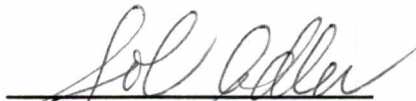
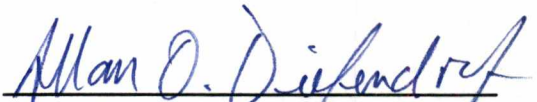


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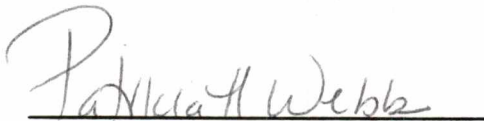
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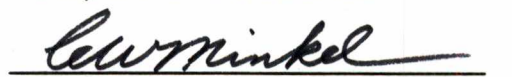

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**IMITATIVE USE OF PROSODY FOLLOWING EARLY RIGHT
HEMISPHERECTOMY: A CASE STUDY**

**A Thesis
Presented for the
Master of Arts
Degree
The University of Tennessee, Knoxville**

Lea Paige Cothran

December 1988

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ABSTRACT

Imitation of loudness contour, intonation, and duration was examined pre- and post-surgically for a single subject undergoing right hemispherectomy. Twenty-six of the subject's attempted imitative utterances, collected and audio-recorded prior to and following right hemispherectomy, were assigned ratings based on their perceived similarity to the clinician's stimulus utterance. Comparisons of performance across the designated conditions were accomplished using a t-test for related samples revealing the following results: (1) The subject's imitation of loudness contour did not differ significantly in its similarity to the clinician's stimulus utterance between pre- and post-surgery conditions; (2) The subject's imitation of intonation tended to increase in similarity to the clinician's stimulus utterance following surgery; (3) The subject's imitation of duration increased in similarity to the clinician's stimulus utterance following surgery. These results contraindicated decreased performance in the imitative use of prosody by the subject following right hemisphere removal. Rather, her performance appeared unaltered for the parameter of loudness contour and noticeably improved for the intonational and durational parameters. Additional analyses examining the relationship between the similarity rating and the complexity of each utterance failed to reveal significant correlations between these variables for any parameter. Thus, complexity did not appear to confound the resultant data with regard to stimulus-response similarity, lending further support to the obtained results. It was concluded that in a very young individual, such as the investigated subject, functional lateralization may not be completed and that the capacity for some degree of cortical reorganization exists, at least with regard to the investigated parameters.

TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION.....	1
II. REVIEW OF THE LITERATURE.....	3
Statement of Purpose and Research Questions. .	8
III. METHODOLOGY.....	9
Subject.....	9
Procedure.....	10
Data Collection.....	10
Data Preparation.....	10
Scoring Procedure.....	12
Data Analysis.....	12
Recording Equipment and Setting.....	13
IV. RESULTS.....	15
Reliability.....	15
Results of the Similarity Scale.....	15
Similarity Rating and Utterance Complexity. . .	23
V. DISCUSSION.....	38
Findings.....	38
Qualifications.....	41
Implications.....	43
VI. SUMMARY.....	45
VII. CONCLUSIONS.....	47
LIST OF REFERENCES.....	49

APPENDICES.	54
A.	55
B.	56
C.	58
VITA	60

LIST OF TABLES

TABLE	PAGE
1. Pre-surgical and post-surgical similarity ratings for the parameters of loudness contour, intonation, and duration.....	16
2. Comparison of pre- and post-surgical conditions for listener ratings of the degree of similarity in loudness contour between stimulus (clinician's utterance)-response (child's attempted imitation) pairs.....	18
3. Comparison of pre- and post-surgical conditions for listener ratings of the degree of similarity in intonation between stimulus (clinician's utterance)-response (child's attempted imitation) pairs.....	21
4. Comparison of pre-and post-surgical conditions for listener ratings of the degree of similarity in duration between stimulus (clinician's utterance)-response (child's attempted imitation) pairs.....	25
5. Correlation between similarity and complexity ratings for the parameter of loudness contour.....	30
6. Correlation between similarity and complexity ratings for the parameter of intonation.....	31
7. Correlation between pre-surgical similarity ratings and complexity ratings for the parameter of duration.....	32
8. Correlation between post-surgical similarity ratings and complexity ratings for the parameter of duration.....	33

LIST OF FIGURES

FIGURE	PAGE
1. Frequency distribution of listener ratings (1-3) of the degree of similarity in loudness contour between stimulus (clinician's utterance)-response (child's attempted imitation) pairs for pre- and post-surgical conditions..	19
2. Scattergram comparing pre- and post-surgical similarity ratings of loudness contour..	20
3. Frequency distribution of listener ratings (1-3) of the degree of similarity in intonation between stimulus (clinician's utterance)-response (child's attempted imitation) pairs for pre- and post-surgical conditions..	22
4. Scattergram comparing pre- and post-surgical similarity ratings of intonation..	24
5. Frequency distribution of listener ratings (1-3) of the degree of similarity in duration between stimulus (clinician's utterance)-response (child's attempted imitation) pairs for pre- and post-surgical conditions..	26
6. Scattergram comparing pre- and post-surgical similarity ratings of duration..	27
7. Relative changes in mean similarity ratings obtained pre- and post-surgically for loudness contour, intonation, and duration..	28
8. Scattergram illustrating the relationship between similarity and complexity ratings of loudness contour..	34
9. Scattergram illustrating the relationship between similarity and complexity ratings of intonation..	35
10. Scattergram illustrating the relationship between pre-surgical similarity ratings and complexity ratings of duration..	36

CHAPTER I

INTRODUCTION

Organizational and functional asymmetries of the brain have been reported (Dimond & Beaumont, 1974; Penfield & Roberts, 1959; Smith & Sugar, 1975; Springer & Deutsch, 1981). The left hemisphere is presumed by many to be responsible for analytic types of tasks, including those functions typically considered to be linguistic. The right hemisphere, on the other hand is purportedly more holistic in its processing and has been implicated in the controlling of visuospatial, musical and prosodic abilities, among others. The introduction of insult or disease, however, may disrupt the typical distribution of these abilities. Subsequently, functions may be transferred from or, in the very young individual, fail to develop in, their usual locations. Instead these functions are assumed by the remaining, undamaged portions of the brain. The premise for such a process lies in the postulation of the brain's flexibility or "neuroplasticity" (Basser, 1962; Chase, 1972; Dimond & Beaumont, 1974; Lenneberg, 1967; Luria, 1963; Smith & Sugar, 1975). Much uncertainty and controversy remains regarding the precise nature and the implications of this phenomenon.

Empirical support of this concept, as well as the determination of specific functional-anatomical relationships have been attempted via numerous avenues. One such avenue is the study of those for whom it becomes necessary, due to such conditions as intractable seizing or large tumors, to remove the entire cortex of one hemisphere.

Previous researchers have examined the performance of hemispherectomy patients in an effort to clarify brain-language relationships (Basser, 1962; Cummings, Benson, Walsh & Levine, 1979; Day & Ulatowska, 1979; Dennis & Whitaker, 1976; Kohn & Dennis, 1974; Smith & Sugar, 1975;

Wilson, 1970). Literature concerning hemispherectomy patients, however, has placed particular emphasis on the loss of the left hemisphere and left hemisphere abilities, whereas only limited attention has been given to right hemisphere removal and subsequent levels of right hemisphere controlled functions. Right hemisphere involvement has been demonstrated in the use and perception of the prosodic elements of speech. This suggested one potential area of investigation.

The overall purpose of this study was to investigate the effects of right hemisphere removal on the imitative use of prosody. Specifically, this investigation sought to compare pre- and post-operative performance of a single subject with regard to the subject's imitative use of loudness contour, intonation, and duration.

CHAPTER II

REVIEW OF THE LITERATURE

The concept of functional asymmetry in the human brain emerged as early as 1836 when Dax first noted the association between loss of speech and left hemisphere damage (in Smith & Sugar, 1975; Springer & Deutsch, 1981). His works, along with that of such persons as Gall, Spurzheim, Bouillaud, Broca, Wernicke, and Jackson, provided the first indication of the existing differences between and within the brain's two hemispheres with regard to organization and function (in Dimond & Beaumont, 1974; Penfield & Roberts, 1959; Smith & Sugar, 1975; Springer & Deutsch, 1981). Subsequent research has supported this basic premise, and efforts continue to further define the purported differences.

Because of the early associations revealed between language and the left hemisphere, this hemisphere for many years was widely regarded as the "dominant" side of the brain. The right hemisphere, therefore, was cast in a subordinate role, and its specialized abilities were not yet disclosed (Springer & Deutsch, 1981). Current thought, however, recognizes that, in the normally developing brain, each hemisphere gradually becomes specialized with regard to particular functions. Generally, in right-handed adults, the left hemisphere is regarded as a sequential processor. It exhibits dominance for analytic abilities, including those typically considered linguistic (Chase, 1972; Dimond & Beaumont, 1974; Gott, 1973; Lenneberg, 1967; Penfield & Roberts, 1959; Springer & Deutsch, 1981; Zaidel, 1976). The right hemisphere, on the other hand, appears to process information in a simultaneous or holistic manner (Springer & Deutsch, 1981; Zaidel, 1976). It is responsible for tasks of visuo-spatial integration and for various aspects of musical abilities (Kimura, 1964; Dimond & Beaumont, 1974; Springer & Deutsch, 1981). Recent evidence, to be

detailed later in this review, also indicates right hemisphere involvement in the paralinguistic or prosodic aspects of speech. These functional descriptions of the left and right hemisphere suggest that each is indeed designed to control certain functions in the normally developed brain. Recovery processes in brain-injured individuals, however, generally indicate that some reorganization of these functions is possible; the completeness of this reorganization and the means by which it is accomplished remain a source of uncertainty.

The notion of neuroplasticity has been advanced in an effort to explain this restoration of function following brain damage (Basser, 1962; Chase, 1972; Dimond & Beaumont, 1974; Lenneberg, 1967; Luria, 1963; Smith & Sugar, 1975). This concept suggests the possibility of a shifting process whereby functions for which one hemispheric area is normally dominant are transferred to other portions of the damaged hemisphere (intrahemispheric plasticity) or to homologous portions of the opposing hemisphere (interhemispheric plasticity) (Luria, 1963; Smith & Sugar, 1975). The conditions necessary for this compensatory process to occur have not been delineated fully. The capacity for compensation may be greatest in early childhood (Basser, 1962; Chase, 1972; Goldman, 1971; Lenneberg, 1967). However, little concurrence exists among researchers regarding the precise boundaries for such a "critical period." Zaidel (1976) argues against the idea of a single critical period, purporting that different functions become lateralized at different points during development. Other researchers have suggested that factors other than age may be more important in determining recovery from brain damage. These factors will be considered in the following review of the literature.

Studies of young hemidecorticates provide a unique opportunity to explore hemispheric specialization, as well as the aforementioned notion of interhemispheric plasticity. These investigations concern individuals who have undergone hemispherectomy, a surgical procedure involving the removal of the entire cortex of one of the brain's hemispheres; only the basal ganglia, the

thalamus, the cerebellum and the brainstem are left intact (Youmans, 1982).

This procedure has been successfully employed in the elimination or reduction of seizure activity previously intractable by less extreme measures (Lindsay, Glaser, Richards, & Ounsted, 1984; Lindsay, Ounsted, & Richards, 1987).

Some researchers have reported restoration of functioning following hemispherectomy approaching premorbid levels for very young patients (Basser, 1962; Cummings et al, 1979; Smith & Sugar, 1975; Wilson, 1970). Basser (1962) asserted that high levels of post-hemispherectomy functioning are indicative not only of a reorganization of brain functions, but also of the benefits accrued from the removal of the adverse influences of the damaged hemisphere.

Although noting some recovery of functions controlled by the removed hemisphere, Teuber (1974) reported the detrimental results of the "crowding effect." Findings from his studies indicated the preservation of language at the expense of other functions for which the remaining hemisphere is normally dominant (in Strauss & Verity, 1983). Reports from a considerable number of other investigators also have contraindicated complete recovery, suggesting residual deficits (Day & Ulatowska, 1979; Dennis & Whitaker, 1976; Kohn & Dennis, 1974). Ian Saint James-Roberts (1981), in a comprehensive analysis of available post-hemispherectomy data, failed to find support for the plasticity model, noting instead that "recovery heterogeneity in each age group is considerable, while both individual differences within groups and minor intergroup differences are parsimoniously explained by etiological, recovery-period, and experiential variables" (p.31). Smith and Sugar (1975) suggested that age may be less critical than integrity of the residual structures in determining level of recovery. In accordance with this suggestion, electroencephalogram (EEG) and computerized tomography (CT) data led Strauss and Verity (1983) to caution against formulating any conclusions regarding functional plasticity in instances where the status of the remaining hemisphere is not known. The possible contribution of this confounding variable

to the conflicting findings across hemispherectomy studies was considered.

Investigations in this area largely have been concerned with the loss of the left hemisphere and subsequent functioning in the areas of perception, cognition, and language. Right hemispherectomies have been used in many instances as controls in investigating functions normally assigned to the left hemisphere. The limited number of studies specifically concerned with processing for right hemisphere tasks largely have focused on visual processing skills (Day & Ulatowska, 1979; Kohn & Dennis, 1974; Strauss & Verity, 1983) and facial recognition abilities (Strauss & Verity, 1983). The effect of right hemisphere removal on other functions for which it is normally responsible remains to be investigated.

One potential area of investigation concerns use of the prosodic elements of speech. Prosody has been defined as a "complex component of the acoustical signal that communicates linguistic, attitudinal, emotional, pragmatic, and idiosyncratic information through the use of pitch, loudness, timbre, tempo, stress, accent, pausing, and intonation" (Ross, Edmondson, Seibert, & Homan, 1988, p.130). A vast amount of evidence exists to indicate some degree of right hemisphere involvement in these processes. A number of studies with normal subjects performing dichotic listening tasks have shown a left ear advantage for pitch (Gregory, 1982), for melody recognition (Kimura, 1964), for intonation discrimination (Graves, Morley, & Marcopulos, 1987), for contour judgements (Blumstein and Cooper, 1974; Shipley-Brown, Dingwall, Berlin, Yeni-Komshian, & Gorden-Salant, 1988), and for decisions regarding an utterance's affective tone (Bryden, Ley, & Sugarman, 1982; Shipley-Brown et al, 1988). In a review of dichotic listening studies, Zurif (1974) qualifies these findings, concluding that auditory lateralization for the acoustic parameters of intonation and emotional tone largely is determined by the nature of the task. He proposes the idea that "intonation, although by itself probably processed by the right hemisphere, enhances the left hemisphere's ability to carry out linguistic decisions" (p.394).

Paradigms other than dichotic listening also are used to investigate right hemisphere functioning. The involvement of the right hemisphere in the processing of the prosodic components of speech is established further via Wada testing (Ross et al, 1988). This procedure involves sodium amobarbital injections into the right hemisphere, temporarily anesthetizing this portion of the brain. Subsequent to this process, normal subjects exhibited modifications in their speech productions, characterized by flattened affect. Evoked potential measures also have been utilized in an attempt to demonstrate hemispheric lateralization during prosodic processing (Papanicolaou, Levin, Eisenberg, & Moore, 1983). Specifically, hemispheric alpha wave asymmetries (suppression indicating greater activity) were explored. Resultant data indicated greater left hemispheric involvement in phonetic tasks and greater right hemispheric involvement in prosodic tasks.

Additionally, inferences regarding hemispheric specialization can be made from the examination of deficits exhibited following brain injury. Right hemisphere damaged subjects demonstrate impairments in reading sentences of varying intonational contour (Shapiro & Danly, 1985), in performing such musical tasks as singing (Springer and Deutsch, 1981), and in imitating rhythm, tempo and intonation patterns (Tucker, 1987). Deficits in the area of affective prosody also have been observed (Bowers, Coslett, Bauer, Speedie, & Heilman, 1987; Gorelick & Ross, 1987; Heilman, Bowers, Speedie, & Coslett, 1984; Ross, 1988; Tompkins & Mateer, 1985; Wolfe & Ross, 1987). Ross has employed the term "aprosodia" to describe these deficits in the comprehension and/or production of prosody. He observed subtypes of aprosodia in right-hemisphere-damaged patients analogous to subtypes of aphasia seen in left-hemisphere-damaged patients. Recovery patterns for the two types of patients also were comparable. Based on this information, he and his colleagues concluded that "organization of affective language in the right hemisphere mirrors that of

propositional language in the left hemisphere" (Gorelick & Ross, 1987, p.559; Ross, 1988; Wolfe & Ross, 1987).

Statement of Purpose and Research Questions

The purpose of this study was to investigate the effects of right hemisphere removal on the imitative use of prosody. This effect was examined by comparing pre- and post-operative judgments of the similarity between stimulus (clinician's utterance)-response (child's attempted imitation) pairs with regard to the parameters of loudness contour, intonation, and duration. Specific research questions were as follows:

1. Did pre- and post-surgical imitative use of loudness contour differ significantly as determined by listener ratings (1-3) of the similarity between stimulus-response pairs?
2. Did pre- and post-surgical imitative use of intonation differ significantly as determined by listener ratings (1-3) of the similarity between stimulus-response pairs?
3. Did pre- and post-surgical imitative use of duration differ significantly as determined by listener ratings (1-3) of similarity between stimulus-response pairs?

CHAPTER III

METHODOLOGY

Subject

The subject, J.P., was a Caucasian female, two years, five months old at the time this study was initiated. She was two years, seven months old upon its completion. At the chronological age of six months, J.P. was diagnosed as suffering from "hypoplastic right brain with seizure disorder," secondary to a second or third trimester vascular event. Seizures involved episodes one to two seconds in duration, characterized by left deviation of the eyes and lowering of the head. Computerized axial tomography (CAT) showed hemi-atrophy of the brain. Additionally, mild left hemiparesis in the lower extremities with more involvement in the upper extremities was exhibited. Despite large doses of Klonopin, Dilantin, Phenobarbital, ACTH, and Depakine, seizures with a right temporal lobe focus continued.

Magnetic resonance imaging (MRI) completed at Vanderbilt University Hospital (8/9/86) revealed a porencephalic cyst in the right temporal lobe. In July 1987, a temporal lobectomy was performed at the Medical College of Georgia. Subsequent reports indicated decreased seizure activity, accompanied by notably improved developmental skills until December of 1987, at which time more frequent seizuring recurred. MRI data obtained from re-evaluations at the Medical College of Georgia (2/9/88) and at Johns Hopkins Hospital (5/25/88) revealed deep and cortical right-sided atrophy of the brain and reappearance of the right temporal lobe cyst. Additionally, mild brainstem cerebellar atrophy and agenesis of the anterior corpus collosum were noted. Due to these findings and to an inability to control J.P.'s seizures pharmacologically, a right hemispherectomy was performed in July of 1988 at Johns Hopkins Hospital. To date,

surgery has provided complete relief from seizing as confirmed by EEG data.

Procedure

Data Collection

Data was collected over 5 sessions, conducting sessions 1 and 2 prior (17 and 16 days) to surgery and sessions 3, 4, and 5 following (50, 54, and 57 days) surgery. Each session involved a 1 to 2 hour visit during which, according to parental report, the child was normally awake and alert. Procedures included observation and taping (both audio and video) of the child in her home as she interacted in a play situation with a teacher of the hearing impaired having further education in the suprasegmental aspects of language. During play, the child generally was encouraged to remain seated on the floor, the couch, or the chair. Situational teaching strategies, which advocate the use of language in meaningful contexts, were employed in an attempt to elicit an imitative speech sample. This involved the introduction of familiar toys for the purpose of structuring numerous activities which were interesting and meaningful to the child, largely including dramatization with dolls, puppets, toy animals and persons, musical instruments, and other items. Similar structuring of all sessions was made possible through reviewing of the videotapes by the examiner and the interacting clinician. This was done in order that the elicited imitations would be more readily comparable for the purposes of the following analyses of speech and language samples.

Data Preparation

Analysis first involved the selection of stimulus (clinician's utterance) - response (child's attempted imitation) samples from pre-surgery and post-surgery

sessions. Utterance selection was accomplished via two steps. First, the total number of stimulus-response samples was reduced by matching samples occurring before and after surgery according to the following minimal criteria: (1) Both the pre- and the post-surgery utterances contained the same number of syllables, allowing for the addition or deletion of one element (eg. "bye-bye chicken" and "bye-bye chick"), and (2) at least 50 percent of the words in each utterance were identical (eg. "hi mama" and "hi mommy").

The procedures described above resulted in the selection of 26 different utterances which occurred both pre- and post-surgically, for a total of 52 utterances. Nineteen of the 52 utterances occurred only once before and once after surgery. The remaining 33 utterances were repeated once or more in one or more sessions. It was necessary therefore to select one pre-surgery and one post-surgery example for analysis. Because the recording quality of these repeated utterances varied, random selection was not ideal. Two certified speech-language pathologists¹, therefore, were selected to compare repeated samples of the same utterance and to choose one of these utterances solely on the basis of recording quality. Collaboration between the two speech-language pathologists while making these selections was permitted. If two or more repetitions of an utterance were judged to be of equal quality, the speech-language pathologists were instructed to select one randomly. Instructions for these procedures were read by the examiner and can be found in Appendix A.

Fifty-two utterances were obtained according to the aforementioned procedures. Of these, five were randomly selected for re-presentation for the purposes of assessing intrajudge reliability. The resultant total of 57 utterances were randomized and re-recorded for presentation. Each presentation consisted of the clinician's stimulus utterance, an approximate 5 second pause, the child's attempted imitative response, and another approximate 5 second pause.

¹. The criteria employed in the selection of judges to participate in utterance selection were as follows: a master's degree in speech-language pathology and a Certificate of Clinical Competence.

Scoring Procedure

Perceptual judgments were accomplished using a 3-point Similarity Scale. This scale was adopted from a 9-point Similarity Scale developed and implemented by Asp (1973) in an investigation requiring evaluation of the speech intelligibility of severely hearing impaired persons. Modifications of this scale were based on pilot testing which disclosed improved reliability when three points were utilized. For the purposes of this study, the 3 points of the scale were identified as follows: number 1 was defined as "similar," number 2 was defined as "less similar," and number 3 was defined as "dissimilar." An utterance was regarded as similar when it was at or close to the target utterance with regard to the parameter being judged. An utterance was regarded as dissimilar when it was not at all close to the target utterance with regard to the parameter being judged. The midpoint or less similar category was used to refer to an utterance that fell between these two extremes; it was neither directly on nor directly off target.

Data Analysis

A certified speech-language pathologist² was utilized for the purposes of making perceptual judgments in this investigation. Her judgments were based on her own experience coupled with a protocol established at the University of Tennessee (Appendix B). All scoring took place in a quiet room, with the judge seated directly adjacent to the examiner. Standardized instructions were read by the examiner (See Appendix C), instructing the judge to compare the similarity of

². The judge selected for making perceptual judgements regarding the prosodic parameters under investigation met the following criteria: A Master's degree in speech-language pathology, a Certificate of Clinical Competence, knowledge of and experience in implementing the Verbotonal System of Aural Rehabilitation, and 5 years clinical experience working with the suprasegmental aspects of speech in children.

the child's imitative response to the clinician's stimulus utterance with regard to the following parameters: loudness contour, intonation, and duration. For the purposes of this investigation, loudness contour was used to refer to relative levels of loudness or change in loudness across an utterance. Intonation was defined as pitch contour. This referred to the change in pitch across an utterance, particularly with regard to the direction of pitch change. Duration was used to refer to the timing of an utterance with regard to its length. Following the presentation of instructions, the opportunity to listen to sample trials for the purpose of task familiarization, and the opportunity to pose questions, the judge began assessment. The 57 tape-recorded stimulus-response pairs were presented auditorily. Each pair was presented twice. The judge indicated her response by circling a number between 1 and 3 during the allotted pauses. This number best represented the judge's perception of the degree of similarity between the stimulus (clinician's utterance) and the response (child's attempted imitation) with regard to the parameter of loudness contour. These procedures were repeated using the same stimulus-response pairs for judgments of intonational similarity and then again for judgments of durational similarity. All scoring was completed in a period of approximately 2 hours and 30 minutes and involved a total of 171 trials.

Recording Equipment and Setting

Recording equipment consisted of an audio and a video cassette recorder. Due to equipment availability, sessions 1 and 2 involved the use of a Magnavox color VHS video camera (Model VR 8278BK), a Magnavox portable video cassette recorder (Model VR 848556), and a Panasonic audio cassette recorder (Model RQ 2309AV). The remaining sessions involved the use of a Panasonic VHS camcorder (Model PV-320) and a Bell and Howell audio cassette recorder (Model 3181A). Additional equipment utilized included a Realistic tie pin

microphone (Model 33-1063) attached to the video recorder, a Craig microphone attached to the audio recorder, and a tripod. Throughout the recordings the camera was hand-held or mounted on the tripod at a distance of approximately 2 meters from the subject and the clinician. The attached microphone was hung 1 meter above the subject's head. The audio cassette recorder was placed on the floor beside the subject, with the attached microphone at a distance of approximately 1 meter from the subject's head. The recording equipment was operated by the examiner, and all recording was conducted in the living room of the subject's home. Rerecording of stimulus-response pairs for presentation was accomplished using two Panasonic audio cassette recorders (Model RQ-323A5; Serial No.s EL107425 & EL106986). Presentation of the utterance pairs for perceptual analysis involved the use of the latter of these two.

CHAPTER IV

RESULTS

Reliability

Intrajudge reliability was assessed by re-presenting five randomly selected stimulus-response samples during the 2 hour, 30 minute scoring session. This permitted a comparison of the two sets of values assigned to the stimuli by the judge for the parameters of loudness contour, intonation, and duration. The percentage of agreement for each parameter was calculated as follows:

$$\frac{\text{AGREEMENT}}{\text{AGREEMENT} + \text{DISAGREEMENT}} \times 100$$

For the parameter of loudness contour, agreement occurred for 3 of the 5 ratings, yielding an intrajudge reliability of 60 percent. For the parameters of intonation and duration, agreement occurred for 4 of the 5 ratings, yielding an intrajudge reliability of 80 percent for each. It should be noted that disagreements occurred on the same utterance for each parameter, with an additional disagreement occurring for the parameter of loudness contour.

Results of the Similarity Scale

Listener ratings of the degree of similarity (1-3) between the stimulus (clinician's utterance) and the response (child's attempted imitation) of 26 utterance pairs are presented in Table 1. Ratings for each of the three

Table 1. Pre-surgical and post-surgical similarity ratings for the parameter s of loudness contour, intonation, and duration.

Item	PARAMETER					
	Loudness Contour		Intonation		Duration	
	<u>Pre</u>	<u>Post</u>	<u>Pre</u>	<u>Post</u>	<u>Pre</u>	<u>Post</u>
1	3	1	2	3	1	1
2	3	2	3	3	3	3
3	3	1	3	1	3	1
4	1	2	2	3	2	2
5	1	3	3	3	1	2
6	1	1	1	2	2	1
7	1	1	3	1	2	1
8	1	2	3	1	1	1
9	3	2	3	3	3	3
10	3	1	1	3	2	1
11	1	1	3	2	3	1
12	1	2	3	1	1	1
13	1	3	2	2	2	1
14	1	1	3	3	1	3
15	2	2	2	3	2	1
16	1	1	3	1	2	1
17	1	1	1	1	1	1
18	1	1	1	1	1	1
19	1	1	2	1	3	1
20	1	1	3	1	2	2
21	1	2	3	1	3	2
22	1	2	2	3	1	1
23	3	2	3	3	1	1
24	1	2	1	3	2	2
25	1	1	2	1	1	1
26	3	1	3	1	3	1

parameters (loudness contour, intonation, and duration) were assigned to 26 utterances prior to surgery and to 26 utterances following surgery. Thus, a total of 156 ratings were assigned overall.

A t-test for related measures was used to determine the significance of the differences between pre-surgical and post-surgical mean ratings for each parameter. As seen in Table 2, this difference was nonsignificant for the parameter of loudness contour ($t=0.171$, $df=25$, $p>.05$). Thus, the subject's imitation of loudness contour did not differ significantly in its similarity to the clinician's utterance between pre- and post-surgery conditions. These results are illustrated further in a histogram (Figure 1) representing a pre- and post-surgical comparison of the frequency distributions of listener ratings (1-3) of loudness contour similarity for each of the 26 stimulus-response utterance pairs. A noticeable difference occurs only for the midpoint value, with only 1 of 26 items receiving a "2" rating pre-surgically but 10 of 26 items receiving a "2" rating post-surgically. Additionally, a greater number of items received both "1" and "3" ratings for the pre-surgical condition than for the post-surgical condition. A scattergram comparing pre- and post-surgical judgments depicts a similar distribution of rating values (Figure 2).

The pre-surgical and post-surgical mean similarity ratings for the parameter of intonation were also subjected to analysis by t-test (Table 3). The difference between these means approached but did not reach the level of significance ($t=1.47$; $df=25$; $p>.05$). Thus, the subject's imitation of intonation tended to increase in similarity to the clinician's utterance following surgery, although this tendency was not statistically significant. These results are illustrated further in a histogram (Figure 3) representing a pre- and post-surgical comparison of the frequency distributions of listener ratings (1-3) of intonational similarity for each of the 26 stimulus-response utterance pairs. Only 5 of 26 items received a "1" rating pre-surgically, whereas 12 of 26 items received a "1" rating post-surgically.

Table 2. Comparison of pre- and post-surgical conditions for listener ratings of the degree of similarity in loudness contour between stimulus (clinician's utterance)-response (child's attempted imitation) pairs.

Condition	Mean Similarity Rating	df	t - value	p
Pre-surgery	1.58	25	0.171	p>0.05
Post-surgery	1.53	25		

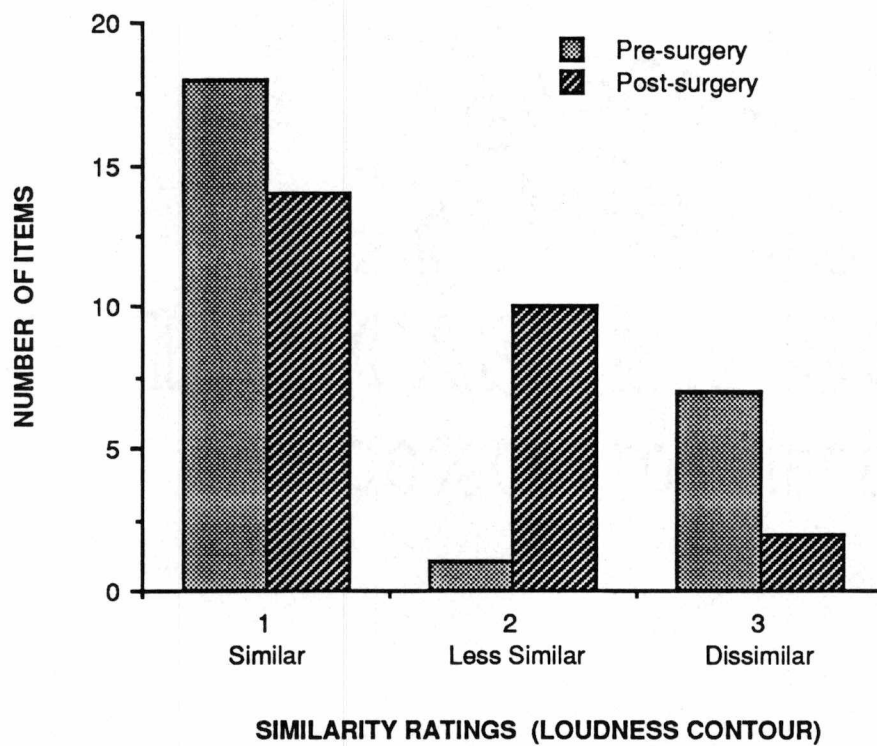


Figure 1. Frequency distribution of listener ratings (1-3) of the degree of similarity in loudness contour between stimulus (clinician's utterance)-response (child's attempted imitation) pairs for pre- and post-surgical conditions.

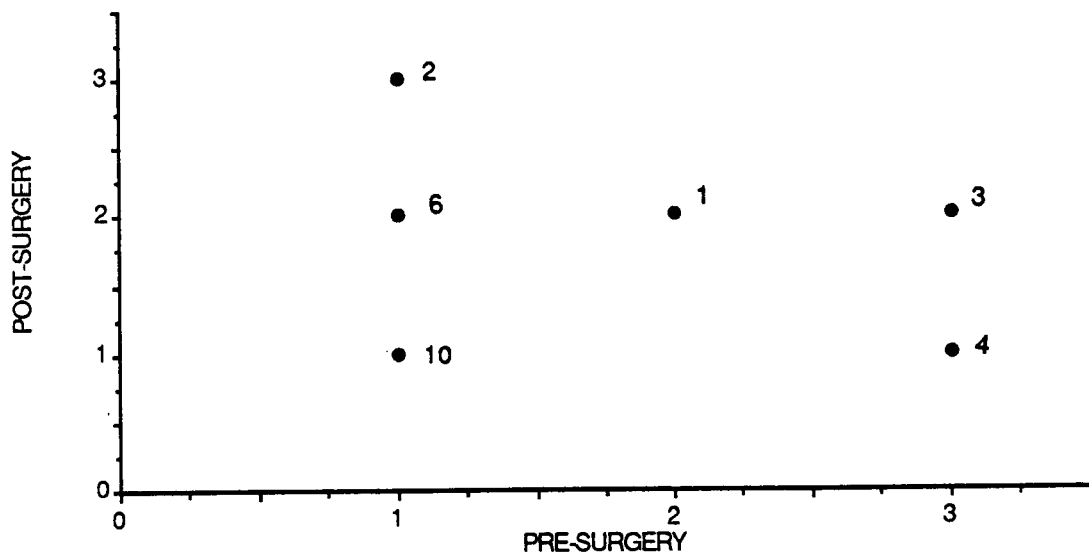


Figure 2. Scattergram comparing pre- and post-surgical similarity ratings of loudness contour.

Note: Numerals indicate the frequency with which items fell on the indicated point.

Table 3. Comparison of pre- and post-surgical conditions for listener ratings of the degree of similarity in intonation between stimulus (clinician's utterance)-response (child's attempted imitation) pairs.

Condition	Mean Similarity Rating	df	t - value	p
Pre-surgery	1.58	25	1.47	p>0.05
Post-surgery	1.53	25		

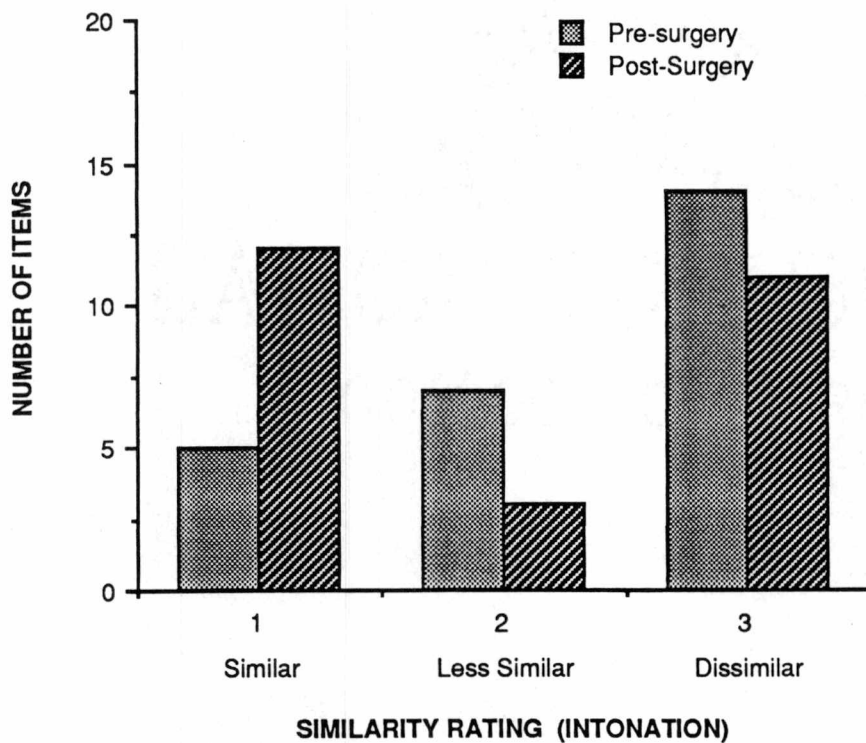


Figure 3. Frequency distribution of listener ratings (1-3) of the degree of similarity in intonation between stimulus (clinician's utterance)-response (child's attempted imitation) pairs for pre- and post-surgical conditions.

Additionally, a greater number of "2" and "3" ratings were assigned pre-surgically than post-surgically. A scattergram comparing pre-and post-surgical judgments depicts a similar distribution of rating values (Figure 4). Continued analysis revealed a significant difference between pre-surgical and post-surgical mean ratings for durational similarity ($t=2.47$; $df=25$; $p<.05$). See Table 4. Thus, the subject's imitation of duration increased in similarity to the clinician's stimulus utterance following surgery. These results are illustrated further in a histogram (Figure 5) representing a pre- and post-surgical comparison of the frequency distributions of listener ratings (1-3) of durational similarity for each of the 26 stimulus-response pairs. The most noticeable difference occurs for "1" ratings which increased from 10 of 26 pre-surgically to 18 of 26 post-surgically. Additionally, "2" and "3" ratings decreased from pre- to post-surgical conditions. A similar distribution of rating values is depicted in Figure 6.

Figure 7 graphically illustrates the relative changes in mean similarity ratings obtained pre- and post-surgically for each of the parameters, including loudness contour, intonation, and duration. Performance, in terms of increased similarity of the subject's imitative responses to the clinician's stimulus utterance, noticeably improved for the parameters of intonation and duration. No such change was observed for the parameter of loudness contour.

Similarity Rating and Utterance Complexity

In addition to the aforementioned analyses involving comparisons of pre- and post-surgical data, the possible relationship between the complexity of an utterance and its assigned similarity value was explored. This relationship was examined for each of the three parameters under investigation, including loudness contour, intonation, and duration. Each utterance was assigned a

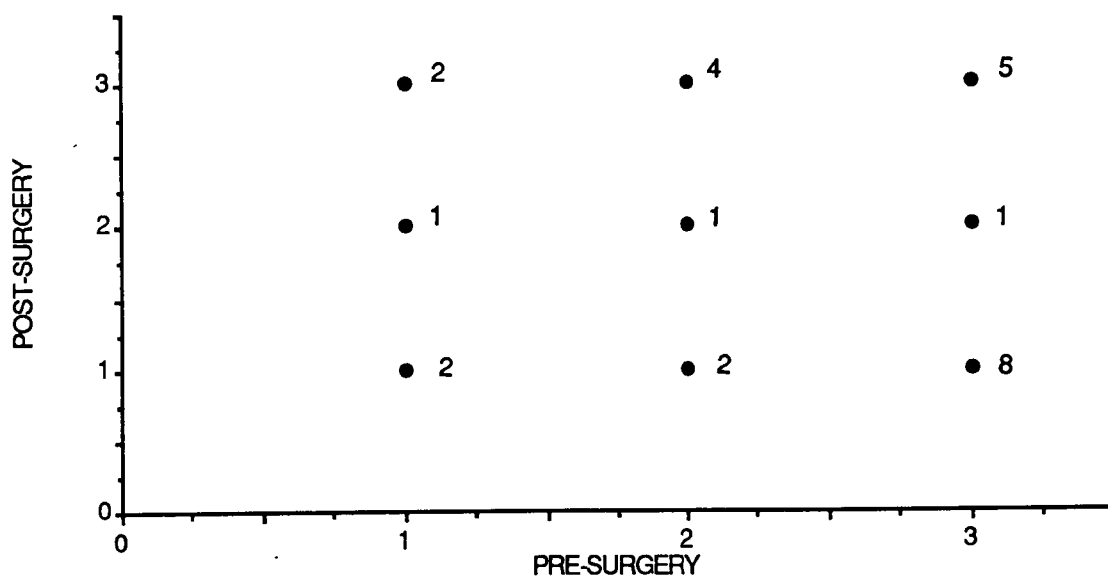


Figure 4. Scattergram comparing pre- and post-surgical similarity ratings of intonation.

Note: Numerals indicate the frequency with which items fell on the indicated point.

Table 4. Comparison of pre- and post-surgical conditions for listener ratings of the degree of similarity in duration between stimulus (clinician's utterance)-response (child's attempted imitation) pairs.

Condition	Mean Similarity Rating	df	t - value	p
Pre-surgery	1.88	25	2.47	p<0.05
Post-surgery	1.42	25		

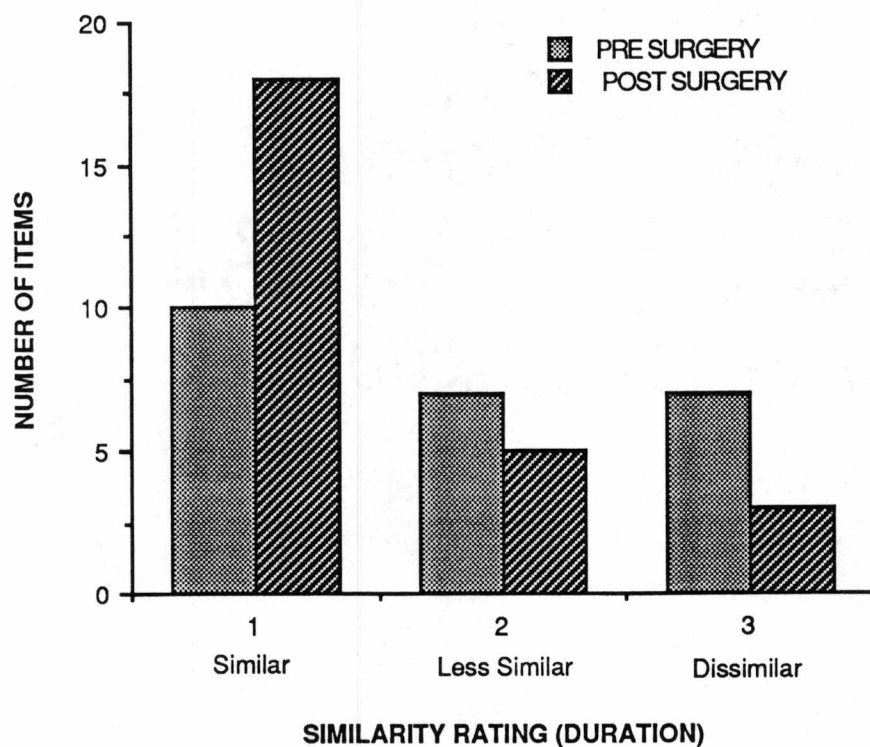


Figure 5. Frequency distribution of listener ratings (1-3) of the degree of similarity in duration between stimulus (clinician's utterance)-response (child's attempted imitation) pairs for pre- and post-surgical conditions.

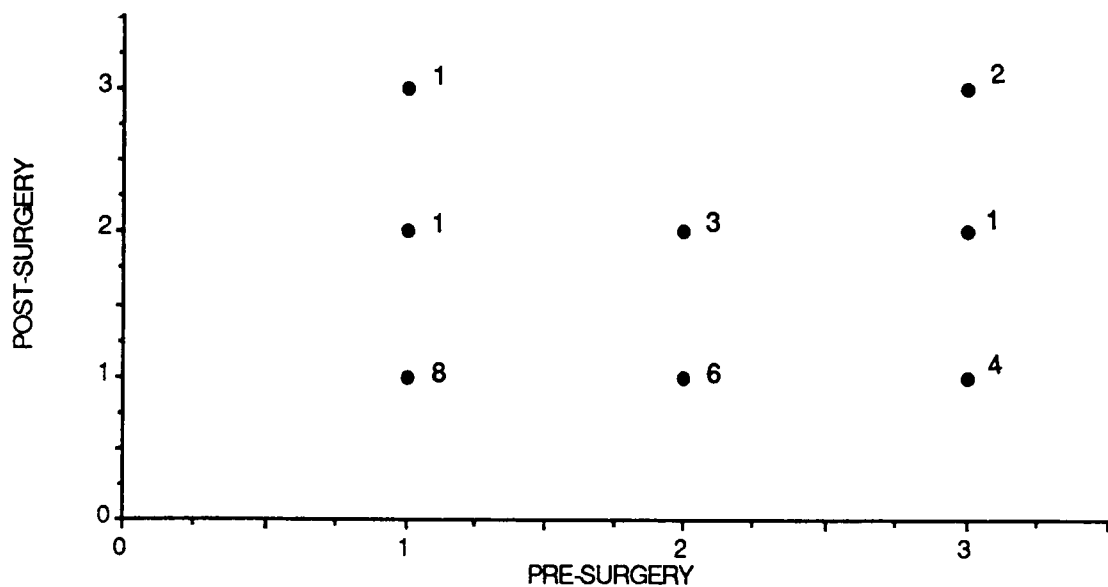


Figure 6. Scattergram comparing pre- and post-surgical similarity ratings of duration.

Note: Numerals indicate the frequency with which items fell on the indicated point.

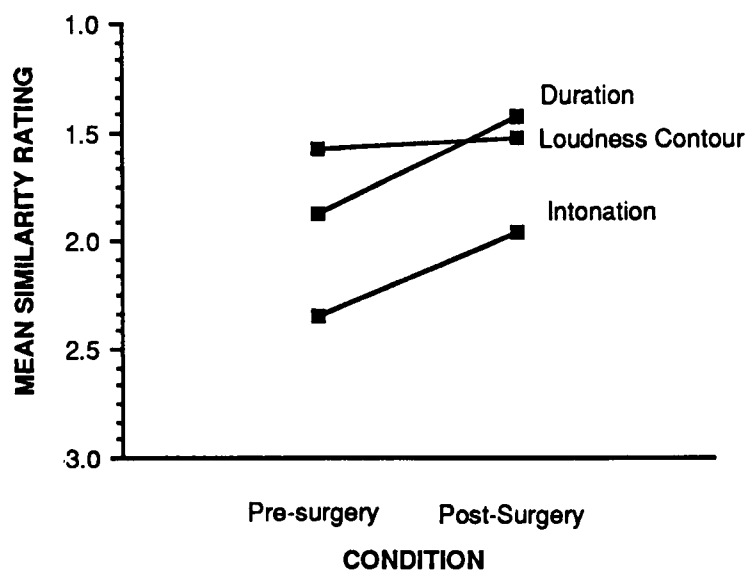


Figure 7. Relative changes in mean similarity ratings obtained pre- and post-surgically for loudness contour, intonation, and duration.

complexity rating based on number of syllables. The resultant ratings were then compared to their corresponding similarity ratings for each parameter via correlation and regression analyses.

In the preceding section, differences between pre- and post-surgery mean similarity ratings were revealed to be nonsignificant for the parameters of loudness contour and intonation. For these parameters, therefore, the combining of pre- and post-surgery ratings was permissible in establishing their relationship to corresponding complexity ratings. Significant differences between pre- and post-surgery mean similarity ratings were found for the parameter of duration, however, disallowing the combining of these scores. Thus, the relationship between similarity and complexity ratings will be considered separately for the pre- and post-surgery conditions of this parameter.

Correlations between similarity and complexity ratings for each parameter are displayed in Tables 5, 6, 7, and 8. Relationships between these ratings were found to be nonsignificant for the parameter of loudness contour ($r=.038$; $p>.05$), of intonation ($r=.042$; $p>.05$), and of duration, both pre-surgically ($r=-.2$; $p>.05$) and post-surgically ($r=-.2$; $p>.05$). Thus only .001 percent, .002 percent, .04 percent, and .04 percent of the variability in similarity ratings for the parameters of loudness contour, intonation, pre-surgical duration, and post-surgical duration, respectively, were accounted for by complexity.

In Figures 8, 9, 10, and 11, the lack of relationship between the variables of similarity and complexity is illustrated further in that no particular pattern of dots is discernable, but rather data dispersion appears to be random. Consequently, calculation of the regression lines reveals the obtained lines to be of little significance for the prediction of similarity ratings from complexity ratings.

Table 5. Correlation between similarity and complexity ratings for the parameter of loudness contour.

Number of Items	Covariance	Correlation	R-squared
52	0.32	0.38	.001

Table 6. Correlation between similarity and complexity ratings for the parameter of intonation.

Number of Items	Covariance	Correlation	R-squared
52	0.41	0.42	.002

Table 7. Correlation between pre-surgical similarity ratings and complexity ratings for the parameter of duration.

Number of items	Covariance	Correlation	R-squared
26	-.182	-.199	.039

Table 8. Correlation between post-surgical similarity ratings and complexity ratings for the parameter of duration.

Number of Items	Covariance	Correlation	R-squared
26	-.154	-.2	.04

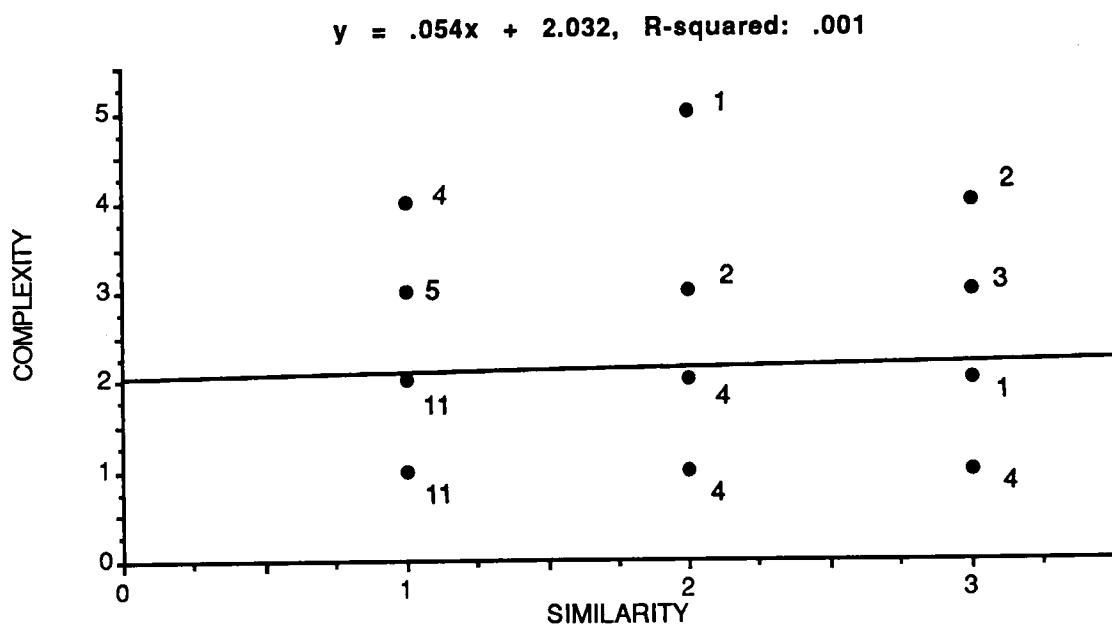


Figure 8. Scattergram illustrating the relationship between similarity and complexity ratings of loudness contour.

Note: Numerals indicate the frequency with which items fell on the indicated point.

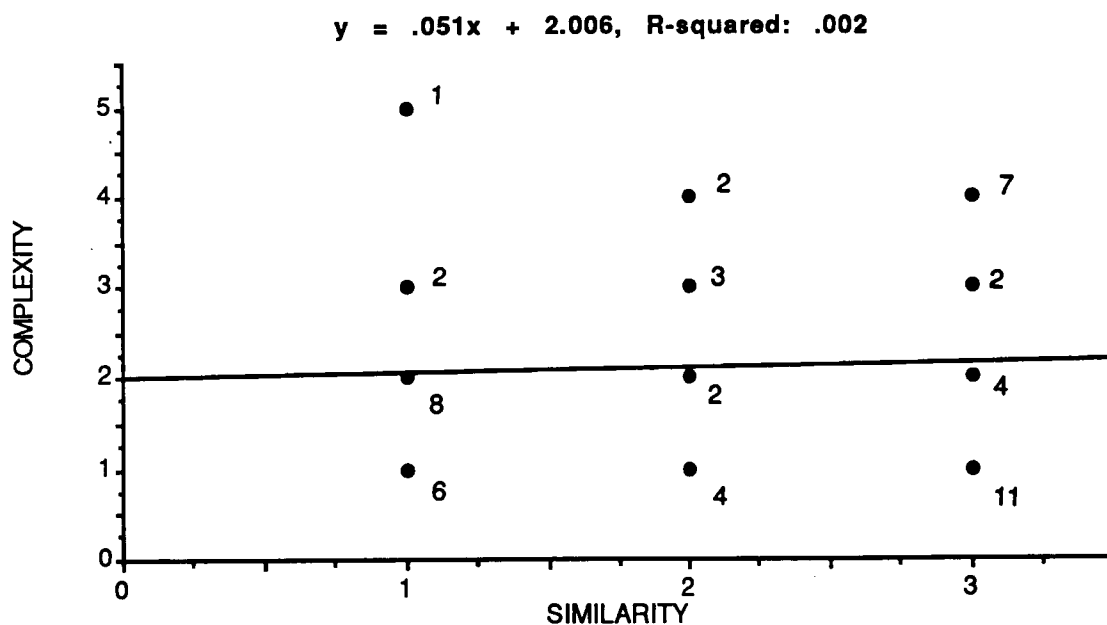


Figure 9. Scattergram illustrating the relationship between similarity and complexity ratings of intonation.

Note: Numerals indicate the frequency with which items fell on the indicated point.

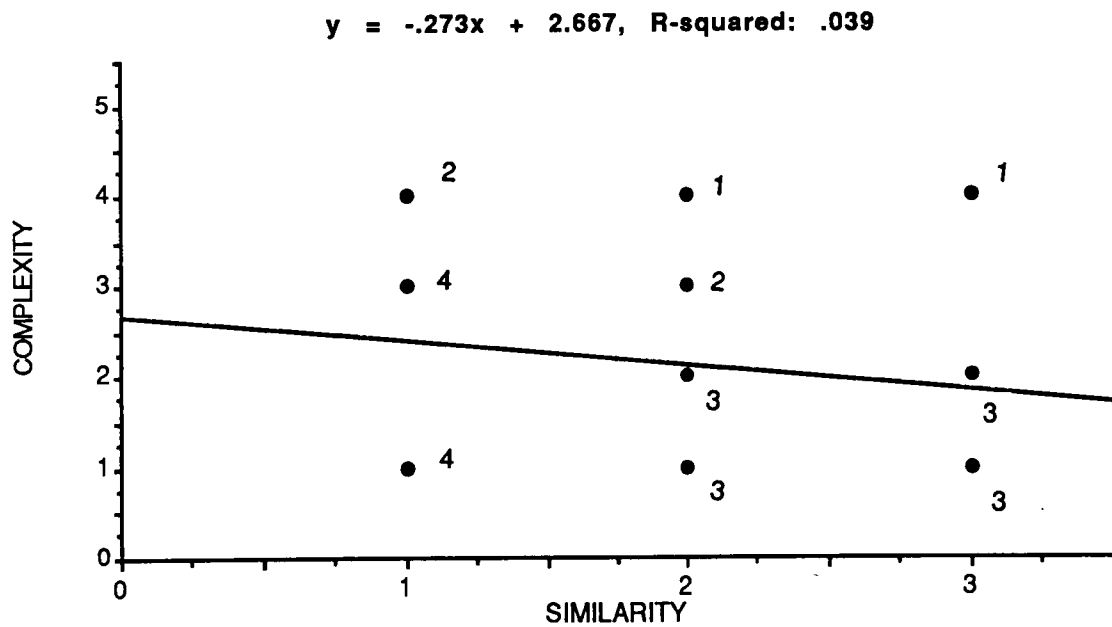


Figure 10. Scattergram illustrating the relationship between pre-surgical similarity ratings and complexity ratings of duration.

Note: Numerals indicate the frequency with which items fell on the indicated point.

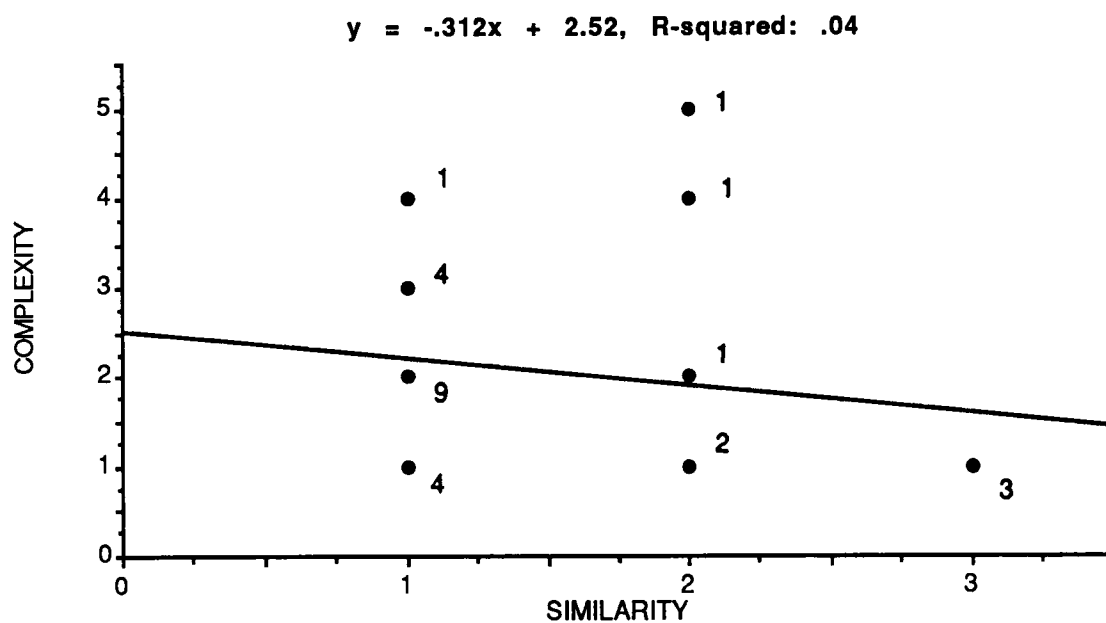


Figure 11. Scattergram illustrating the relationship between post-surgical similarity ratings and complexity ratings of duration.

Note: Numerals indicate the frequency with which items fell on the indicated point.

CHAPTER V

DISCUSSION

Findings

The goal of this investigation was to determine the effects of right hemispherectomy on the imitative use of prosody. Specifically, pre- and post-surgical performances of a single subject were compared with regard to the imitative use of loudness contour, intonation, and duration. Prior to this investigation, uncertainty existed as to possible outcomes. The possibilities considered are discussed in the following paragraphs.

Empirical indications of the right hemisphere's involvement in prosodic functioning (Blumstein & Cooper, 1974; Bryden et al, 1982; Graves et al, 1987; Gregory, 1982; Kimura, 1964; Papanicolaou et al, 1983; Ross et al, 1988; Shipley-Brown et al, 1988; Zurif, 1974) and deficits in this area subsequent to right hemisphere damage (Bowers et al, 1987; Gorelick & Ross, 1987; Heilman et al, 1984; Ross, 1988; Shapiro & Danly, 1985; Springer & Deutsch, 1981; Tompkins & Mateer, 1985; Tucker, 1987; Wolfe & Ross, 1987) suggested the possibility of a decrement in the subject's imitative use of the parameters investigated following removal of her right hemisphere. This possibility was entertained further in light of those investigations of hemispherectomy patients reporting results contraindicating their complete recovery (Day & Ulatowska, 1979; Dennis & Whitaker, 1976; Kohn & Dennis, 1974). Although all of these investigations were not concerned solely with this study's topic of right hemispherectomy and "right hemisphere" functions, they did speak to the issue of neuroplasticity.

Contradicting the evidence reported in the previous paragraph are numerous other reports of hemispherectomy patients exhibiting post-surgical functioning

approaching premorbid levels (Basser, 1962; Cummings et al, 1979; Smith & Sugar, 1975; Wilson, 1970). These studies did support the idea of the brain's plasticity, particularly in the early years, and, for the purposes of this study, suggested an alternative hypothesis of unchanged performance following removal of the subject's right hemisphere. Basser's (1962) extensive investigation of hemispherectomy patients led him to support this alternative and to further suggest possible improvements in functioning due to elimination of the adverse influences of the removed hemisphere.

The results of the present study, based on listener ratings (1-3) of the degree of similarity between stimulus (clinician's utterance)-response (child's attempted imitation) pairs, revealed the following:

1. The subject's imitation of loudness contour did not differ significantly in its similarity to the clinician's stimulus utterance between pre- and post- surgery conditions.
2. The subject's imitation of intonation tended to increase in similarity to the clinician's stimulus utterance following surgery, although this tendency was not statistically significant.
3. The subject's imitation of duration increased in similarity to the clinician's stimulus utterance following surgery.

These results contraindicated decreased performance in the imitative use of prosody by the subject following removal of her right hemisphere. Rather, her performance appeared unaltered for the parameter of loudness contour and noticeably improved for the intonational and durational parameters. Additionally, it should be noted that failure to find significant improvement with regard to loudness contour may have been attributable to the poor intrajudge reliability reported for this parameter as opposed to the remaining two. Results regarding loudness contour, therefore, must be interpreted cautiously. The lack of

significance may have been indicative of the difficulty encountered in the perceptual assessment of this parameter rather than the actual lack of change.

In addition to comparisons between the subject's pre- and post-surgical prosodic levels of functioning, the possible relationship between the complexity of an utterance and its assigned similarity rating was explored. That utterance complexity, indexed according to syllable length, could impact upon the child's performance and/or upon judgment of this performance was conceivable. Some possibilities considered were that the child might have experienced increased difficulty in imitating more complex utterances, adversely affecting her prosodic performance, or that the judge might have been better able to assess a parameter across utterances of greater length. In either of these cases, some relationship between ratings of similarity and complexity would have been observed. Based on the performed analyses, however, no such relationship was discernable. Correlations calculated for determining the degree of relationship between these two variables were negligible for each of the parameters being investigated. Thus, complexity did not appear to confound the resultant data with regard to stimulus-response similarity, lending further credence to the obtained results.

Anecdotal reports regarding the subject's pre-and post-surgical performances were considered in order to provide additional information regarding the questions posed in this investigation. Prior to being informed regarding the findings of the study, persons with prolonged contact with JP before and after surgery were questioned. Questions concerned the subject's use of those prosodic elements described by the examiner and any changes with regard to these elements subsequent to surgery. Following the first post-surgery session, the interacting clinician expressed her immediate observations of JP's substantial improvement in all aspects of speech and language development, including the areas of investigation. Similar observations were made by JP's parents and by

those therapists from whom she receives speech and language therapy on a twice weekly basis.

Generally, the results of this study do not suggest that prosodic functioning is influenced detrimentally by removal of the right hemisphere in a patient of this early age. Observed changes were nonsignificant or in a positive direction. These results are consistent with those reported in the investigations of Bassler (1962), Cummings and his colleagues (1979), Smith and Sugar (1975), and Wilson (1970) and thus contribute additional support regarding capacity for compensatory reorganization of functioning in the brain when modified during the early years (Bassler, 1962; Chase, 1972; Goldman, 1971; Lenneberg, 1967). In fact, it may well be that the interhemispheric neuroplasticity of the young brain, coupled with the elimination of the previously interruptive activities of the removed hemisphere, may lead to actual improved functioning, as asserted by Bassler (1962). For the single subject investigated in this study, this explanation appeared applicable to right hemisphere removal and to subsequent levels of functioning with regard to the imitative use of loudness contour, intonation, and duration.

Qualifications

Before further discussing the implications of the findings reported in this study, some qualifying considerations merit attention. First, the nature of this study requires the employment of a case study design so that the effects of a rare surgical procedure on the prosodic elements of speech might be observed. Although the value of the information gained from such a unique opportunity is far from negligible, the limitations of a single-subject research in terms of generalization must be considered. Follow-up studies, which examine similar phenomena occurring in other right hemispherectomy patients, are necessary to

substantiate the findings purported by this study.

An additional problem highlighted by the present investigation is that of establishing a valid and reliable means for assessing the suprasegmental aspects of speech. As pointed out by Koike and Asp (1981), attempts toward developing standardized measures of speech and language largely have been limited to the segmentals, thus excluding prosodic parameters. This is particularly pertinent for very young or low functioning infants whose level of functioning precludes their appropriate participation using even those instruments which are currently available, such as the Tennessee Test of Rhythm and Intonation (Koike & Asp, 1981).

Perceptual ratings, therefore, were employed for the purposes of this study. Pilot studies conducted prior to this investigation, however, revealed poor agreement between even those judges with extensive training in this area of speech-language pathology. This appears to be indicative not of any perceptual misjudgments, but rather of their use of different standards of judgment. This was resolved in the present investigation by the use of a single judge whose standards were outlined in detail. Only when the demonstrated inconsistencies are resolved will the use of multiple judgments be effective, and such a resolution will not be obtained easily. The complexities of the suprasegmentals have limited such efforts. Yet, more extensive information is required regarding this aspect of speech for purposes of both research and clinical application, particularly as they concern very young and low functioning children. Only with information gained by such endeavors will the establishment of appropriate norms and the development of valid and reliable means of assessing the suprasegmental aspects of speech be possible for this population.

Also, it should be noted that many researchers distinguish among different types of prosody and are particularly concerned with the distinction between affective prosody and propositional or linguistic prosody (Shipley-Brown et al, 1988). It is generally believed that the former type is localized in the right

hemisphere (Bowers et al, 1987; Gorelick & Ross, 1987; Heilman et al, 1984; Ross, 1988; Tompkins & Mateer, 1985; Wolfe & Ross, 1987); however, much uncertainty remains regarding the hemispheric localization of the latter. It was not the purpose of the present study to explore this issue, nor would the limitations imposed by the subject's young age and developmental status have permitted such an exploration. Nevertheless, the implications of the proposed distinctions among prosodic subtypes merit consideration and perhaps further investigation in hemispherectomy patients who present characteristics amiable to researching this topic.

Also, it should be pointed out that no attempt was made to analyze the interacting clinician's utterances across pre- and post-surgical conditions in this investigation. Acoustic measures would have been useful in revealing any changes that the clinician might have employed in an attempt to elicit the desired response. Thus, despite the structural similarity of the pre- and post-surgery sessions, cautious interpretation is warranted regarding those differences observed in the child that may in fact have been due to differences in the clinician.

Finally, instrumental analyses of both stimulus and response utterances for the purpose of comparing their similarity would provide an acoustic correlate for the perceptual data gathered in this study. Such information would comprise a worthy topic for a follow-up investigation.

Implications

Results from the present investigation provide important insight into brain-language relationships and into the concept of neuroplasticity, particularly as related to the prosodic parameters of loudness contour, intonation, and duration. The limitations imposed by the developmental status of the investigated subject did not allow for a more indepth examination of the impact of right

hemispherectomy on different prosodic types, such as those described in detail by Shipley-Brown and colleagues (1988). Nevertheless, this study's results do suggest that removal of the right hemisphere does not appear to detrimentally affect imitation of the investigated parameters. In fact, the changes noted in this study were largely positive in nature, suggesting the brain's early capacity for functional reorganization (neuroplasticity) and the possible benefits accrued from the elimination of the seizure interference previously imposed by the removed hemisphere. With regard to the former, it seems likely that the extensive and longstanding right hemisphere damage evidenced in this child lent to the early occurrence of the atypical functional organization noted, and upon relinquishment of disruptive seizuring, the left hemisphere was able to better exercise control over its assigned functions. The overall improvement noted in the subject's linguistic development following surgery included those aspects of language for which the left hemisphere is normally assumed to be responsible, as indicated by increases of 4-6 months in receptive language and 8 - 10 months in expressive language on the Sequenced Inventory of Communicative Development (SICD), lending additional support to this speculation.

The need for future research utilizing right hemidecorticates and other right-hemisphere-damaged patients to examine prosodic functioning is apparent, as is the need for examination of other proposed right hemisphere functions in these patients. Resultant information will provide a more complete picture of the language patterns, both segmental and suprasegmental, expected for patients for whom the right hemisphere is modified or removed. Subsequently, the role of the speech-language-hearing specialist in rendering diagnostic and therapeutic services to this population will be clarified, and the quality of any services indicated will be much improved.

CHAPTER VI

SUMMARY

The imitative use of loudness contour, intonation, and duration by a single subject prior to and following right hemispherectomy was investigated. Speech samples were elicited by an interacting clinician for the purposes of perceptual analysis. Twenty-six of these utterances, occurring in both pre- and post-surgical conditions, were rated utilizing a Similarity Scale (Asp, 1973). This scale permitted judgments as to the degree of similarity between the clinician's stimulus utterance and the child's attempted imitative response across the two designated conditions. Ratings (1-3) indicative of the perceived similarity were assigned for each of the three parameters being investigated by a certified speech-language pathologist with extensive training and experience in the area of suprasegmentals.

Pre- and post-surgical comparisons of the data were accomplished with a t-test for related samples, utilizing an alpha level of .05 as the criterion. Correlation and regression analyses also were performed to examine the relationship between assigned similarity ratings and utterance complexity in terms of syllable length. The results of this study failed to reveal a decrement in performance for the imitative use of any of the parameters investigated, following removal of the right hemisphere. No changes were observed in loudness contour, and improvement was noted for both intonation and duration, the latter being statistically significant. Additionally, no relationship was revealed to exist between utterance complexity and assigned similarity ratings, contraindicating the confounding influence of utterance length on the obtained results. These results support the idea of the brain's early interhemispheric plasticity and suggest the remarkable capacity of the left hemisphere to assume an expanded role in the absence of its right counterpart. It is concluded that in a very young

patient, such as the subject investigated, the lateralization of functions may not be completed and that the capacity for some degree of functional reorganization exists, at least with regard to the investigated parameters. Future research is needed, however, to substantiate and expand upon these results.

CHAPTER VII

CONCLUSIONS

Hemispherectomy has been performed in an effort to eliminate or reduce seizure activity previously untractable by less extreme measures. Post-surgical consequences are of major concern, and possible outcomes in terms of level of functioning remain a source of uncertainty. Reports from numerous investigators indicate residual deficits for patients following hemispherectomy (Day & Ulatowska, 1979; Dennis & Whitaker, 1976; Kohn & Dennis, 1974); others report post-surgical functioning which approaches and may even surpass the patient's premorbid status (Basser, 1962; Cummings et al, 1979; Smith & Sgar, 1975; Wilson, 1970). Information derived from case studies provides a significant means of documenting levels of functioning subsequent to hemisphere removal. The present study addressed the effect of right hemispherectomy on the suprasegmental aspects of language. Specifically, a single subject's pre- and post-operative imitative use of loudness contour, intonation, and duration was investigated.

As a case study, obvious limitations exist with regard to the generalization of this investigation's results. Nevertheless, resultant information successfully highlights the potential benefits accrued from hemispherectomy in those cases for which it is indicated. For the present subject, the most obvious benefit involved elimination of seizure activity as confirmed by EEG data obtained at Children's Hospital in Knoxville, Tennessee (8/99) and at Johns Hopkin's Hospital (9/88). Additionally, standardized testing and anecdotal information indicated substantial improvement by the subject in all aspects of development and specifically in receptive and expressive language skills. Finally, in the area of prosodic functioning, the present study revealed the subject's performance to be

unaltered for the parameter of loudness contour and noticeably improved for the intonational and durational parameters.

Results of this investigation suggest, therefore, that for the child studied, right hemisphere removal was not accompanied by deficits in prosodic functioning. Instead, functional organization of the brain as it concerns abilities in this area appears to be less rigidly defined than previously supposed. Owing to the important role of prosody in the communicative process, the implications of such findings are significant. The data from this study indicate that hemispherectomy provides a potential means of relieving the adverse impact of seizing while maintaining normal levels of functioning in such areas as loudness contour, intonation and duration, thereby strengthening and expanding the existing empirical basis for this procedure.

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APPENDICES

APPENDIX A

Instructions for the selection of utterances:

"You are going to be listening to samples of recorded utterances. The quality of these utterances will vary. You are to compare repeated samples of the same utterance and select that utterance which you feel has the highest quality of recording and therefore will be most easily heard and judged with regard to the parameters of intonation, loudness contour, and duration. The utterances should not be compared on the basis of articulatory accuracy, but rather on clarity for the purpose of permitting perceptual judgments. If two or more utterances are believed to be of equal quality, select one randomly."

APPENDIX B

Standards of judgement utilized for similarity ratings:

The judge utilized in this investigation described her standards for performing similarity judgments as follows:

Loudness contour was assessed by comparing the stimulus and the response in a relative fashion. Generally, the child's voice volume was lower than that of the interacting clinician, lending to the notation of patterns of loudness change rather than actual loudness level. A score of "1" denoted an appreciable attempt by the child to mimic the loudness pattern of the stimulus utterance. A slight change in loudness level by the child in response to changes noted in the stimulus utterance were scored as "2." An assignment of a "3" was given in those instances in which there were no changes in the loudness contour of the child resembling those characterizing the stimulus utterance.

For the parameter of intonation, the judge reported and was observed to attempting to match the intonational patterns of both the stimulus and the response of each pair with her own voice. Thus, the changes noted between her own productions formed a basis for judgment. A "1" was assigned to those responses in which the child was successful in following the direction of pitch change noted in the stimulus. A score of "2" indicated some intonational change by the child resembling that produced by the clinician, although changes were not completely parallel between the two. When the child failed in her attempt to follow the clinician's pattern, producing no change or producing an opposing pattern, a rating of "3" was assigned.

For the parameter of duration, timing of both the stimulus and the utterance of each pair was assessed by a counting procedure. A rating of

"1" was used when the durational counts for the stimulus and the utterance were closely matched. A "2" denoted some, but not complete success by the child in her attempt to follow the clinician's duration. An item was valued at "3" when the attempted durational pattern was perceived as directly or nearly opposite that presented.

APPENDIX C

Instructions for the assignment of similarity ratings:

In the present study, one subject's utterances are being compared pre- and post-surgically with regard to the following parameters: duration, intonation, and loudness contour. For the purposes of this study, intonation refers to pitch contour. This involves the change in pitch across an utterance, particularly with regard to the direction of pitch change. Duration refers to the timing of an utterance with regard to its length. Loudness contour refers to relative levels of loudness and change in loudness across an utterance.

The subject's utterances have been rerecorded in a random matter. Therefore, pre- and post-surgery vocalizations are varied with regard to presentation, and you will have no knowledge of when each of the utterances was obtained.

Each presentation consists of a clinician's stimulus utterance and the child's attempted imitation of that utterance, followed by an approximate 5 second pause. This presentation will then be repeated, again followed by an approximate 5 second pause. You are to compare the similarity of the child's attempted imitation to the clinician's stimulus utterance. The comparison will be made using a 3 point scale, seen on the answering sheet. The points on this scale are as follows: 1 for similar, 2 for less similar, and 3 for dissimilar. This is a forced choice comparison in which you must select that one value which best represents your perception of the similarity between the clinician's stimulus utterance and the child's attempted imitative response. An utterance is regarded as similar when it is at or close to the target utterance with regard to the parameter being judged. An utterance is regarded as dissimilar when it is not at all close to

the target utterance with regard to the parameter being judged. The midpoint or less similar category is used to refer to an utterance that is between these two extremes; it is neither directly on nor off target. You will indicate your selection by circling the appropriate value during the allotted pauses. You are free to make any other markings in your paper that will be of help to you in making your judgments.

During the first 57 trials you will be judging similarity on the basis of loudness contour only. Remember that we defined loudness contour as relative levels of loudness and change in loudness across an utterance. Do not base your judgments on articulatory accuracy or on any parameter other than loudness contour. You will be instructed when this parameter is to be changed.

You will now be allowed to hear example trials to familiarize yourself with the task and the rating scale. During and following these trials, you will be given the opportunity to ask questions.

During the next 57 trials you will be judging similarity on the basis of intonation only. Remember we defined intonation as pitch contour. This refers to the change in pitch across an utterance, particularly with regard to the direction of pitch change

During the next 57 trials, you will be judging similarity on the basis of duration only. Remember we defined duration as the timing of an utterance with regard to its length. Do not base your judgments on articulatory accuracy or on any parameter other than intonation. You will be reinstructed when this parameter is to be changed.

VITA

Lea Paige Cothran was born in Greenwood, South Carolina on February 25, 1964. She attended elementary and middle school in that city, graduating from Greenwood High School in June 1982. In the fall of that same year, she entered the College of Charleston in South Carolina. During her four years at the college, she became a member of Psi Chi, Phi Kappa Phi, and Omicron Delta Kappa honor societies, she acted as executive vice president of Alpha Delta Pi Sorority, and she received the College of Charleston Alumni Medal and Outstanding Student in Psychology Award. She graduated summa cum laude with a Bachelor of Science degree in May of 1986. The following September she accepted the Hilton A. Smith graduate fellowship at the University of Tennessee in Knoxville, entering the master's program in the department of Audiology and Speech Pathology. She became a member of the University of Tennessee's Phi Kappa Phi, as well as the National-Student-Speech-Language-Hearing-Association. In December of 1988, she received the Distinguished Achievement Award from her department, and she graduated with a Master of Arts degree in Speech Pathology.