-ear advantage. It has been replicated many times, and verified for nonsense CV syllables differing in the consonant (Shankweiler & Studdert-Kennedy, 1967) and for sentences (Bever, 1971), for monaural (Bakker, 1969) and for dichotic presentations, for accuracy of recognition (Broadbent & Gregory, 1964) and for response latency (Springer, 1971).

Kimura (1961, 1967) attributed the right-ear advantage to the convergence of two factors: cerebral dominance and prepotency of the crossed auditory pathways over the uncrossed ones. Regarding the first factor, there is no dissent in the literature. That the direction of the effect reflects a specialized ability of the contralateral hemisphere has been quite

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convincingly demonstrated by Kimura herself. It is the second part of Kimura's interpretation, which intends to explain why, given dominance say of the left hemisphere, there is right-ear advantage, that is now largely questioned. Since the distinction between the two problems has been sometimes blurred, we feel necessary to precise that the different kinds of models we shall discuss here do not apply to account for (or to describe) hemispheric asymmetries but to account for lateral asymmetries in performance.

Kimura's interpretation may be considered a structural one, structural meaning here, in the words of Studdert-Kennedy (1975, p. 124), a "wiring account of ear advantages in terms of ear-to-hemisphere connections". The discovery by Sparks and Geschwind (1968) and by Milner, Taylor, and Sperry (1968) of an almost complete suppression of the left-ear signal in split-brain patients, listening dichotically to verbal material, led most authors to assume that the right-ear advantage results from degradation of the left-ear signal during its passage through the corpus callosum. This addition to Kimura's initial interpretation (Kimura, 1964, decided explicitly to ignore the "much slower" commissural connections) does not change the structural nature of the model.

An alternative model, devised not specifically for ear differences but for perceptual lateral asymmetries in general, has been proposed by Kinsbourne (1970, 1973). According to this model, expectancy of information whose processing is lateralized in the brain induces preparatory activation of the specialized hemisphere. This activation automatically produces an orientation of covert attention to the contralateral side of space. Thus, in the classical dichotic listening situation, when the subject is waiting for verbal material, his attention is involuntarily biased to the right, resulting in a right-ear advantage. Another assumption of this model is that, when attention is voluntarily focused on one particular side, cognitive processes lateralized in the opposite hemisphere are favored. This could explain why lateral asymmetry in performance occurs under experimental procedures controlling for the orientation of focused attention. In this case, verbal items coming from the attended left side would encounter the dominant left hemisphere in a lower level of activation than verbal items coming from the attended right side.

There are at least two points about which the models of Kimura and Kinsbourne set forth different claims and predictions. One concerns the characterization of the auditory laterality effect as an ear-of-entry or a spatial position effect, that is, as the result either of stimulating a particular ear or of receiving sounds from a particular side. The other concerns the extent to which the laterality effect measured on one task may be affected by the nature of the processing entailed in another, previous task.

Kimura's interpretation is consistent with an ear-of-entry, but not with a spatial position effect; the reverse holds for Kinsbourne's model. Relevant to this point is a set of experiments by Morais and Bertelson. They have shown that laterality effects may be obtained (1) with presentations over loudspeakers placed 1 m to the left and 1 m to the right of the subject (Morais & Bertelson, 1973), and (2) with stereophonic presentations through earphones, in which apparent localization to the left or right is created by means of a time delay between stimulation of the two ears by the same message (Morais & Bertelson, 1975). These outcomes clearly support a spatial-position characterization of the laterality effect in audition.

An intriguing aspect in the results of the latter experiments is that side differences were smaller in the time-delay stereophonic condition than in a dichotic listening situation. The authors provided data suggesting that this difference was better accounted for in terms of a difference in the apparent lateralization of the sources in the auditory space rather than in terms of ear-to-hemisphere connections. More conclusive was a result found in a later experiment (Morais, 1975a) using presentations over loudspeakers. If, with loudspeakers, an advantage of the right-side over the left-side message occurred along the contralateral pathway as a consequence, at least in part, of stimulating the right ear first and/or at a higher intensity level, then the auditory laterality effect should still be present, though reduced to some extent, when the subjects are misled about the spatial origin of the sounds. However, with real sources, invisible to the subjects, at 90° to the left and to the right from the median plane, lateral asymmetry was found to disappear completely when dummy loudspeakers were put at 45° rather than at 90°. It seems, therefore, that in the dichotic listening situation the right-ear speech signal is better processed not because it reaches the right ear, but because it appears to the subject to proceed from the right side.

Indeed, another kind of structural model might be consistent with a spatial position effect, if the contralateral and ipsilateral pathways are thought of as relating halves of space rather than ears and if, in addition, some information loss during passage through the corpus callosum is assumed. The most important difference from Kimura's interpretation would then be, besides the role of the callosum, the implicit reference to mechanisms of auditory localization rather than to the principle of occlusion or to the number of fibers (see Kimura, 1967). However, we would still have to explain how the false belief of subjects about the spatial position of the sources may annul the advantage of a message labeled by the auditory mechanisms "from 90° to the right" over the message labeled "from 90° to the left." On the other hand, a model like Kinsbourne's, resting exclusively on the role of cognitive and attentional processes, seems to be unable to account for another result reported in Morais (1975a): Placing real loudspeakers at 45° and fictitious ones at 90° rather than 45° is not sufficient to create a right-side advantage. This finding is inconsistent with the assumption that focusing attention 90° to the right favors the processes accomplished in the dominant left hemisphere, while focusing attention 90° to the left has a detrimental effect on those processes.

Let us consider now whether or not side differences in a particular task are dependent on the context in which this task is performed. Kinsbourne's assumption that adopting a cognitive set proper to one hemisphere biases attention to the opposite side received partial support from a dichotic listening experiment by Spellacy and Blumstein (1970). This experiment examined the effect of differential expectancy for verbal and nonverbal material on the recognition of consonants and vowels. Expectancy, or set, was supposed to be created by presenting CVC nonsense syllables, used as test stimuli, either in a context of CVC real words or in a context of sung melodies and sound effects. In each case, half of the dichotic pairs were test stimuli and half served to create the context. Half of the test stimuli differed in vowel and half in initial consonant. The results were that the right-ear advantage for consonants was relatively independent of set, but for vowels there was a left- or a right-ear advantage according to whether the context consisted of nonverbal or verbal items. The fact that the manipulation of the context influenced the ear effect for vowels is consistent with the idea that the spatial distribution of attention is affected by the adoption of a set for processes which are lateralized in the brain, but the fact that the same effect was not observed for consonants casts some doubt on Kinsbourne's hypothesis that ear differences in the dichotic listening situation result from an involuntary lateral orientation of attention. While a strictly structural model of the laterality effects in audition cannot accomodate the context effects on vowel recognition, one could still assume, in view of the results observed for consonants, that structural factors play the major role in determining lateral asymmetry. Material with known lateral dominance might not be sensitive enough to reveal the effects of covert attention, but might reveal instead those of a neural (hence, permanent) constraint.

The relevance of Spellacy and Blumstein's results for the discussion of Kinsbourne's model depends, however, on the extent to which manipulating the nature of the material employed in half the trials of a series can change the distribution of preparatory cerebral activity. The fact that musical stimuli frequently do not yield a left-ear advantage through an entire experiment (Spellacy, 1970; Kallman & Corballis, 1975) may have contributed to reduce the real difference between the two contexts. On the other hand, since only one type of material was used on each trial and the intertrial interval might not be negligible, it is possible that any change in the relative degree of hemispheric activation produced by a particular trial had completely vanished before the beginning of the following trial. Thus, it seemed to us that a more suitable way of manipulating the distribution of cerebral activity immediately before the onset of the test stimuli might be to charge the subject with a concurrent activity engaging either the same hemisphere as needed for the main task or the opposite one.

In the present experiment, the subject's task was to respond to the presence or absence of /ba/ in a dichotic pair of CV syllables, differing in the consonant or in the vowel; the dichotic pair was preceded by a binaural melody (or sentence) which either had or had not to be held in memory for comparison with a following token of the same or a different melody (or sentence). The latency of the response to the dichotic pair of stimuli was measured. Different sessions were devoted to the two phonemic contrasts (consonantal or vocalic), to the two contexts (musical or verbal), and to the two kinds of instructions concerning the additional material (to ignore it or to retain it for later recognition). In order to insure that any effect of context was an effect on covert attention (that is on unconscious distribution of capacity between the sides), not on the orientation of voluntary attention, the subjects were asked to monitor one ear only on each block of trials.

METHOD

Materials and Experimental Situation

The CV synthetic syllables used in the present experiment were provided by Dr. C. J. Darwin who prepared them with a parallel formant speech synthesis program on the Elliott 4130 computer at the University of Sussex. They were recorded on four tapes as pairs of simultaneous and different syllables lasting 300 msec, one on one track and the other on the other track. The pairs of syllables /ba-da/, /ba-ga/, and /da-ga/ were recorded on two of those tapes; the pairs of syllables /ba-bɛ/, /ba-bi/, and /bɛ-bi/ on the other two. Eighty pairs were recorded on each tape. On track 1 the syllable /ba/ appeared 40 times and each of the other two syllables 20 times. For the pairs with /ba/ on track 1, each of the other two syllables appeared evenly on track 2. For the remaining pairs, /ba/ appeared 20 times on track 2, 10 times with each of the other syllables, and each of these syllables appeared 10 times with one another. All 80 trials were randomized. On the tapes in which the syllables differed in the consonant the syllable on track 1 was recorded at a pitch of 100 Hz and the syllable on track 2 at a pitch of 161 Hz. On the tapes in which the syllables differed in the vowel syllables were recorded on both tracks at the same pitch: 150 Hz. The use of a different pitch on each track of the "consonants" tapes was intended to decrease discrimination difficulty.

Additional materials were recorded before and after each pair of syllables. Melodies were used in two of the four tapes (one "consonant" and one "vowel" tape), sentences in the other two. The melodies consisted of 20 couples of unfamiliar solo violin passages (5 or 6 notes) which lasted an average of 2.6 sec and were continuous within their duration. The two melodies of each couple differed in the last three notes, the last two, or the last one. The sentences, uttered by a female voice with neutral intonation and lasting an average of 2.9 sec, were in French and contained seven to nine words. There were 20 couples, 10 in the active form and 10 in the passive form. The two sentences of each couple differed in one word only; in half the couples the difference was carried by one phoneme only, and in the other half the different words, while acoustically quite dissimilar, were semantically related. For four of the five couples of sentences with same form and same type of difference, the different word was the final one and for the remaining couple it was in the middle of the sentence.

On each tape each pair of CV syllables was preceded, with a 2 sec silent interval, by one melody or one sentence (depending on the tape) and followed, with a 3 sec silent interval, by the same or another melody or sentence. In half the trials the two melodies or sentences were the same, in the other half they were different and belonged always to the same couple. Each melody, as each sentence, appeared with the same frequency. The order in which melodies, or sentences, were used through the tape was randomized. Each was recorded simultaneously on both tracks. A silent interval of 4 sec was introduced between the second melody, or sentence, of one trial and the first melody, or sentence, of the following trial.

Syllables were delivered at an intensity level of about 50 db SPL, melodies and sentences at an intensity level of about 40 db SPL, over Sharp HA-10 headphones from a Revox A77 stereophonic tape recorder. Intensity was measured using a Measuring Amplifier Brüel & Kjaer Type 2606. An electronic timer (Advance TC-12 Timer–Counter) connected to a voice key, which was fed to one of the output channels of the tape recorder, measured the time from syllable onset to response.

Subjects

Subjects were retained or not after the first two sessions (practice sessions) depending on whether or not they obtained less than 30% errors in responses to syllables and less than 10% in responses to melodies or sentences. Three subjects exceeded one of these limits and were eliminated. Eight subjects, five males and three females with an age range of 19–25 years, were retained for the testing. All were right-handed, with no known history of hearing disorder. None was experienced in musical dictation. Three of them had already served in experiments using synthetic syllables. Each subject was tested individually in a quiet room for ten 50-min sessions. They were paid 60 Belgian francs per session plus bonus and penalties depending on speed and accuracy as described later.

Procedure

The subject was seated at a table, on which was a two-way switch which the subject held between the thumb and the index finger of his right hand. His right forearm rested on the table. He was told that, on each trial, he would hear one melody or one sentence (depending on session) which would be presented binaurally, 2 sec later a pair of simultaneous syllables, one on the left ear and the other on the right ear, and 3 sec after the syllables the same or a different melody or sentence. He was instructed before each block of trials to focus attention on one particular ear during the syllables presentation and to judge whether the target /ba/ occurred or not on this ear; he had to move the switch as quickly as possible away from his body if /ba/ occurred, and towards his body if it did not. In half the conditions the subject was instructed to pay attention to the additional material preceding the pair of syllables, to hold it in memory and to respond orally, after the second presentation, whether the two melodies or sentences were the same or different; in the other half, the subject was told that no attention should be paid to the additional material since there would be no task on it.

There were eight conditions in the present experiment. They were defined in terms of the contrasting phoneme of the syllables pairs (consonant: *C*, or vowel: *V*), the additional material in the tapes (melody: *M*, or sentence: *S*), and the instructions concerning this material (relevant: *R*, or irrelevant: *I*). Each of the eight conditions (*CMR*, *CMI*, *CSR*, *CSI*, *VMR*, *VMI*, *VSR*, *VSI*) was run in one experimental session. Half the subjects had *M* conditions in the first four experimental sessions and *S* conditions in the last four; the other half had *S* conditions in sessions 1 to 4 and *M* conditions in sessions 5 to 8. For each group of 4 sessions so defined, half the subjects had *C* conditions before *V* conditions, and the other half had *V* conditions before *C* ones. For each of the four groups of two sessions so defined, one subject had *R* conditions before *I* ones, and the other subject had *I* conditions before *R* ones.

The four groups of experimental sessions, 1–2, 3–4, 5–6, and 7–8, were run on different days or half days and between the two sessions of each group there was a rest pause of 20 min. The experimental sessions were preceded by two practice sessions during which the subject listened to the 80 trials of each of the four tapes under conditions *CMR*, *CSR*, *VMR*, *VSR*, in the same order as in the respective experimental sessions. In each experimental session, the corresponding tape was played back two times in 8 blocks of 20 trials. The order in which attention was focused on one particular ear was counterbalanced both within and across subjects: the four subjects who had the order RLRLLRLR in sessions 1, 2, 5, and 6 had the order LRLRRLRL in sessions 3, 4, 7, and 8; the four subjects who had the order LRLRRLRL in sessions 1, 2, 5, and 6 had the order RLRLLRLR in sessions 3, 4, 7, and 8. Thus, for each session and for each subject, the first and the fifth blocks (as the second and the sixth, the third and the seventh, the fourth and the eighth blocks) were exactly the same as regards trial sequence, but they differed in the ear on which attention was focused. Position of earphones in the head was such that subjects listened to track 1 of each tape across the whole experiment. When, after a block of trials, instruction was given to attend the other ear, earphones were also reversed.

After each response to syllables presentation, the subject was told whether he had been "fast" or "slow", meaning faster or slower than the mean correct reaction time on the previous session. After an error on this task, the subject was told of it and no information regarding speed was given. For each fast reaction time the subject was awarded 0.5 Belgian francs; for each error, 1 franc was deducted. However, fast reaction times to the syllables were not rewarded on the trials in which the subject did not respond correctly to the melodies or sentences. A small lamp placed in front of the subject was lighted up by the experimenter to signal errors on the additional material. The latency of the responses to the additional material was not recorded.

RESULTS

Mean correct reaction times (in msec), standard deviations, and percent errors, by ear, by type of response (/ba/ or ~/ba/), and by condition, are shown in Table 1. Classification of subjects according to the ear for which they had faster reaction times is shown in Table 2.

A six-way analysis of variance (including as factors Ear, Phonemic contrast, Type of additional material, Instruction concerning the additional material, Type of response, and Subject) was performed on the mean reaction time data. Phonemic contrast interacted with Type of response ($F = 13.21$, $df = 1,7$, $p < .01$) and with Type of additional material

TABLE 1

MEAN CORRECT REACTION TIMES (IN msec), STANDARD DEVIATIONS, AND PERCENT ERRORS BY TYPE OF RESPONSE (/ba/ and ~/ba/) AND BY EAR FOR EACH OF THE EIGHT CONDITIONS

Con-	Mean RTs				*SD*				Errors (%)			
	/ba/		~/ba/		/ba/		~/ba/		/ba/		~/ba/	
dition	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
CSR	444	431	457	408	128	112	134	109	30.9	21.2	24.1	19.7
CSI	441	422	447	430	110	107	137	126	24.4	18.1	20.6	18.1
VSR	352	340	420	393	103	102	128	107	19.5	15.3	20.6	16.9
VSI	390	361	415	388	128	114	116	98	15.4	18.1	23.8	17.9
CMR	419	450	434	424	114	122	127	119	23.8	20.9	22.8	18.8
CMI	434	436	436	419	109	108	126	104	25.5	20.3	21.9	24.1
VMR	410	403	459	443	108	119	120	113	22.8	20.9	19.7	11.6
VMI	413	407	470	441	111	107	118	121	25.1	21.6	18.4	15.3

TABLE 2

CLASSIFICATION OF SUBJECTS ACCORDING TO THE EAR FOR WHICH THEY HAD FASTER REACTION TIMES, AND ONE-TAILED SIGN TESTS

Condition	Faster ear		
	Left	Right	None
*CSR**	1	7	—
*CSI****	1	5	2
*VSR***	—	8	—
*VSI***	—	8	—
*CMR****	4	4	—
*CMI****	5	3	—
*VMR****	3	4	1
*VMI****	3	5	—

* $p = 0.034$.
** $p = 0.004$.
*** p = not significant.

($F = 6.84$, $df = 1,7$, $p < .05$). These interactions are shown in Fig. 1. The interaction Ear × Type of additional material fell short of significance at the .05 level ($F = 5.44$, $df = 1,7$). However, as this interaction might depend on phonemic contrast (Ear × Type of additional material × Phonemic contrast: $F = 5.46$, $df = 1,7$, $p < .10$), two separate five-way analyses of variance were performed, one for the "consonant" conditions, the other for the "vowel" conditions. In the "consonant" analysis, the interactions Ear × Type of additional material and Ear × Type of additional material × Instruction concerning the additional material (see Fig. 2) were both significant at the .05 level (respectively, $F = 6.93$, $df = 1,7$, and $F = 7.31$, $df = 1,7$). In the "vowel" analysis, only the interaction Ear × Type of additional material × Instruction concerning the additional material × Type of response was significant ($F = 8.03$, $df = 1,7$, $p < .05$).

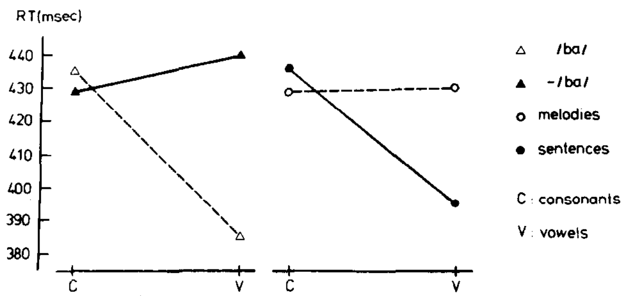

FIG. 1. The Phonemic contrast × Type of response and Phonemic contrast × Type of additional material interactions.

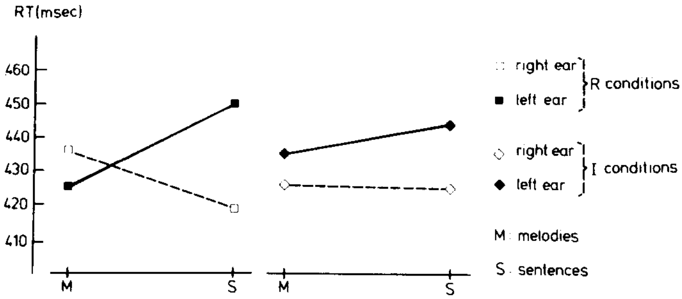

FIG. 2. The Ear × Type of additional material and Ear × Type of additional material × Instruction concerning the additional material interactions in the "consonant" conditions.

Regarding percent errors, in no condition were the differences between ears significant at the .05 level. However, there was a trend favoring the right ear in each of the eight conditions.

The averaged error rates for the two additional tasks, comparing melodies and comparing sentences, were respectively about 4% and less than 1%. Reaction times for syllables in the "relevant" verbal context conditions were also examined as a function (1) of the type of sentence (active vs passive), and (2) the locus of the difference between the two sentences of each trial (word vs phoneme). No systematic effect and no systematic interaction with the ears or with the vowel/consonant contrast in the main task were observed for any of those two factors.

DISCUSSION

Subjects were faster in responding to the presence or the absence of a target /ba/ on the right ear when the left ear was simultaneously stimulated by another syllable than in responding in the reverse situation, provided that the syllables were presented in a verbal context. No significant ear difference was observed, however, in percent errors. It is thus suggested once again (see Springer, 1971) that response latency may be a more sensitive index of laterality than percent of errors.This was apparently the case in several studies which tried to reveal ear differences with monaural presentation (Springer, 1973; Morais, 1975b; Morais, 1976) and it seems to be the case now in studying the effects of context on the auditory lateral asymmetry. In fact, in the present study, a significant effect of context on right-ear advantage is observed for consonants at the level of reaction times, but not at the level of error scores.

The right-ear advantage in detecting the presence or the absence of /ba/ with, on the other ear, a competing syllable differing in the consonant, was 31 msec when the subject had to rehearse a sentence presented some seconds earlier, and gave way to a small left-ear advantage (−11 msec), when the subject had to hold a melody in memory. This contextual effect has important implications regarding the origin of auditory laterality effects. It argues against an interpretation based exclusively on structural factors, which would predict constant ear differences whatever the context. The present finding, observed under conditions which controlled for the orientation of voluntary attention, implies that the laterality effect for one particular stimulation is affected by other ongoing activity: the predominance, at the moment of testing, of a particular type of mental activity determines which ''channel'' (side) dominates the other to at least as great an extent as does any intrinsic difference between the ''channels''. We mean here by intrinsic difference between the ''channells'' any difference resulting from a structural constraint of the auditory projection system in the ''strength' with which the left side input and the right side input reach the processing centres.

Kinsbourne's assumption that activation of one hemisphere directs involuntary attention to the contralateral side of space is, of course, consistent with the reversal in laterality effect observed here for consonants. It must be stressed that this reversal cannot be accounted for simply on the basis of hemispheric activation without recourse to the notion of orientation of involuntary attention, even if this notion remains largely mysterious. It was probably the combination of the notion of hemispheric activation with a structural view of the determinants of laterality effects that led one author, Allard (1972), to state that ''if the right hemisphere is activated by a nonverbal set, it is difficult to see what effect this arousal could have on verbal material, which presumably requires the specialized equipment found in the left hemisphere (. . .). It is difficult to see how any reversal of laterality could occur, since laterality is the root of the whole theory. Kinsbourne's theory can predict that a set will make a hemisphere better at what it can already do, or better at something it normally does with the same efficiency as the other hemisphere'' (p. 329). However, activation of the right hemisphere by the attempt to memorize a melody did not make the left hemisphere worse at its processing of syllables differing in the consonant. In fact, response latency averaged over the two ears does not seem to have varied with context, since we observed a mean reaction time of 432 and 435 msec in conditions *CMR* and *CSR*, respectively. (A different picture was, however, observed in the ''vowel'' conditions on which we shall comment below.) Activation of the right hemisphere simply affected the distribution of the left hemisphere capacity for processing consonants betwen the left- and right-ear inputs. Since the subject tried to focus attention on one ear only on each block of trials, we must further conclude that the allocation of processing capacity to speech from a particular side escapes, to some extent, the subject's conscious control.

The fact that in condition *CMR* mean reaction times to the left ear were only slightly faster than to the right ear, with no difference in the distribution of subjects, may be due to several factors: to the fact that subjects were expecting a verbal task, so that some degree of activation of the left hemisphere was preserved; to the 2-sec silent interval between the offset of the melody and the onset of the syllables which may have been sufficient to lose some part of the hemispheric imbalance that would result from perceiving and storing a melody; to the possibility that the two hemispheres are not specialized in their respective abilities to the same extent; and, finally, to the possibility that some structural feature of the auditory projection system, in addition to hemispheric activation, contributes to right-side advantage for speech processing.

The ear-effects of conditions *CSR* and *CMR* discussed above were averaged over the two responses signaling the presence or the absence of the target /ba/. There is, however, some evidence that both the size and the direction of the laterality effect depend on the type of response. In fact, for /ba/ responses right-ear advantage (13 msec) with verbal context changed, with musical context, into left-ear advantage (−31 msec), while for ~/ba/ responses greater right-ear advantage in the first situation was just reduced in the second situation (from 49 to 10 msec). This may indicate that different processes underlie the two decisions. It has already been suggested (Morais, 1976) that selective preparation to a particular syllable in a paradigm which permits a yes–no classification may eliminate the laterality effect by intervention of a nonphonetic matching strategy. However, the absence of right-ear advantage for the positive responses would not be expected under a dichotic listening situation (compare Springer, 1971 with Springer, 1973), since degradation of the signal presented at one ear by competitive stimulation of the other ear would prevent such a match. On the other hand, the fact that negative responses were not slower than positive ones is puzzling, since a response by exclusion just as a response following phonetic checking would normally produce some loss of time. This point requires, indeed, further experimental data. Nevertheless, with respect to the contextual effect on consonants, it should be noted that the size of the detrimental effect on right-ear advantage, when the concurrent activity is to retain a melody rather than to rehearse a sentence, is about the same for the /ba/ and ~/ba/ responses (respectively, 44 and 39 msec).

While, for conditions *CSR* and *CMR*, the ear difference was respectively of 31 msec favoring the right ear and 11 msec favoring the left ear, for conditions *CSI* and *CMI*, where the subject was merely exposed to the additional material without having to work on it, the ear difference was respectively of 18 and 8 msec favoring the right ear. The *I* conditions gave thus weaker contextual effects (a scarce difference of 10 msec between the effects obtained with exposure to a sentence and with exposure to a melody) than the *R* conditions, and this fact is statistically expressed in the

Ear × Type of additional material × Instruction concerning the additional material interaction. It seems, then, that for consonants greater changes in the relative degree of hemispheric activation may result from deliberate mental activities than from simple exposure to stimuli.

We shall now discuss the results observed for the "vowel" conditions. A somewhat unexpected finding was that for both *VSR* and *VSI* conditions all subjects gave faster reaction times to the right ear than to the left ear and that this ear difference was of about the same magnitude as the one observed for consonants. Previous studies showing a laterality effect for vowels made vowels difficult to decode by the subjects, either using a very unfavorable signal-to-noise ratio (Weiss & House, 1973), or employing very short vowels (Studdert-Kennedy, 1972), or introducing unpredictability concerning the size of the vocal tract (Haggard, 1971; Darwin, 1971). The present results suggest that a right-ear advantage may be obtained for syllables differing in the vowel and presented without additional material, provided that dichotic competition is used *and* a fast decision is called for.

More puzzling is the fact that, contrary to consonants, no significant effect of context on right-ear advantage was observed for vowels. The right-ear advantage was 24 msec in the two *VS* conditions and merely dropped to 14 msec in the two *VM* conditions. However, to claim on the basis of this slight difference that for vowels there is no contextual effect would be incautious, because the distribution of subjects according to the faster ear shows that while in the verbal context all subjects scored better on the right ear, three out of the eight subjects scored better on the left ear in the musical context.

There are two other points in the comparison of results for vowels and for consonants for which we have no satisfactory explanation. The first is the fact that responding to vowels, but not responding to consonants, was much faster in a verbal context than in a musical context. The second is the fact that /ba/ responses were much faster than ~/ba/ ones only for syllables differing in the vowel. We might speculate that for these syllables it is easier to use a prephonetic matching strategy, since under dichotic competition discrimination between formants at different positions on the frequency scale might be easier than discrimination between formant transitions. In this case, however, we should predict a smaller ear effect for vowels than for consonants, and this was not observed.

In comparing Spellacy and Blumstein's (1970) results with our own, it should be noted that the only contradiction lies at the level of percentage errors for vowels. In fact, Spellacy and Blumstein found an effect of context on relative ear accuracy for vowels, but not for consonants, while in the present experiment there was no contextual effect on ear accuracy for either phonemic category. We can only speculate about the origins of this discrepancy. It is true that we used a reaction time paradigm and found for vowels a percent of errors about twice as high as that observed in Spellacy and Blumstein's recognition task, but it is not clear how this could be critical. A more plausible reason for the discrepancy might be that Spellacy and Blumstein did not control for the orientation of voluntary attention, while we did by asking subjects to focus attention on one ear only. The contextual effect reported by those authors might be an effect on the orientation of voluntary attention rather than a perceptual or cognitive constraint (e.g. through some form of involuntary attention) on the lateral focusing of attention.

CONCLUSION

The prime outcome of the present experiment is the vanishment of right-ear advantage in reaction times to CV syllables differing in the consonant when the subjects have to hold a melody in memory. The same effect could not be demonstrated for CV syllables differing in the vowel; however, significant right-ear advantage for vowels was observed only in a verbal context.

The contextual effect on right-ear advantage for consonants discrimination shows that the distribution of the left-hemisphere processing capacity between the left and right ear inputs is affected by the nature of other ongoing activities in the brain; it also shows, as a consequence, that auditory laterality effects cannot simply result from some anatomical or functional feature of the system connecting the ears and the hemispheres.

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