# THE EFFECTS OF THE MELODIC ASPECTS OF SPEECH AND HEMISPHERIC SPECIALIZATION ON AUDITORY VERBAL PROCESSING

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BY

PHOEBE I PARKER, B.Mus.Ed.

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# INTRODUCTION

Even though scientists have been speculating about the specialization of the cerebral hemispheric processes for over a hundred years (Benton, 1972), only recently have the methods and knowledge been available to begin a more thorough investigation of the subject. Most of the areas previously explored have involved studying the perception processes of visual stimuli with lesser amounts of research studying the input of auditory and tactile stimuli. To the music and speech therapists, however, the auditory stimuli are the most pertinent. To learn and study all aspects of audition should be a priority of all professionals in the field.

Literature pertaining to the specialized processes of both the right and left hemispheres of the brain was reviewed, and though many studies provide information concerning the perception of both visual and tactile stimuli (Gazzaniga, 1968, 1970; Levy-Agresti and Sperry, 1968; Sperry, 1958), the literature concerning auditory stimuli is the most relevant to this paper. The following review will be confined to discussing various aspects of auditory stimuli as well as the physiological and perceptual implications of such stimuli in relation to hemispheric dominance.

## Purpose

The purpose of this study was to examine the melodic aspects of speech and to expand upon existing literature (Broadbent, 1974; Blumstein and Cooper, 1974) concerning processing of these verbal intonation contours in relation to hemispheric dominance. Through this study a more effective means of presenting auditory information was sought so as to stimulate future consideration regarding melody as an integral factor involved in memory or learning. Even though Isern (1959, 1961) described songs to be a more effective teaching tool than stories for memory, more research is needed to verify melody as a valuable aspect of auditory learning as well as to determine effective modes of relaying melody and speech.

## Review of the Literature

Penfield (1969) states that the speech mechanism of right-handed people is invariably in the left hemispheres of the brain while left-handed people have their speech mechanism in either the right or left hemispheres. Within this speech or dominant hemisphere are three cortical speech areas including the posterior speech cortex, which is devoted to the ideational transaction of language, the anterior speech cortex, considered to be a secondary area; and the superior cortex, located in the supplementary motor area.

Before the final perception of verbal language occurs, the speech travels in several energy forms and through several mediums. Upon receiving a spoken word the sound waves reach the ear drum and then activate the nerve cells in the cochlea which correspond to each vibration frequency. The electrical potentials evoked make an afferent auditory stream which is flashed to the thalamic nuclei and out to the audio-sensory cortex on both sides of the brain and then back into circuits of central integration. Next, the sound pattern is sent to the ideational speech mechanism in the cortex. A "translation" then occurs in the speech mechanism and the altered message echoes back into circuits of the central integrating system and the mind obtains the idea of the word (Penfield, 1969).

Penfield (1959) reports that one important sensory area in the human cortex which received streams of nerve impulses from the ears is the "buried transverse gyri of Heschl, which form part of the first temporal convolution on each side and run deep onto the lateral fissure of Sylvius" (p. 17). Removal of one transverse gyrus of Heschl affects hearing little, "perhaps because the incoming auditory impulses pass from each ear to both auditory areas" (p. 18). Darwin (1974) supports the above supposition when he states that "the afferent fibers of the auditory system project from either cochlea to both hemispheres" (p. 57). However, more cells fire to the contralateral ear than to the ipsilateral ear and there will be a slight tendency for the hemisphere contralateral to the stimulated ear to respond more than the hemisphere ipsilateral to the stimulated ear. Darwin (1974) supposes that the longer the duration of the sound the less is the ipsilateral occlusion and the ipsilateral pathway is occluded more when similar sounds are played dichotically than when very different sounds are played.

A study by Rosenzweig (1951) was conducted to present quantitative evidence to show that the response to sound of the contralateral ear was significantly larger than the response to the sound of the ipsilateral ear at both hemispheres. The question was also asked whether the two ears were represented by overlapping populations of cortical units. Five anesthesized cats were used to record electrophysiological responses at their auditory cortex.

To determine whether each ear was represented by a larger population of cortical units at its contralateral hemispere, the size of cortical responses was compared when one and then the other ear was stimulated by generated clicks through earphones. The amplitude of the response served as a rough measure of the number of cortical units that had been excited. The response of each ear tended to be larger at the contralateral hemisphere with the difference between the responses of the two ears being larger at the right hemisphere than the left. The ipsilateral representation of cortical units was about three-quarters that of the contralateral representation. Results also showed that many of the units that responded to ipsilateral stimulation also responded to contralateral stimulation.

How the interaction of the hemispheres work is still a major unknown in the coverage of the topic of hemispheric specialization and how the commissures operate is the question (Teuber, 1974). According to a study by Springer and Gazzaniga (1974), results indicated that the portion of the callosum important for interhemispheric transfer of speech is anterior to the splenium and posterior to the first one-third to one-half of the callosum. Though information such as the above is pertinent, the question of the operation of the commissures is still not answered.

The function and processes of most areas of the brain are as yet a mystery to man and despite extensive research into the understanding of cerebral functioning very few hypotheses can be validated without dispute. The actual anatomy of the brain can be more objectively studied and has been studied regarding certain areas of the temporal speech cortex. Geschwind and Levitsky (1968) found marked anatomical asymmetries between the upper surfaces of the human right and left temporal lobes. In a study using one hundred brains the planum temporale was found to be larger on the left in sixty-five percent of the brains and larger on the right in only eleven percent of the brains. The left planum was also found to be one-third longer than the right planum. In a later study (Galaburda, LeMay, Kemper, and Geschwind, 1978), asymmetries in the planum temporale were found as early as the thirty-first week of gestation. The left planum averaged $3.6 \pm 1.0$ centimeters in length while the right planum averaged $2.7 \pm 1.2$ centimeters. The left planum, then, was nearly one centimeter longer than the right and one-third larger in area. The major cytoarchitectonic asymmetry was the greater extent of the tempoparietal cortex on the left side. This area, which is related to language function, had a volume approximately seven times larger on the left side of the brain than on the right side.

Physiological data seem to show that brains without particular asymmetry are more common to left-handed people; left-handed people are more likely than right-handed to show reverse asymmetry but the extent of asymmetry is less striking; and in some cases the asymmetry is the same direction in the left-handed as in the right-handed, but again is less striking in magnitude. Other conclusions drawn were that the region which is larger on one side of the brain may vary from being slightly larger to many times larger; asymmetries appear to be inborn since they are present in the fetus; and there may be sex differences in the distribution and extent of asymmetries (Galaburda, LeMay, Kemper, Geschwind, 1978). Several studies (Zangwill, 1960; Rossi and Rosadini, 1967; Milner, Branch, and Rasmussen, 1964) concur that some left-handers may have language and kindred processes imperfectly lateralized to either hemisphere and therefore may be considered lacking determinate cerebral dominance. Bakan (1971) and Briggs and Nebes (1976) suggest there may be more hemispheric integration in women than in men thus supporting the earlier statement regarding sex differences in the distribution and extent of cerebral asymmetries.

Despite the difference in asymmetries of the hemispheres which might be related to handedness or sex, the left hemisphere is still commonly referred to as the dominant or speech hemisphere. "For most people (nearly all right-handers and many left-handers) the left hemisphere is dominant for language" (Krashen, 1977, p. 107). Bever (1971) claims that "the learned processes of utilization of language structure in actual comprehension are functionally 'located' in the dominant hemisphere" (p. 234). Bever supports this statement with three findings which are as follows: "1.) There are more 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" (p. 234).

Liberman (1974) states that "linguistic information has at least three different shapes: An acoustic (or auditory) vehicle for transmission; a phonetic representation consisting of consonants and vowels, appropriate for processing and storage in a short-term memory; and a semantic representation (or its less linguistically structured based) for a nonlinguistic intellect and long-term memory" (pp. 43-44). The conclusion tentatively drawn by Liberman is that highly encoded aspects of speech (those most in need of grammatical decoding) are almost always processed in the language hemisphere while the encoded segments may or may not be processed in the language hemisphere. Liberman also supposes the possibility that some people process all language elements linguistically while other people may use nonlinguistic processing when possible, thereby accounting for some individual differences in the "degree" of ear advantage.

Bever (1971) conducted a study which supports Liberman's theory concerning highly encoded aspects of speech being processed in the language hemisphere. Subjects in Bever's study heard ten seven-word sequences either randomly ordered or composing a sentence. Following the sequence was an interval of silence followed by subjects counting backward to prevent a rehearsal effect.

The results showed that more sentences were responded to correctly by subjects who heard the sentences in their right ears as well as more words in the sentences being correctly recalled by subjects who heard them in their right ears. No differences in ear preference appeared for subjects who heard the random word sequences. This and another study by Bever (1971) using varied syntactic structure both "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 judgments and immediate recall. While this phenomenon requires further study, it indicates that listening to speech affects the dominant ear differently from the nondominant ear, even with monaural stimulation" (pp. 239-240).

Another study involving the syntactic and semantic sentence structure was reported by Jarvella, Herman, and Pisoni (1970) in which the role of the left and right ears was evaluated in a short-term memory task. All sentences had the same syntactic structure but varied in semantic integration and were presented monaurally. The subjects were required to count backward following each sentence and after five seconds were requested to repeat back what they could remember. "For both levels of semantic integration, sentences presented to the right ear were recalled faster and with fewer errors than sentences presented at the left ear" (p. 85). The results indicated that "laterality factors related to cerebral dominance for language functions influence short-term memory for sentences heard monaurally" (p. 85). Frankfurter and Honeck (1973) also indicated a right-ear advantage in the short-term memory recall of monaurally presented sentences.

Though the left hemisphere consistently indicates a superiority in the recall of sentences, tests have shown that the right hemisphere also possesses a certain amount of language comprehension (Gazzaniga, 1967). In another study (Gazzaniga, 1974), the right hemisphere proved decidedly inferior to the left hemisphere in overall command of the language as well as response to verbs. However, the right hemisphere did respond well to concrete nouns. Grammar seemed poorly developed in the right hemisphere. Gott (1973) described some effects of a dominant left hemispherectomy in a twelve-year-old girl and found the comprehension of verbal speech to be one of the least impaired of language functions. From this case study, evidence appeared that the unassisted right hemisphere could direct some functions of receptive and expressive language. Auditory comprehension appeared evident for numbers, letters, and the syntax and semantic use of words.

Not only has word comprehension been indicated to be processed in the right hemisphere but also intonation patterns of speech have been shown to be better detected in the right hemisphere (Broadbent, 1974). In a study conducted by Blumstein and Cooper (1974), the purpose was to determine whether the perception of filtered intonation contours was lateralized and to determine the effects of a linguistic response on the perception of intonation contours. Subjects in this experiment were forty college students who were right-handed and with no hearing impairments. Stimuli in all tests consisted of four intonation contours filtered from real speech. Each sentence was composed of three-word monosyllables and primary stress was placed on the last word in the sentence. The sentences were low-pass filtered so as to preserve the intonation contours and speech-like quality while causing the words and most phonetic information to be unintelligible. The filtered contours were presented dichotically and half of the subjects were required to identify the contours by their sentence type while the other subjects were required to identify the same intonation contours by their melodic pitch pattern. Thus a comparison was made of the effects of a linguistic task versus a nonlinguistic task for the same stimuli. For the nonlinguistic response task demanding identification of a melodic contour there was a significant left-ear superiority and a non-significant left-ear advantage for the linguistic response task requiring identification of correct sentence types. A second study involving intonation contours by the same authors (1974) supports these experimental results in the suggestion "that the role of the left hemisphere is at best minimal. In fact, the consistency of the left-ear advantage in all analysis suggests quite clearly that the right hemisphere is more actively involved than the left in the processing of intonation contours" (p. 155).

Not only have intonation contours been shown to be processed in the right hemisphere, but the related aspect of musical melody has also been shown to be processed in the minor hemisphere. Dide (1938) in Benton (1972) "advanced the view that musical function depended upon the integrity of the superior temporal gyrus of the right hemisphere in analogy to the dependence of language functions on Wernicke's area in the left hemisphere" (p. 12). Jaynes (1976) reports that six-month-old babies being given EEG's have had recording electrodes placed directly over Wernicke's area of the left hemisphere and what corresponds to Wernicke's area of the right hemisphere. When tape recordings of speech were played the left hemisphere showed the greatest activity but when recordings of a music box or singing were played the activity was greatest over the right hemisphere. Milner (1967) found an impairment in the discrimination of tonal patterns and tone quality in patients who had right temporal lobectomies. Other studies supporting the theory of right hemispheric processing of music were presented by Cook (1973), King and Kimura (1972), and Kimura (1964) in which dichotic presentations of melodies indicated that a greater number of musical phrases were recognized when presented to the left ear.

Hemispheric function was studied in two reported articles in which sodium amobarbitol was injected into the right or left carotid artery which then depressed the corresponding hemisphere for several minutes (Gordon, 1973; Bogen and Gordon, 1971). Right carotid injections grossly disturbed singing in all patients while speech was unaffected except for a slight slur, slowness, and monotonicity of words. Patients had difficulty in spontaneously beginning songs and experienced unsuccessful attempts to change pitch at appropriate times. Correct rhythm was indicated though the tune was amelodic which indicated that the right hemisphere may be more important for singing than for speech (Bogen and Gordon, 1971).

Milner (1962) and Shankweiler (1966) both did studies involving patients who had had unilateral lobectomies. A left temporal lobectomy resulted in no change in the overall score of melody recognition while a right temporal lobectomy resulted in significant post-operative loss of melody recognition (Shankweiler, 1966). In Milner's (1962) study patients were tested on the Seashore Measures of Musical Talent and those who had right temporal lobectomies made more errors than those with left temporal lobectomies. The most marked differences were for tonal memory, timbre, and loudness. The results were the same regardless of whether Heschl's gyrus was removed, which then left the side which the lesion was on as the only important variable.

Jellison (1976) conducted research on the accuracy of temporal order recall for verbal and song digit-spans presented to both ears. The purpose of the study was to measure the accuracy of recall of digits in temporal order using dichotically presented verbal (V) and song (S) input modes to both the left and right ears. The combinations of ear and mode factors were as follows: LV/RS, LS/RS, LV/RV, and LS/RV.

Each subject in Jellison's experiment was asked to recall the numbers in the order they were heard and each digit was scored correct if written correctly by name and ordinal position. There existed a possible total score of three hundred and ninety-two for each subject, one hundred and ninety-six for each ear and ninety-eight for each ear mode.

The conclusions of Jellison's study were as follows: 1.) No significant differences were found between the three method pairs (LV/RV, LS/RS, LS/RV). However, significantly more correct responses were found for LV/RS when compared to LV/RV. 2.) Except for a significant left ear advantage for the method LS/RV, a significant right ear advantage was evidenced for LV/RS, LS/RS, and LV/RV. 3.) LV/RS indicated significantly lower scores for left verbal input while the same method (LV/RS) indicated significantly higher scores for right song input than all other songs. 4.) Significant differences were found for all verbal/song pairs of the same digit position with song resulting in significantly higher scores for all pairs. 5.) Group means for song input were consistently higher for the musically trained group compared to the musically untrained. 6.) A right-ear advantage was found for song input in contrast to a left-ear advantage generally reported in the literature for most music stimuli.

Jellison's study utilized the theory of hemispheric specialization to test the effects of melody on digital recall. More studies are needed indicating the practical application of hemispheric specialization in learning situations. Albert, Sparks, and Helm (1973) describe one such method termed Melodic Intonation Therapy (MIT) which imbeds "short phrases and sentences in a simple, non-linguistically loaded melody pattern" (p. 130) to produce improvement in the expressive ability of aphasic clients. The melodies involved in this method have limited pitch variation and each sentence-item is composed so that the inflection pattern, rhythm, and stress are similar to the speech prosody of the sentence (Sparks, Helm, and Albert, 1974). Sparks, Helm, and Albert (1974) concluded that "perhaps the most acceptable hypothesis at this time, then, to account for the efficacy of MIT is that increased use of the right hemispheric dominance for the melodic aspects of speech increases the role of that hemisphere in inter-hemispheric control of language, possibly diminishing the language dominance of the damaged left hemisphere" (p. 315).

This conclusion implies that the "right hemisphere has language areas which perhaps are not fully utilized under normal conditions" (Albert, Sparks, and Helm, 1973, p. 131).

The above articles on MIT propose the need for a better understanding of hemispheric communication. This understanding might result in the more efficient conveyance of information to normally functioning brains (Buchsbaum, 1979). Nebes (1977) states that "if the right hemisphere does indeed process data in a manner different from the left, we may be shortchanging ourselves when we educate only left-sided talents in basic schooling. Perhaps when people speculate about an inverse relationship between scholastic achievement and creativity, they are really talking about the effect of overtraining for verbal skills at the expense of non-verbal capacities. Many problems can be solved either by analysis or synthesis; but if people are taught to habitually examine only one approach, their ability to choose the most effective and efficient answer is diminished" (p. 105).

Research, then, is needed in the area of developing new learning procedures utilizing the knowledge of hemispheric communication (Bogen, 1977; Nebes, 1977). This author's experiment proposes to research one aspect of learning in respect to the information compiled concerning the hemispheric processes.

## Statement of the Problem

The experimental question asked is as follows: Will auditory memory of contextual verbal material be aided more through the input of intoned speech with normal melodic aspects (M) and/or flattened speech without normal melodic aspects (F)? The combination of ear (L,R) and input mode (M,F) factors are LM/RM, LF/RF, LF/RM, and LM/RF.

## METHOD

### Subjects

The forty-eight persons who served as subjects were volunteers from the staff and students at The Ohio State University and were given no compensation for their participation in the study. The forty females and eight males were determined to be right-handed by self-report and were screened with an audiometer to determine the existence of normal hearing levels in both ears.

### Design

This experiment was arranged in a multigroup posttest only design with the Logical Memory Subtest of Wechsler's Memory Scale (1945) as the dependent variable. The independent variable was the mode of auditory input including combination of ear (left, right) and speech (melodic, flattened) modes delivered as follows: LM/RM, LF/RF, LF/RM, and LM/RF. Groups were balanced in regard to sex of subjects.

A Kruskal-Wallis test, as discussed in Gibbons (1976), was applied to posttest ranks of this study to determine differences between the four treatment groups in regard to posttest medians.

Materials

The auditory reel-to-reel tape was made at Haskins Laboratory, New Haven, Connecticut on a DDP 224 computer built by Computer Control Corporation. The computer program used was UTLYFILE which allowed access to any type of file for the purpose of copying, deleting, and renaming. Speech synthesis was accomplished using speech synthesis by rule in the FOVE program sequence. All speech variables such as rhythm, decibel level, timing, etc. were controlled thereby leaving intonation as the only factor changed within the stimuli. A calibration tone was recorded at the beginning of the tape and during the study a VU meter was used to equalize intensity levels of the two channels to within $\pm 1$ decibel. The tape was recorded in the following manner for each treatment group: ($T_1$) intoned speech on all five paragraphs; ($T_2$) intoned speech on first two paragraphs with flattened speech on last three paragraphs; ($T_3$ and $T_4$) intoned speech on first paragraph, flattened speech on second paragraph, and dichotic presentation of intoned and flattened speech on last three paragraphs. The first three paragraphs in each group were used to acclimate the subjects to synthesized speech. There were approximately fifteen seconds of silence between each paragraph. The content of the five paragraphs is presented in Appendix A.

The Logical Memory Subtest of the Wechsler Memory Scale (1945) was used as the scoring component of the auditory stimuli. The last two paragraphs heard by each treatment group were the two paragraphs from this subtest. The raw score was based on the average number of ideas remembered from the two paragraphs and an independent observer and the author scored the test using the scoring procedure defined by the experimenter and presented in Appendix B. During the scoring the independent observer was not aware of the treatment group of which the subject was a member.

A portable audiometer was used to determine if volunteers had hearing within normal range and both left and right ears were tested at 15 decibels with hertz levels at 500, 1000, 2000, and 4000 for each ear.

The tape was played on a Crown 700 series reel-to-reel tape recording panel at 70 decibels with a recording level of 74 decibels. The subjects heard the tape over Telephonics TDH-50 headphones with the fourth treatment group reversing the headphones to produce the reversed dichotic presentation. Sound level was controlled by a Grason-Stadler 1704 audiometer.

Subjects recorded their responses on a General Electric cassette tape recorder on Scotch cassette tapes.

## Procedure

The study was conducted in the Audiology Laboratory at Nisonger Center of The Ohio State University. The subjects were in an IAC 1200 series sound-treated room with the experimenter operating the recording equipment from an observation room which allowed her to see, hear, and speak with the subjects. The study was conducted by the author who presented the instructions, administered the audiometer test, and monitored the recording equipment.

Each subject was randomly assigned to a treatment group and was first given uniform instructions of the context of the experiment which are presented in Appendix C. Following these instructions, the subject signed the Texas Woman's University consent form and then was given the audiometer test. After determining the subject had normal hearing ranges in each ear, the subject was given the headphones to put on and was closed in the soundproof room.

While in this room subjects listened to three taped paragraphs intended to familiarize them with computer synthesized speech as well as the mode of speech with which they were to be tested. Each treatment group heard a binaural presentation of intoned synthetic speech in the first paragraph, and treatment group one and two heard the same mode in their second paragraph. Treatment groups three and four heard a binaural presentation of flattened speech for their second paragraph. The third paragraph was recorded in the same mode as the last two which were the scored paragraphs. In these last three paragraphs, treatment group one heard a binaural presentation of intoned speech (LM/RM), treatment group two heard a binaural presentation of flattened speech (LF/RF), treatment group three heard intoned speech in the right ear with flattened speech in the left (LF/RM), and treatment group four heard flattened speech in the right ear with intoned speech in the left ear (LM/RF).

Following each of the last two paragraphs the experimenter counted backward from five to reduce any recency effect and then the subject turned on the cassette recorder and began a response. The subjects were to repeat the last two paragraphs as precisely as possible and to verbally record their responses on tape so that the test could be scored later by both the experimenter and an independent observer. Subjects were allowed two minutes to respond to each separate paragraph, however, no subject utilized a full two minutes.

## RESULTS

The present section consists of the range of agreement between independent observers and the results of the scores between the four treatment groups including $T_1$: LM/RM, $T_2$: LF/RF, $T_3$: LF/RM, and $T_4$: LM/RF.

The range of agreement between the experimenter and an independent observer in regards to the scoring of the memory test was from 87-100% and percentages for each subject are shown in Appendix D. Percentages were determined by the formula:

$$\frac{\text{number of agreements}}{\text{total number of agreements + disagreements}} \times 100$$

The raw scores for individual subjects on the Wechsler Memory Scale, Subtest IV, are presented in Appendix E and all forty-eight scores were used in the final analysis. The score rankings and sum of scores are included in Table 1. Table 2 includes the mean scores of the rankings of each treatment group. The Kruskal-Wallis test was used to analyze the data which found differences between groups to be nonsignificant at the .05 level.

Table 1

Analysis of Score Rankings for Results

of Wechsler Memory Scale, Subtest IV

| Subject | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|---|
| | LM/RM | LF/RF | LF/RM | LM/RF |
| 1 | 4 | 37 | 8.5 | 29.5 |
| 2 | 21 | 44.5 | 41 | 17.5 |
| 3 | 25.5 | 25.5 | 29.5 | 1 |
| 4 | 25.5 | 47.5 | 29.5 | 46 |
| 5 | 12 | 2 | 15 | 41 |
| 6 | 3 | 12 | 12 | 37 |
| 7 | 33.5 | 44.5 | 6 | 8.5 |
| 8 | 5 | 15 | 31 | 25.5 |
| 9 | 29.5 | 21 | 33.5 | 47.5 |
| 10 | 37 | 41 | 41 | 15 |
| 11 | 33.5 | 21 | 21 | 8.5 |
| 12 | 17.5 | 8.5 | 33.5 | 41 |
| Sum of Scores | 247 | 319.5 | 291.5 | 318 |

Note: $H = 1.46$, $df = 3$, $p < .05$

Table 2

Mean Score Rankings for Treatment Groups

| $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|
| LM/RM | LF/RF | LF/RM | LM/RF |
| 20.45 | 26.63 | 24.12 | 26.79 |

## DISCUSSION

The results clearly do not support any significant differences in scores on the Wechsler Memory Scale, Subtest IV, between groups receiving different auditory input modes of the verbal material.

It is interesting that the lowest group mean score occurred with the first treatment group which involved the subjects listening to synthesized speech most like that of normal speech. The author would have anticipated this group receiving one of the higher mean scores as they should have had the least difficulty in interpreting the more normalized speech as well as having three warmup paragraphs in the same input mode with which to acclimate themselves to the test mode. One explanation for this low mean score, however, could be that these subjects never heard a change of mode as other treatment groups did and therefore allowed their concentration to lapse by the time they listened to the test paragraphs.

Another interesting observation related to the use of synthesized speech was that a higher group mean was observed in the second treatment group. This group, hearing flattened speech, appeared to the experimenter to be one of the groups which would have a lower mean score due to the unfamiliarity of the subjects with listening to amelodic speech. However, this form of computerized speech is that which is commonly heard in presently popular futuristic science fiction films and several subjects commented independently upon this similarity. Also in group two were three subjects who were closely involved with handicapped (cerebral palsy or deaf) people who had affected speech. These subjects, again independently, mentioned following the experiment that listening to the synthesized speech was not difficult as it reminded them of the affected speech of the handicapped. Since the experimenter originally considered synthesized speech to be equally difficult to understand, these above factors must be considered as variables affecting the results.

Another variable to consider in analyzing the results is the level of concentration among the subjects. Since subjects participated anywhere between 8:00 a.m. and 5:00 p.m., time of day may obviously have been a factor involving alertness, degree of tiredness, etc. which may have contributed to the ability to concentrate on the memory test.

Though the nonsignificance of differences of the scores between groups can be interpreted as indicating no difference on scores of the Logical Memory Subtest of the Wechsler Memory Scale, this analysis does not necessarily explain hemispheric processing. Since each group heard the same paragraphs the experimenter could assume that the dichotic presentations would be the most difficult to understand due to the strange sensation of hearing different stimuli in each ear. If this were the case, then, scores for the third and fourth treatment groups should be lower and yet they are not, thereby indicating an unknown factor compensating for the difficulty of the auditory mode. The author speculates that there is a possibility of hemispheric specialization for speech and melody as that unknown factor and the dichotic presentation, especially in the fourth treatment group (which had the highest mean), to be the facilitator of that hemispheric processing.

Another possible explanation of the nonsignificance of differences between groups may relate to Liberman's (1974) theory that some people process all language elements linguistically while others use nonlinguistic processing when possible. Since the subjects in this experiment were asked to repeat each paragraph "as precisely as possible," the conclusion may be drawn that some subjects chose to repeat the material verbatim and yet others chose to repeat an ideational interpretation of the paragraph. According to several researchers (Liberman, 1974; Bever, 1971), highly encoded aspects of speech are processed in the left hemisphere while less encoded aspects may or may not be processed in the left hemisphere. Therefore a subject's interpretation of the instructions may have affected whether he processed the phonetic or semantic representation of the material which in turn may have been a variable affecting hemispheric processing.

Another interesting facet of the data may be observed in the scores of the male subjects. With two of the eight male subjects being in each treatment group, the two highest scores for males both fell in the fourth group. This treatment involved intoned speech being heard through the left ear and flattened speech through the right ear (LM/RF). In future studies a larger population of men should be studied to determine if this phenomenon could be upheld to show a significant difference between groups. Many past studies (Galaburda, et al., 1978, Bakan, 1971; Briggs and Nebes, 1976) indicate that men may have less hemispheric integration than women thereby indicating a more definite asymmetry between hemispheric processing.

If this phenomenon is confirmed with a larger population of males, then this processing difference may be better established.

Many other implications for future study are indicated from this experiment. To diminish the effects of concentration variability and familiarity with synthesized speech, it would be advisable to significantly increase the number of subjects in each treatment group or to modify the design to control for such variables. Another consideration is that within the dichotic presentations of speech in this study there may not have been enough of a significant difference between auditory stimuli to cause hemispheric competition in the processing. The logical direction to take would be to emphasize the melodic aspects of speech in the mode opposing the flattened speech. Coming from this study with a small difference between modes, the next step might be to introduce "Sprechgesang" as one of the input modes and then possibly a melodic presentation outside the pitch variations of normal speech. Both of these presentations should oppose the flattened speech to emphasize differences in presentations. Another consideration would be to present the auditory information monaurally as Jarvella, et al. (1970) and Bever (1971) did and successfully showed ear differences for repeating monaurally presented sentences.

The need to study learning procedures, brain processing, and input modes for information is important for the future development of both education and therapy. Music therapists would especially be interested in research related to information processing of brain-damaged or learning-disabled individuals. This study has attempted to approach some of the above while contributing to the known information concerning the melodic aspects of speech. Future implications for study are numerous and as this form of experiment has not been previously reported in the literature, it is the author's hope that similar investigations will follow and thereby expand the knowledge and resources of both researchers and practitioners.

# APPENDIX A

## Paragraph Content

## Paragraph Content

### Paragraph One

The famous author, Mark Twain, said, "There is a moral sense and there is an immoral sense. History shows us that the moral sense enables us to perceive morality and how to avoid it, and that the immoral sense enables us to perceive immorality and how to enjoy it."

### Paragraph Two

The name of this article is, "Meet Pam Dawber." Pam Dawber was born in Detroit, Michigan. She became interested in acting in high school. In college she studied art and music. She also traveled across the country to trade shows where she introduced new car models. Then she began making commercials. In 1971 she visited New York City; just for fun she went to apply for a job with a model agency. Pam was hired. While modeling and making TV commercials she began taking acting and voice lessons. She also appeared in plays in New York. She went out to the West coast where she later got one of the leads in the "Mork and Mindy" show. Now Pam has apartments in New York City and Los Angeles. Her real home, however, is a rustic cabin on the Delaware River in New York state. Pam enjoys cooking, canoeing, and skiing. She is also an excellent horsewoman and swimmer. She likes to read. Her favorite books are about health food.

Paragraph Three

Speech is so familiar a feature of daily life that we rarely pause to define it. It seems as natural as walking and only less so than breathing, yet it needs but a moment's reflection to convince us that this naturalness of speech is but an illusory feeling. The process of acquiring speech is, in sober fact, an utterly different sort of thing from the process of learning to walk. In the case of the latter function, culture, in other words, the traditional body of social usage, is not seriously brought into play. The child is individually equipped by the complex set of factors that we call biological heredity, to make all the needed muscular and nervous adjustments that result in walking.

Paragraph Four

Anna Thompson, of South Boston; employed as a scrub woman in an office building, reported at the City Hall Station that she had been held up on State Street the night before and robbed of fifteen dollars. She has four little children, the rent was due, and they had not eaten for two days. The officers, touched by the woman's story, took up a collection for her.

Paragraph Five

The American liner New York struck a mine near Liverpool Monday evening. In spite of a blinding snowstorm and darkness, the sixty passengers, including 18 women, were all rescued though the boats were tossed about like corks in the heavy sea. They were brought into port the next day by a British steamer.

# APPENDIX B

## Scoring Procedure

## Scoring Procedure

### Paragraph Four

| Correct Memory | Alternative Memory |
|---|---|
| 1) Anna Thompson | 1) no alternative |
| 2) of South | 2) no alternative |
| 3) Boston | 3) no alternative |
| 4) employed | 4) worked, was |
| 5) as a scrub woman | 5) washerwoman, cleaning lady |
| 6) in an office building | 6) no alternative |
| 7) reported | 7) said, told |
| 8) at the City Hall | 8) municipal |
| 9) Station | 9) building |
| 10) that she had been held up | 10) robbed |
| 11) on State Street | 11) no alternative |
| 12) the night before | 12) previous night, last night |
| 13) and robbed | 13) no alternative |
| 14) of fifteen dollars | 14) no alternative |
| 15) She had four | 15) no alternative |
| 16) little children | 16) children, kids |
| 17) the rent | 17) no alternative |
| 18) was due | 18) owed |
| 19) and they had not eaten | 19) no alternative |
| 20) for two days | 20) no alternative |
| 21) The officers | 21) policemen |
| 22) touched by the woman's story | 22) felt sorry for her |
| 23) took up a collection | 23) collected money, donated money |
| 24) for her | 24) no alternative |

## Scoring Procedure

### Paragraph Five

| Correct Memory | | Alternative Memory | |
|---|---|---|---|
| 1) | The American | 1) | no alternative |
| 2) | liner | 2) | ship, boat, steamer |
| 3) | New York | 3) | no alternative |
| 4) | struck a mine | 4) | no alternative |
| 5) | near Liverpool | 5) | no alternative |
| 6) | Monday | 6) | no alternative |
| 7) | evening | 7) | night |
| 8) | In spite of a blinding | 8) | bad, severe, heavy |
| 9) | snowstorm | 9) | storm, blizzard, weather |
| 10) | and darkness | 10) | no alternative |
| 11) | the sixty passengers | 11) | people |
| 12) | including 18 | 12) | no alternative |
| 13) | women | 13) | no alternative |
| 14) | were all rescued | 14) | were saved |
| 15) | though the boats | 15) | ships |
| 16) | were tossed about | 16) | were thrown around |
| 17) | like corks | 17) | no alternative |
| 18) | in the heavy sea | 18) | in the waves |
| 19) | They were brought into port | 19) | They were brought in |
| 20) | the next day | 20) | later |
| 21) | by a British | 21) | no alternative |
| 22) | steamer | 22) | ship, liner, boat |

# APPENDIX C

## Instructions to Subjects

## Instructions to Subjects

To begin with you will be given an audiometer test to determine your hearing levels in each ear. Following this test you will be asked to listen to five separate paragraphs over headphones and to verbally repeat as precisely as possible the content of the last two paragraphs.

There will be silence between each paragraph and preceding the fourth paragraph I will say, "This is the fourth paragraph." You will then hear the fourth paragraph and following this fourth paragraph I will count backwards from five (5,4,3,2,1) at which time you are to turn on the recorder by pressing the "record" and "play" buttons at the same time. Then repeat that fourth paragraph as precisely as possible and when you are done turn off the recorder. Then I will say, "This is the fifth paragraph." You will then hear the fifth paragraph and following this fifth paragraph I will count backwards from five (5,4,3,2,1) at which time you are to turn on the recorder by pressing the "record" and "play" buttons at the same time. Then repeat that fifth paragraph as precisely as possible and when you are done turn off the recorder and you will be finished.

# APPENDIX D

## Observers' Range of Agreement

Observers' Range of Agreement

| Subject | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|---|
| 1 | 100% | 91% | 100% | 91% |
| 2 | 90 | 92 | 100 | 89 |
| 3 | 100 | 100 | 100 | 100 |
| 4 | 95 | 96 | 100 | 100 |
| 5 | 93 | 100 | 94 | 96 |
| 6 | 100 | 87 | 100 | 100 |
| 7 | 100 | 100 | 93 | 100 |
| 8 | 100 | 100 | 100 | 95 |
| 9 | 89 | 94 | 90 | 100 |
| 10 | 100 | 100 | 96 | 94 |
| 11 | 95 | 90 | 90 | 100 |
| 12 | 100 | 88 | 96 | 96 |

APPENDIX E

Raw Data

Raw Scores from the Wechsler Memory Scale,

Subtest IV

| Subject | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|---|
| 1 | 5.5 | 11 | 7 | 10 |
| 2 | 9 | 12 | 11.5 | 8.5 |
| 3 | 9.5 | 9.5 | 10 | 3.5 |
| 4 | 9.5 | 13 | 10 | 12.5 |
| 5 | 7.5 | 4 | 8 | 11.5 |
| 6 | 4.5 | 7.5 | 7.5 | 11 |
| 7 | 10.5 | 12 | 6.5 | 7 |
| 8 | 6 | 8 | 9 | 9.5 |
| 9 | 10 | 9 | 10.5 | 13 |
| 10 | 11 | 11.5 | 11.5 | 8 |
| 11 | 10.5 | 9 | 9 | 7 |
| 12 | 8.5 | 7 | 10.5 | 11.5 |

Note Males: $T_1$:6, 12; $T_2$: 1, 12; $T_3$: 5, 12;
$T_4$: 5, 12

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