The Effects of Interactive Songs on Syllable Production in a Child with Agenesis of the Corpus Callosum

Kelly D. Beens

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THE EFFECTS OF INTERACTIVE SONGS ON SYLLABLE PRODUCTION
IN A CHILD WITH AGENESIS OF THE CORPUS CALLOSUM

by

Kelly D. Beens

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Grazie mille to my mom for encouraging me through the bleak times and reminding me how to renew my strength. To the countless "significant others" in my life, thank you for not giving up on me through the storm and sharing the joy of my rainbow.

Finally, I dedicate this thesis to the subject, who has touched my life in a special way. May he continue to grow, explore, and learn, as he embraces the world with his smile.

Kelly D. Beens
THE EFFECTS OF INTERACTIVE SONGS ON SYLLABLE PRODUCTION IN A CHILD WITH AGENESIS OF THE CORPUS CALLOSUM

Kelly D. Beens, M.A.
Western Michigan University, 1995

Agenesis of the corpus callosum is a disorder which has been the focus of clinical research on various tasks involving interhemispheric transfer of information. However, therapeutic intervention for individuals with this disorder has not been located in the literature by this researcher. Speech-language therapy for a five-year-old male incorporating interaction with songs was employed to activate various portions of the congenitally separated cerebral hemispheres and to encourage information transfer through non-traditional ways to facilitate syllable production.

The child received speech-language therapy for 15, 30-minute sessions. He was prompted to participate physically (with actions or manipulation of props) and verbally in the singing of the songs. A voice output communication device was also incorporated into the treatment program in alternate treatment phases to provide the child with an additional modality of participation and to further facilitate speech production.

Measures of total syllables produced by the child were calculated for the first five minutes of each session (pre-session probe) and the last five minutes of each session (post-session probe). Results indicate total number of syllables produced by the child increased immediately following treatment in each session as well as over time. Results also indicate that introduction of a voice output communication device did not particularly increase syllable production when compared to interaction with songs without the device.
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CHAPTER I

INTRODUCTION

The corpus callosum is the largest commissure in the brain and connects the left and right cerebral hemispheres. The corpus callosum is primarily responsible for interhemispheric transfer of information and integration of cognitive, language, sensory, and motor functioning. Agenesis of the corpus callosum is a disorder in which the corpus callosum is absent from birth. This disorder has been the focus of clinical research on various tasks involving interhemispheric transfer of information, including language functions. However, therapeutic intervention for individuals with agenesis of the corpus callosum who have concomitant language disorders has not been reported in the literature.

A five-year-old male with agenesis of the corpus callosum who was experiencing severe delays in speech and language development enrolled in the university clinic for speech-language therapy. The present study consisted of 15, 30-minute sessions. In order to facilitate speech production, therapy activities integrated language functions, which are historically believed to be lateralized to the left cerebral hemisphere, and music, which is reported to be lateralized to the right cerebral hemisphere. In addition, a voice output communication device was included in alternate treatment phases to provide the child with an additional modality with which to participate and to encourage speech production.

The purpose of the study was to determine the effectiveness of participation in songs, with and without a voice output communication device, in facilitating speech in a child with agenesis of the corpus callosum and a severe delay in expressive language.
CHAPTER II

REVIEW OF RELATED LITERATURE

Cerebral Dominance and Lateralization of Function

Traditionally speech and language functions have been attributed to the left cerebral hemisphere, and the right cerebral hemisphere has been viewed as primarily responsible for musical and emotional functions (Geschwind, 1974; Broadbent, 1975). Dichotic listening tasks have shown verbal input to be lateralized to the right ear (left hemisphere) while musical/nonverbal input is lateralized to the left ear (right hemisphere) (Kimura, 1961; Kimura, 1964; Darwin, 1975). Kimura (1981) also concluded that contralateral pathways to the left hemisphere are more effective than ipsilateral pathways. In a study of sung speech, the right hemisphere was dominant for melody while the left hemisphere was dominant for letter sequences (Bartholomeus, 1974). Intonation patterns of a spoken voice were reported to be perceived better by the right hemisphere than the left (Blumenstein & Cooper, 1974). Intonation patterns were dominant in the hemisphere opposite that which is dominant for the meaning of speech. The right hemisphere was also determined to be dominant in the perception of emotional voices (King & Kimura, 1972).

Based on the studies of speech perception that showed responses in the right hemisphere for tasks involving music, Broadbent (1975) stated that speech perception involves processes in both hemispheres. Gordon (1983) stated that the right hemisphere is more involved in singing than the left hemisphere but that singing is not completely lateralized to the right hemisphere. Milner (1975) cautioned against strict adherence to theories of hemispheric specialization and commented that the hemispheres
interact when competing information is presented simultaneously. Le Doux (1983) also stated that cognitive functions are not completely dependent on one hemisphere or the other but involve complex processes and integrated functions. Dimond (1971) demonstrated an increased ability to register words directed to each hemisphere rather than both words presented to the left or right hemisphere alone. Dimond and Beaumont (1974) concluded that the use of both cerebral hemispheres (two perceptual systems) resulted in greater output of the brain than was present in either hemisphere alone.

Buffery (1974) reported functional adaptation and reorganization of cerebral function following damage to the brain. Buffery cited wide variance in adaptation from patient to patient due to the time of trauma, site and extent of lesion, as well as personal characteristics of the patient.

Disconnection Syndrome

The corpus callosum is the primary commissure which connects the left and right cerebral hemispheres. It consists of approximately 200 million fibers that cross-connect nearly all regions of the cerebral cortex (Sperry, 1975). Current understanding of the function of the corpus callosum has been attributed, in part, to studies of commissurotomy patients who have had their corpus callosum severed as a treatment for intractable epilepsy.

Sperry (1975) reported strong lateralization for language (speech and writing) in the disconnected left hemisphere and lateralization of nonlinguistic functions (perceptual insight and processing of spatial patterns) in the disconnected right hemisphere. Tramo and Bharucha (1991) observed lateralization of auditory functions mediating chord priming in the right hemispheres of patients post-callosotomy. Normal interaction between harmonic relatedness and intonation was found in these split-brain patients when the auditory information was presented to the right hemisphere. Sperry,
Gazzaniga, and Bogen (1969) commented that the right hemisphere's influence on singing or uttering familiar words or exclamations needed to be explored further.

A disconnection syndrome has been described in patients who undergo transection of the corpus callosum (Sperry et al., 1969). Sperry et al. (1969) reported a lack of change in overt behavior in individuals who demonstrate this syndrome. Commissurotomy patients were reported to have well-preserved speech, verbal intelligence, calculation, motor coordination, verbal reasoning and recall, personality, and temperament, which contributed to normal daily functioning (Sperry, 1975). Each hemisphere was reported to function independently with its own memories and learning experiences (Sperry et al., 1969; Sperry, 1975). In addition, Sperry and associates reported permanent deficits in interhemispheric transfer of information and integration of sensory and motor functions. For example, patients were consistently unable to describe the pictures or objects presented visually to the left side of the vertical meridian in spoken or written language. However, Sperry (1975) also stated that typical split-brain deficits are easily compensated with eye movements and auditory cues that bilaterализate sensory information. These cross-cueing strategies were reported to strengthen with practice (Sperry, 1975). Sperry (1975) hypothesized that intact brainstem routes and feedback from peripheral changes enable emotional effects that are activated in one hemisphere to trigger involvement of the opposite hemisphere.

Temple, Jeeves, and Vilarroya (1989) commented that commissurotomy patients have atypical brains prior to surgery due to seizure activity. Therefore, interhemispheric transfer of information in individuals with agenesis of the corpus callosum may not necessarily be comparable to transfer among individuals with commissurotomy. Lassonde (1994) reported that most early research of individuals born without a corpus callosum did not demonstrate the disconnection syndrome observed in individuals who had the corpus callosum surgically severed. However,
Lassonde commented that recent studies indicate impairments in interhemispheric communication in acallosal patients. Examples of these studies follow.

Agenesis of the Corpus Callosum

Etiology

Agenesis of the corpus callosum is a condition which results from partial or total failure of callosal axons to cross the midline during the first trimester of fetal development (Rauch & Jinkins, 1994). A variety of factors may contribute to the agenesis. Full or partial agenesis of the corpus callosum is a major feature of Aicardi Syndrome, which also includes chorioretinal lacunae (white or pinkish areas of retinal discoloration) and infantile spasms. This chromosomal-linked syndrome is present only in females (Aicardi & Chevrie, 1994). Callosal agenesis is also a symptom of Andermann Syndrome, an autosomal recessive disorder which is accompanied by mild to moderate mental retardation and sensorimotor neuropathy (Andermann & Andermann, 1994). In addition, callosal agenesis usually occurs with Shapiro Syndrome, Acrocallosal Syndrome, Menkes Disease, and FG Syndrome (Wisniewski & Jeret, 1994; McCardle & Wilson, 1993). It sometimes occurs as a result of environmental pathogens (Fetal Alcohol Syndrome or intrauterine infections) or metabolic diseases (Wisniewski & Jeret, 1994).

Agenesis of the corpus callosum is a condition that may occur alone or in combination with developmental, central nervous system, and organ system abnormalities (Wisniewski & Jeret, 1994). In a review of 705 cases, Jeret, Serur, Wisniewski, and Lubin (1987) found mental retardation (73-85%), seizures (42%), and hyper- or hyporeflexia (50%) to be the most common clinical findings. Other common findings included ocular abnormalities, hypertelorism (wide-set eyes), low-set
ears, and palate abnormalities. Hydrocephalus and costovertebral abnormalities were seen in approximately one fourth of the cases.

Epidemiology

The majority of persons with agenesis of the corpus callosum are male (53.7%) (Jeret et al., 1987). Approximately .0005% to 0.7% of all children are born with callosal agenesis (Grogono, 1968; Larsen & Osborn, 1982). Jeret et al. (1987) reported that 15% of individuals with agenesis have normal intelligence (i.e. IQ >70). However, agenesis of the corpus callosum is typically diagnosed when patients present with developmental disabilities or other neurological problems (Wisniewski & Jeret, 1994). On the other hand, Sauerwein, Nolin, and Lassonde (1994) commented that agenesis of the corpus callosum often goes undetected in individuals with normal or superior cognition until autopsy or neuroradiological examination for some other reason.

Development

O'Brien (1994) collected data from 47 parents of children with partial callosal agenesis, total callosal agenesis, or Aicardi Syndrome. Because the subjects were drawn from a family support group, the sample may have been more severely disabled than the overall populations of these groups. Of the subjects with complete agenesis of the corpus callosum, 77.5% were reported to have no expressive language, 13% were reported to have a mild delay, and 10% were reported to have a marked delay in expressive language. By 6 years, only approximately one quarter of the subjects with complete agenesis of the corpus callosum were walking. O'Brien also reported that 19% of the children with complete callosal agenesis did not have independent...
meaningful hand use. Only 39% of the children with complete callosal agenesis were reported to use a pencil.

Sauerwein, Nolin, and Lassonde (1994) stated that, due to compensation, manual dexterity and motor coordination in the young child with agenesis of the corpus callosum can be greatly improved through physiotherapy and occupational therapy at a time when plasticity is greatest. Jeeves (1994) commented that rehabilitation and relearning as they relate to callosal functions should be investigated further. Thus far, reports of physical, occupational, or speech-language therapy have not been located by this researcher.

Behavior

Less than 10% of the children with complete agenesis of the corpus callosum in O'Brien's (1994) study demonstrated hyperactive tendencies; however, 42% in this same group were reported to demonstrate lethargy. The children with total callosal agenesis demonstrated more self-injurious behavior and aggression than the children with partial callosal agenesis, but not as much as the children with Aicardi Syndrome. Children with complete callosal agenesis were not reported to show diffuse anxiety. 19.5% were reported to be dysphoric, 13% often fearful, 19.5% irritable, and 26% to demonstrate temper tantrums. Social indifference, described by O'Brien as lack of empathic interest, was reported in 16% of the children with complete callosal agenesis. Emotional non-communicativeness was reported in 61.5% of this same group, which was referred to by O'Brien as resulting in the parents' inability to know what their child is feeling. In addition, echolalia and "meaningless" or "out of place" conversation was common in subjects who had some expressive language.

O'Brien (1994) concluded that a behavioral phenotype of emotional non-communicativeness, linguistic anomaly, and lethargy in the absence of autism is typical
of these individuals with agenesis of the corpus callosum. His findings further suggested that the extent of the callosal lesion impacts the behavior exhibited by the individuals.

Memory

Auditory memory was assessed in four subjects with agenesis of the corpus callosum by Geffen, Forrester, Jones, and Simpson (1994). Three subjects with complete agenesis of the corpus callosum demonstrated poor memory retrieval, as evidenced by poor recall with good recognition of auditorily presented words. Geffen et al. suggested that these memory problems may be related to difficulty with transference, inhibition, and facilitation of information between or within the cerebral hemispheres by the corpus callosum.

Cognition

Level of cognitive functioning is strongly related to the severity of co-existing central nervous system malformations. Individuals with syndromes with multiple defects, such as Aicardi and Andermann, appear to be most affected (Aicardi & Chevrie, 1994; Andermann & Andermann, 1994; Geoffroy, Wisniewski, & Jeret, 1994).

Normal intelligence has been reported in cases of callosal agenesis (Temple & Ilsley, 1994; Sauerwein, Nolin, & Lassonde, 1994). Results of neuropsychological evaluation which included intellectual capacities, attention/concentration, memory, language, perceptual abilities, motor skills, perceptuo-motor integration, and somatosensory function indicated that individuals with agenesis of the corpus callosum can have normal cognitive abilities, although they tend to function at the lower end of the normal range (Sauerwein et al., 1994). Sauerwein et al. commented that these
individuals provided an opportunity to investigate means of functional compensation in the absence of the corpus callosum.

**Motor Ability**

In a study of bimanual coordination, Jeeves, Silver, and Jacobson (1988) provided evidence that the anterior parts of the corpus callosum are crucial for interhemispheric integration of the lower motor system in each hemisphere. An intact corpus callosum appears to be necessary for fast, coordinated bimanual performance (Silver & Jeeves, 1994).

**Sensory Modalities**

**Visual**

In addition to callosal involvement in interhemispheric transfer of information, the corpus callosum is also involved in midline functions. Results of tests on various sensory modalities conducted by Lepore, Lassonde, Poirier, Schiavetto, and Veillette (1994) indicated that involvement of the corpus callosum in midline function is important in the visual and lemniscal somatosensory systems but may be redundant in the auditory and spino-thalamic somatosensory systems. Results of a study by Vanasse, Forest, and Lassonde (1994) suggested that the absence of a disconnection syndrome in individuals without a corpus callosum is only partially explained by ipsilateral lemniscal connections.

Fischer, Ryan, and Dobyns (1992) investigated interhemispheric transfer and cognitive function in patients with agenesis of the corpus callosum of normal intelligence. Results of visual interhemispheric transfer tasks suggested deficits in information transfer to the left hemisphere.
A consistent impairment was discovered in the recall of complex visual information (Temple & Ilsley, 1994). Temple and Ilsley suggest that the deficit in visual memory may be related to poor recall of information which was not well-organized during encoding.

**Spatial**

Spatial perception disturbances were reported by Meerwaldt (1983) for an eight-year-old subject with agenesis of the corpus callosum. Based upon performance on the rod orientation test, the subject demonstrated impairment in interhemispheric transfer of tactile information. Results indicated almost complete dominance of the right hemisphere for spatial perception.

Given various tasks of spatial cognition, all of the acallosal subjects in a study reported by Temple and Ilsley (1994) demonstrated deficits in visuo-constructional tasks that required coordination and complex execution of motor movements. Acallosal subjects demonstrated difficulty in copying tasks, evidencing disorganization.

**Tactile**

A substantial lag in transfer of tactile information between the cerebral hemispheres was reported by Geffen, Nilsson, Simpson, and Jeeves (1994). Cross-sectional and longitudinal results indicated deficits in ipsi- and cross-localization of finger sequences. Results of tactile interhemispheric transfer tasks investigated by Fischer et al. (1992) suggested deficits in access to the right hemisphere.

Koeda and Takeshita (1993) reported unilateral tactile naming disorder in the left (non dominant) hand in two girls with agenesis of the corpus callosum. Both girls had daily epileptic seizures and mild or moderate mental retardation. The results
suggested a classical disconnection deficit, due to the lack of brain capacity and neural plasticity.

**Auditory**

Fischer et al. (1992) conducted a study of dichotic listening in two acallosal subjects. Results of the dichotic listening tests revealed a slight left ear (right hemisphere) advantage in both acallosal subjects.

**Compared to Sensory Modalities in Multiple Sclerosis**

Pelletier, Habib, Lyon-Caen, Salamon, Poncet, and Khalil (1993) investigated interhemispheric transfer of auditory, sensory, and motor information as it relates to callosal involvement in multiple sclerosis. Although the child in the present study does not have multiple sclerosis, the work of Pelletier et al. (1993) provides information about the corpus callosum's role in integration of information. The results of their study may provide useful information for other individuals who demonstrate deficits in interhemispheric transfer and integration of information because of abnormalities of the corpus callosum. Results of a verbal dichotic listening task, a crossed tactile finger localization task, and an alternate finger tapping task indicated that interhemispheric integration of information was impaired in proportion to degree of atrophy of the corpus callosum and diffusion of white-matter lesions. These researchers discovered performance on each task was associated to atrophy of distinct parts of the corpus callosum. This information regarding function of the corpus callosum indicates that an individual with complete agenesis of the corpus callosum, such as the child in the current study, may similarly show impairment in integration of auditory, sensory, and motor information.
**Language Performance**

**Lateralization**

Saul and Sperry (1968) reported that speech developed in both hemispheres in a case of agenesis of the corpus callosum, as determined by intracarotid Amytal injection. However, using a dichotic listening task, Lassonde, Bryden, and Demers (1990) reported language function to be more strongly lateralized in subjects with agenesis of the corpus callosum than in IQ-matched controls. Their results indicated that agenesis of the corpus callosum does not lead to bilateral representation of linguistic functions. Chiarello (1980) reviewed language-mediated tests in individuals with callosal agenesis and found a relative lack of split-brain symptoms on tasks involving language.

**Syntax-Pragmatics-Semantics**

McCardle & Wilson (1993) identified specific language impairments in syntactic and pragmatic-semantic areas in children with FG syndrome (named for the first letter of the last name of the children for whom the syndrome was first described) and suggested that this information may be the basis for expectations for children with this syndrome and also may be generalized to provide expectations for other individuals with isolated agenesis of the corpus callosum. Sanders (1989) reported deficits in syntactic comprehension, as related to assigning correct semantic roles to some sentence forms, in a six-year-old subject with agenesis of the corpus callosum.

Dennis (1981) described specific deficits in the syntactic-pragmatic component of language in a case study of a patient with agenesis of the corpus callosum with normal intelligence. However, results of a study of language function in adults with callosal agenesis by Jeeves and Temple (1987) did not support the notion that the corpus callosum is necessary for normal development of specific language functions.
One of their subjects demonstrated widespread language deficits not restricted to the syntactic-pragmatic component (also poor word retrieval from semantic cues, sentence construction, and comprehension of active affirmative sentences), while the other subject demonstrated a specific deficit which does not encompass the syntactic-pragmatic component (retrieval of words from rhyme clues).

**Phonology**

Temple, Jeeves, and Vilarroya (1989) investigated the interhemispheric transfer of information and development of integrated cognitive functions in two children with normal intelligence and agenesis of the corpus callosum. A clear deficit in rhyming performance was established for these children with fluent speech, as demonstrated through impaired performance in rhyme detection, rhyme judgment, rhyme fluency, rhyme recognition, and semantic recognition tasks. The deficits in retrieval of words from rhyme clues suggest a deficit in phonological processing. Temple, Jeeves, and Vilarroya (1990) investigated the reading abilities of these same subjects and reported an appropriate overall word reading level but identified a significant impairment in the ability to read nonwords aloud. The acallosal children could read irregular words but had difficulty reading non-words. Results indicated that deficits in explicit phonological processing also lead to deficits in the development of the phonological reading approach. This, however, is not sufficient to cause a severe impairment in word reading.

Temple and Ilsley (1994) also reported significant deficits in performance on rhyming tasks requiring decomposition, analysis, and synthesis of speech-related material in two cases of complete agenesis of the corpus callosum with normal intelligence, clear articulation of speech, and normal gross language skills. Temple and Ilsley (1993) investigated the impact of this deficit in phonological processing on the
discrimination of speech sounds. Impairment in phonemic discrimination was reported on tasks of simple phonemic discrimination, auditory discrimination of paired words, auditory discrimination of words and non-words, and repetition of words and non-words. The performance of the acallosal children suggested a possible impairment in the initial registration or analysis of auditory material. Temple and Ilsley concluded that a more profound impact upon language development may occur in children that have more severe impairments in auditory discrimination.

Functional Compensation

In a comprehensive view of various split-brain phenomena in acallosal subjects, Jeeves (1994) concluded that bilateral representation of function does not likely occur in agenesis of the corpus callosum.

Lassonde, Sauerman, Chicoine, and Geoffroy (1991) investigated the callosal plasticity using intra- and intermanual tasks with acallosal and callosotomized subjects. They speculated that the plasticity in acallosal and young callosotomized subjects is related to a period of neural development. Lassonde et. al. (1991) suggested that development of ipsilateral or subcortico-cortical connections may occur in the absence of transcallosal projections although they may not be present under normal conditions. They further hypothesized that this cerebral plasticity (i.e. reinforcement of existing ipsilateral or subcortical connections of the somatosensory system) enables individuals with agenesis of the corpus callosum to achieve tactile cross-integration. Innocenti (1981) reported growth of cortical connections before synaptic stabilization occurs in later development. If an individual is born without a corpus callosum, opportunities for new connections may exist.

In a study conducted by Sauerwein and Lassonde (1983), two subjects with agenesis of the corpus callosum processed verbal and non-verbal visual stimuli
similarly to normal-IQ and IQ-matched controls in intrahemispheric tasks, although with slower responses. These subjects also demonstrated interhemispheric transfer of information but with more errors and slower response times than the control groups. Sauerwein and Lassonde suggested that residual secondary commissures or cerebral reorganization compensate for interhemispheric transfer of information in individuals with agenesis of the corpus callosum.

A subject in a study of interhemispheric transfer of visual, tactile and auditory information showed an enlarged anterior commissure (Fischer et al., 1992). These results provide support that an enlarged anterior commissure is a key component of functional compensation for individuals with total agenesis of the corpus callosum. Karnath, Schumacher, and Wallesch (1991) also supported the capacity of extracallosal commissures such as the anterior commissure for the transfer of visual information but reported limitations.

Music in Speech and Language Therapy

Music has been used therapeutically in a variety of ways over the years with individuals with speech and language disorders. Speaking and singing are activities which share melody, rhythm, and tempo (Miller, 1982). Cohen (1988) used a superimposed rhythm to decrease the speaking rate of an adolescent with a right hemisphere injury. Cohen (1992) also found that singing instruction using a group approach with patients with aphasia, apraxia, and dysarthria increased intelligibility, speaking fundamental frequency variability, speech rate, and verbal output.

Relaxation exercises, development of body image, breathing and vocalization exercises, articulation activities, word and phrase rhythms, and vocabulary and concept development are applications of music in speech-language therapy as suggested by Zoller (1991). In addition, Zoller cited development of vocabulary and concepts such
as categories, verbal opposites and prepositions, and verbs and sequential actions through movement songs.

Several studies have concluded that music facilitates vocabulary development and improves expressive language abilities. In a study of learning and transfer of new vocabulary in first grade students, Madsen (1991) found that the number of new vocabulary words learned was greater for a group of students who received instruction with a combination of music and gestures than for those students instructed with gestures only or the control group. Music served as an additional clue to be processed, a motivator, and a reinforcer. The music-gesture group also transferred a greater number of words into a different context. Madsen concluded that music enhanced new word learning and transference of these words to new contexts.

Hoskins (1988) studied the effect of antiphonal singing with picture cards on the verbal response of preschool children who are developmentally delayed and mentally retarded with language delays. This use of music in language therapy led to an improvement on expressive vocabulary tests.

Melodic Intonation Therapy (MIT) is a therapeutic technique that is based on the premise of mediation of music in the right cerebral hemisphere. MIT has been used successfully to facilitate and stimulate propositional speech in patients with severely nonfluent aphasia (Albert, Sparks, & Helm, 1973; Sparks, Helm, & Albert, 1974; Helm-Estabrooks & Albert, 1991).

Krauss and Galloway (1982) studied the effect of Melodic Intonation Therapy (MIT) on two children with developmental verbal apraxia and expressive language delay. Using a modified MIT protocol which included visual materials to cue the children and longer presentation of the intonation pattern, they discovered a shift from short phrases to longer phrases and sentences and marked improvement of articulation skills by both subjects on all verbal tasks. Overall results indicated significant gains in
verbal naming, phrase length response, verbal imitation tasks, and articulation skills. Krauss and Galloway commented on the resiliency and plasticity of children's brains and hypothesized that MIT may utilize intact portions of the brain to facilitate speech and language development when receptive language exceeds verbal output.

Intersystemic Reorganization

Rosenbek, LaPointe, and Wertz (1989) described intersystemic reorganization as a means of improving verbal output in individuals with aphasia or apraxia by systematically using unique sensory inputs in therapy. In the approach recommended by Rosenbek et al., speech is paired with gestural, auditory, and visual input to represent the meaning of language in more than one way. Intact modalities are stimulated to improve weak modalities. An aspect of the gestural reorganization program described by Rosenbek et al. includes auditory, visual, and tactile cues to the utterance by the clinician. The concept of intersystemic organization as a means of facilitating speech output may also be applied to other individuals with brain dysfunctions or abnormalities. Pairing auditory, gestural, and visual representations of spoken communication in therapy for individuals with agenesis of the corpus callosum may similarly stimulate different areas of the brain where the concepts are represented. This may be applied to the child in the current study. Starting with and building on the child's functional system, namely gestural communication, may facilitate improvement in less functional systems, such as verbal output.

Augmentative Communication

Augmentative communication is a consideration for any individual with severe expressive language delays or disorders. Expressive language delays accompanied agenesis of the corpus callosum in the child from the current study. Therefore,
applications of augmentative communication strategies for various disorder types were explored.

After reviewing 58 research studies with individuals with a variety of communication disorders (aphasia, apraxia, autism, dysarthria, glossectomy, laryngectomy, and mental retardation), Silverman (1989) concluded that augmentative communication can significantly improve the ability to communicate in almost any severely communicatively impaired child or adult. Reichle and Karlan (1988) and Romski, Lloyd, and Sevcik (1988) suggested that augmentative communication systems facilitate language comprehension. Fristoe and Lloyd (1979) reported that signing facilitates production of vocal/verbal responses.

Based upon a review of 26 studies with populations of individuals with aphasia, apraxia, autism, dysarthria, and mental retardation, Silverman (1989) further reported that using augmentative communication strategies appears to facilitate speech. Results indicated increased verbal output in children and adults without a decrease in motivation for speech communication.

Among other findings reported by Silverman (1989), in a review of 17 studies with subjects who had diagnoses of apraxia, autism, dysarthria, and mental retardation, noncommunication impacts of augmentative communication included increased participation, attention span, self-confidence, and independence.

Use of an augmentative communication system does not mean that only one mode of communication is the best system for all situations. Individuals with severe communication disorders benefit from a variety of approaches. Musselwhite and St. Louis (1988) discussed a multi-modality approach which placed communication on a continuum with augmented communication at one end and vocal communication at the other end. Reichle and Karlan (1988) reported a multi-modality approach to augmentative communication in which children received concurrent training in two
different modes and continued to receive intervention for speech. A multimodal communication system which included natural speech, gestures, manual signs, and voice output communication aids was also reported for a child with developmental apraxia of speech (Culp, 1989). A multi-modality approach which includes augmentative communication may also be appropriate for an individual with agenesis of the corpus callosum and severe expressive language delays, such as the child in the current study, who effectively communicates nonverbally in some situations but ineffectively in others.

Statement of the Problem

A wide variety of studies indicate that the use of music in speech-language therapy and the use of augmentative communication systems for individuals with various communication disorders can lead to increased verbal output. However, there is a lack of reported studies describing therapeutic intervention for persons with agenesis of the corpus callosum and severe communication disorders.

Research has indicated that cerebral lateralization of music occurs in the right hemisphere and lateralization of language occurs in the left hemisphere. Songs combine right hemisphere activity (music) and left hemisphere activity (language). If the two elements of songs, music and language, were applied in a therapeutic intervention program, both cerebral hemispheres would be stimulated. For individuals with agenesis of the corpus callosum this treatment approach may stimulate interhemispheric transfer of information through means other than the corpus callosum due to cerebral plasticity and functional compensation that has been reported in the literature.

The reported success of intersystemic intervention for individuals with aphasia and apraxia also lends support to the notion of using multiple modalities to stimulate
representation of meaning in various areas of the brain and to facilitate verbal output. A treatment approach that combines music, language, and motoric participation may provide multiple means of stimulating distinct areas of the brain that may facilitate speech production.

Experimental Questions

Based upon the studies of cerebral lateralization of music and language, reported success of the use of music, augmentative communication, and intersystemic therapy for individuals with communication disorders, and the lack of reported studies of speech-language intervention for persons with agenesis of the corpus callosum, the following research questions were posed:

1. Will the number of syllables produced by a child with agenesis of the corpus callosum and expressive language delay increase with the introduction of a treatment program that encourages interaction in songs?

2. Will the number of syllables produced by the child further increase with the addition of a voice output communication device to the treatment program?
CHAPTER III

METHODS

Subject

The subject was a five-year-old male who was diagnosed with complete agenesis of the corpus callosum following magnetic resonance imaging (MRI) at two years of age. The child's parents sought neurological consult when concerned with his delayed development (e.g., walked at 18 1/2 months; said single words at 18 months). The child did not present signs of seizure. His brother did not experience similar developmental delays, and testing did not establish a genetic link. Vision was reported to be within normal limits at 2 years, 10 months of age. Hearing was reported to be within normal limits at 3 years, 2 months of age. The child demonstrated right hand dominance.

A multidisciplinary developmental evaluation at three years, two months of age suggested mild to moderate delays in cognition, severe delays in receptive and expressive language, severe delays in oral motor sequencing skills, moderate delays in fine motor skills, mild delays in some gross motor skills and some age-appropriate gross motor skills, and age-appropriate social skills.

Additional speech-language evaluation at three years, eight months of age revealed severely delayed receptive and expressive language with a discrepancy between his receptive and expressive language skills. In addition to this, an inability to imitate vocalizations in the presence of normal vegetative functioning suggested developmental verbal apraxia.
The child received approximately four months of individual speech-language therapy (50 minute sessions, two times per week) at the Charles Van Riper Language, Speech, and Hearing Clinic (CVRLSHC) at Western Michigan University. He then attended the Preschool Language Intervention Program at the CVRLSHC for ten months. Within the preschool program, he participated in whole group language activities (90 minutes) as well as individual language therapy (30 minutes) two times each week. The child rejected attempts at signing in previous semesters of therapy when working with a clinician other than this researcher. Music was occasionally incorporated into group therapy in the preschool program. The subject appeared to enjoy listening to records and playing rhythm instruments. Intervention preceding this study did not focus upon music or augmentative communication. The experimenter, a graduate student in speech-language pathology, was the child's clinician for approximately six months within the context of the Preschool Language Intervention Program as well as the summer semester used for this research.

Differential facial expressions, elaborate gestures, and varied inflectional patterns were key components of the child's communication system. He primarily used facial, hand, and whole body gestures to signify communicative intent; however, he also produced vocalizations/verbalizations. His communication functions included greeting ("hi"), seeking attention ("me"), commenting ("in there"), requesting objects ("juice") and actions ("more"), responding ("yeah"), and rejecting ("uh uh"). The child produced a few intelligible words (e.g., mom, dad, me, juice, hot). Appropriate prosody was evident in the client's unintelligible vocalizations. He relied primarily upon nonverbal communication to transmit messages. The child demonstrated relatively good comprehension of functional language; he responded appropriately to clinician's questions and comments in conversation. The child had a well-developed sense of humor. He understood more than situational humor. He also responded to
verbal humor (joking or teasing by clinicians) with sustained eye contact, loud laughter, and other exaggerated nonverbal signs of understanding (e.g., full-arm pointing).

Formal testing of language comprehension was attempted when the child was four years, three months of age. Testing was difficult to complete due to the child's noncompliance and suspected difficulty tracking the picture selections. At that time, formal test results indicated performance of at least two years, six months of age on the Peabody Picture Vocabulary Test--Revised (Dunn & Dunn, 1981) and at least two years, ten months to three years of age on the Test for Auditory Comprehension of Language--Revised (Carrow-Woolfolk, 1985). Due to the child's age-appropriate initiations and responses in conversation, the clinician was not convinced that the test results accurately reflected the child's true comprehension level.

Five days before the current study was started (July 13, 1994), the child participated in an individual therapy session with the experimenter that did not include musical activities or a voice output communication device. The session was play-based, and the child selected toys for play from the same set which were used in the current study. Total number of syllables produced by the child during five-minute segments of this session were tallied from the videotape of therapy to illustrate the child's level of functioning at the time the study took place. The child produced 21 syllables while playing with dishes in the first five minutes of therapy. He produced 48 syllables while playing with dolls in a five-minute segment in the middle of the session and 56 syllables while playing with dolls and blocks during the last five minutes of the therapy session. The number of syllables produced by the child in this individual therapy session was judged by the experimenter to be somewhat greater than that which was typically produced by the child in group activities in the preschool or in clinician-directed individual therapy.
Environment

Environmental consistency was an important consideration. All treatment sessions took place in an individual therapy room in the preschool of the CVRLSHC. Fourteen of the fifteen sessions were conducted within the same room; one session took place in an adjacent room. A predetermined set of toys was available during the pre-session and post-session probes of each session. The child was free to select which toy he wanted and to change activities at any time during the pre-session and post-session probes. The toys included a McDonald's "drive-thru" (plastic replica that opened up to simulate a window that separated the customer from worker; a grill, cash register, and various food items were also components of the "drive-thru"); a set of dishes, pots, and pans; baby dolls with a stroller, blanket, and bottles; assorted shaped wooden blocks; and the Fisher Price farm set. These toys were typically chosen by the child and elicited the most consistent verbalizations during free play in the preschool program.

Treatment Stimuli

Twelve preschool songs were chosen as the vehicles for language therapy. Physical and verbal participation in the songs were used to facilitate turn-taking, vocabulary development, and speech production. Zoller (1991) suggested guidelines for selecting songs to use in speech-language therapy. The following factors from this list were considered in choosing the songs for the present study. The songs had a small and fairly low pitch range, were concrete and encouraged movement, had a high degree of repetition of words and melody, and used common names and the syntax of everyday language. A variety of songs was presented to maintain the child's attention and interest. With the exception of Sammy (Palmer, 1972), all of the songs were
traditional songs of unknown origin that are commonly printed in preschool activity and song books. They included *The Itsy Bitsy Spider*, *Are You Sleeping?*, *Happy Birthday*, *Row Row Row Your Boat*, *Rock-A-Bye Baby*, *Old MacDonald*, *Monkeys Jumping on the Bed*, *If You're Happy and You Know It*, *Twinkle Twinkle Little Star*, *Wheels on the Bus*, and *Five in Bed*. To assure equitable presentation of the twelve songs, four different songs were focused upon in each of three days per treatment phase (see Table 1). The schedule of songs was kept consistent for later comparison of treatment days that used the same songs. Participation was encouraged through various props and actions (see Table 2). Decisions about which songs would be presented on which day in each phase were based on the amount of time required to sing each song, as well as whether props or actions accompanied the singing. For example, *Row Row Row Your Boat*, which is approximately 30 seconds in duration, was presented on the same day as *Old MacDonald*, which is approximately 90 seconds in duration. The song lists were formulated so that four songs could be sung within the five-minute pre-session and post-session probes. In each session two songs used props and two songs incorporated actions. Words to the songs are printed in Appendix E.

Table 1

<table>
<thead>
<tr>
<th>Day One</th>
<th>Day Two</th>
<th>Day Three</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Itsy Bitsy Spider</em></td>
<td><em>Row Row Row Your Boat</em></td>
<td><em>If You're Happy and You Know It</em></td>
</tr>
<tr>
<td><em>Sammy</em></td>
<td><em>Rock-A-Bye Baby</em></td>
<td><em>Twinkle Twinkle Little Star</em></td>
</tr>
<tr>
<td><em>Are You Sleeping</em></td>
<td><em>Old MacDonald</em></td>
<td><em>Wheels on the Bus</em></td>
</tr>
<tr>
<td><em>Happy Birthday</em></td>
<td><em>Monkeys Jumping on the Bed</em></td>
<td><em>Five in Bed</em></td>
</tr>
</tbody>
</table>
Table 2
Actions or Props Used for Each Song

<table>
<thead>
<tr>
<th>Song</th>
<th>Activity</th>
<th>Actions or Props Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Itsy Bitsy Spider</td>
<td>actions</td>
<td>finger and arm movements</td>
</tr>
<tr>
<td>Sammy</td>
<td>actions</td>
<td>walk/fly/swim/hop/crawl</td>
</tr>
<tr>
<td>Are You Sleeping?</td>
<td>props</td>
<td>bells</td>
</tr>
<tr>
<td>Happy Birthday</td>
<td>props</td>
<td>party hats, present, cupcake</td>
</tr>
<tr>
<td>Row Row Row Your Boat</td>
<td>actions</td>
<td>rowing</td>
</tr>
<tr>
<td>Rock-A-Bye Baby</td>
<td>actions</td>
<td>rocking with arms</td>
</tr>
<tr>
<td>Old MacDonald</td>
<td>props</td>
<td>cow, pig, horse, sheep, barn</td>
</tr>
<tr>
<td>Monkeys Jumping on the Bed</td>
<td>props</td>
<td>monkeys on a &quot;bed&quot;</td>
</tr>
<tr>
<td>If You're Happy and You Know It</td>
<td>actions</td>
<td>clap, stomp, shout</td>
</tr>
<tr>
<td>Twinkle Twinkle Little Star</td>
<td>actions</td>
<td>finger movements</td>
</tr>
<tr>
<td>Wheels on the Bus</td>
<td>props</td>
<td>bus (with wheels, windows, door)</td>
</tr>
<tr>
<td>Five in Bed</td>
<td>props</td>
<td>cardboard people on dowel</td>
</tr>
</tbody>
</table>

Design

An interaction design (McReynold & Kearns, 1983) was chosen to measure the effect of participation in interactive songs, both with and without a voice output communication device, on syllable production in the child. Kearns (1986) classified this as an additive interaction design because the goal of the study was to compare the entire treatment package (prompted participation in interactive songs) (represented by B treatment phases) to the package plus one additional component, the use of a voice output communication device (represented by BC treatment phases). The purpose of
this interaction design was not simply to compare two treatments but rather to evaluate
the contributions and the interactive effects of both components. In this design, one
must look for a recognizable increase in syllable production during the BC phases that
is greater than the increases in syllable production from the B phases to show that the
additional component (C) made a significant difference in the treatment program.

The independent variables were the treatment package, including the songs and
prompting hierarchy, and the voice output communication device. The dependent
variable was the total number of syllables produced by the child in the pre-session and
post-session probes. A syllable was defined in this study as a vowel nucleus that
began and ended with zero to three consonants (Boothroyd, 1986). Boothroyd (1986)
provided the following examples, where V is a vowel and C is a consonant, to illustrate
this definition: eye (V), tie (CV), eyed (VC), hide (CVC), and stripes (CCCVCC).
Similar examples of the subject's syllables are as follows: uh (V), yeah (CV), and nere
(CVC). Variations in duration of the vowel nuclei did not affect the number of
syllables counted.

The study followed an A-B-BC-B-BC format, with three sessions per phase. The first three sessions were used to establish baseline (A). The remaining phases alternated between a treatment package of prompting participation in songs (B) and the treatment package plus use of a voice output communication device (BC). More data points per phase were desirable, but scheduling conflicts precluded more than three sessions per phase. Three data points were sufficient to demonstrate a trend. The subject participated in a total of 15 therapy sessions.

Each session was approximately thirty minutes long and followed an A-B-A format. The first five minutes of each session was used for the pre-session probe of syllable production to demonstrate the effect of treatment on syllable production over
time, followed by 20 minutes of treatment and a five-minute post-session probe to demonstrate the immediate effects of the treatment session on syllable production.

**Procedures**

The experimenter and child engaged in free play from the various toys available for the first five minutes of each session. During this time, the experimenter sang the four songs to be used in that session without engaging the child in participation. She interjected comments, questions, or responses where appropriate to make the play as natural as possible. The voice output communication device was not available during this probe.

During the twenty minutes of treatment in each session, the experimenter prompted the child to participate physically (by acting out or manipulating props) and verbally in the selected songs. A prompting hierarchy based on a modified Mand-Model approach described by Rogers-Warren and Warren (1980) and recommended by Fey (1986) was utilized. While interacting with the props or performing the actions, the experimenter modeled the appropriate response/song twice with a time delay between presentations. At this point the child was not prompted to respond. If he responded, he was verbally reinforced and confirmed by additional modeling. If no response was given by the child, he was asked to participate or told it was now his turn. The experimenter asked the child to first simulate the action by performing the movements or manipulating the props. If he responded, he was verbally reinforced and confirmed by additional modeling. Physical assists with actions were provided when there was no response. The child was then asked to tell the action or sing the song. Again the child was verbally reinforced and confirmed by modeling if he responded. If no response was given, the experimenter modeled the stimulus again and requested imitation. Table 3 demonstrates the decision-making in the treatment hierarchy.
Table 3
Treatment Steps and Decision-Making Based on Child Responses

<table>
<thead>
<tr>
<th>TREATMENT STEPS</th>
<th>CHILD RESPONSE</th>
<th>CONSEQUENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Model Target &amp; Pause</td>
<td>Attempts participation</td>
<td>verbal praise</td>
</tr>
<tr>
<td>B: sing</td>
<td></td>
<td>go to 2</td>
</tr>
<tr>
<td>BC: sing &amp; activate IntroTalker</td>
<td>No response</td>
<td>go to 2</td>
</tr>
<tr>
<td>2. Model Target</td>
<td>Attempts participation</td>
<td>verbal praise</td>
</tr>
<tr>
<td>B: sing</td>
<td></td>
<td>go to 3 or 4</td>
</tr>
<tr>
<td>BC: sing &amp; activate IntroTalker</td>
<td>No response</td>
<td>go to 3</td>
</tr>
<tr>
<td>3. Ask for Physical Participation</td>
<td>Performs action or manipulates prop</td>
<td>verbal praise</td>
</tr>
<tr>
<td>&quot;It's your turn. Show me ___.&quot;</td>
<td></td>
<td>go to 4</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>provide physical assistance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>go to 4</td>
</tr>
<tr>
<td>4. Ask for Verbal Participation</td>
<td>Attempts to speak or sing the target</td>
<td>verbal praise</td>
</tr>
<tr>
<td>&quot;It's your turn. Tell me ___.&quot;</td>
<td></td>
<td>go to 1 with a new target</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>go to 5</td>
</tr>
<tr>
<td>5. Model Target &amp; Request Imitation</td>
<td>Imitates target</td>
<td>verbal praise</td>
</tr>
<tr>
<td>&quot;Say ___.&quot;</td>
<td></td>
<td>go to 1 with new target</td>
</tr>
<tr>
<td></td>
<td>No response</td>
<td>go to 1 with new target</td>
</tr>
</tbody>
</table>

The IntroTalker, a dedicated voice output communication device, was used in 6 treatment sessions (the BC phases) as an additional avenue for the child to take a turn in the songs. Previous studies reviewed by Silverman (1989) have shown augmentative communication to increase speech production in individuals with a variety of severe expressive communication disorders. The use of picture symbols and a voice output
device was incorporated to provide the child with another avenue to take turns in the songs, as well as to facilitate speech production. An array of eight picture locations (2 inches by 2 inches) was used in each of these sessions. Picture Communication Symbols (PCS) (Johnson, 1981) were selected to correspond with objects or actions in the songs rather than other graphic symbols because they have been reported to be easy to recognize and learn. They visually resemble their referents. Mirenda and Locke (1989) reported PCS to be more transparent (guessable) than Blissymbols for nonhandicapped preschoolers and for school-age children and adults with intellectual disabilities. Bloomberg, Karlan, and Lloyd (1990) also found that PCS were more translucent (learnable) than Blissymbols, Pictogram Ideogram Communication symbols (PIC), and Picsyms for nouns, verbs, and modifiers. The PCS were produced with Boardmaker, a Macintosh software program (Mayer-Johnson Co., 1989). Repetitive phrases from the songs were digitally recorded by the clinician. A list of the PCS and corresponding digitally recorded messages are listed in Appendix A.

The experimenter followed the same treatment hierarchy during the phases with the IntroTalker (BC) as was used during the phases without it (B). In addition, the experimenter modeled appropriate responses with the device and prompted the child to activate the device for his turn in the song. During the models, the experimenter activated the device while singing the same part of the song. The child typically accessed the picture locations directly with his right index finger.

The experimenter and child engaged in free play during the last five minutes of each session. The child selected a toy for play from the various toys available. During this time, the experimenter sang the four songs that were presented in that session without prompting the child to participate.

A Panasonic videocamera was used to videotape the 15 treatment sessions in their entirety. Time and date stamping were utilized to ensure equal time for analysis.
The experimenter transcribed five minutes of pre-session and post-session syllable production for each session.

Data Transcription

The experimenter transcribed the child's and experimenter's utterances during the five minutes preceding and following treatment in each session exactly as produced. The child's utterances were often unintelligible words or strings of syllables such as "ee ee ee" or "uh uh." Due to limitations in transcription with phonetic symbols on the computer keyboard, these vocalizations/verbalizations were typed as if they were spelled how they sounded. The experimenter replayed all segments of videotape as many times as were necessary to include all syllables of vocalization/verbalization, frequently comparing segments of the typed transcript online with the videotape.

Data Analysis

Total number of syllables produced by the child were calculated from the transcripts of the videotapes. As mentioned previously, a syllable was defined as a vowel nucleus that began and ended with zero to three consonants (Boothroyd, 1986). For example, "ee ee ee" was counted as three syllables, and "na in nere" was counted as three syllables. Variations in duration of the vowel nuclei did not affect the number of syllables counted.

Intrarater Reliability

Approximately one month after the videotaped sessions were transcribed and the total number of syllables were calculated for each pre-session and post-session probe, the experimenter randomly selected one-minute samples from the pre-session and post-session probes in each session (total of 30 minutes, or 20% of samples). She
reviewed the one-minute videotaped samples and tallied the child's syllable production on blank data sheets. The total number of tallies were divided by the total number of syllables previously calculated from the transcripts of the samples. Intrarater reliability was 98.62%.

Interrater Reliability

Two second year graduate students in speech-language pathology also served as raters (J.B. and A.M.). They attended a 15-minute training session conducted by the experimenter which oriented them to the child, instructed them to the task of counting syllables, and provided examples. Specific instructions to the raters are listed in Appendix B. The raters viewed random one-minute videotaped samples from pre­session and post-session probes in each session (30 minutes, 20% of the total baseline conditions). The raters tallied the child's syllable production on blank data sheets. The raters' total syllable counts were divided by the total number of syllables from the transcripts of the samples. Interrater reliability was 87.87% (J.B.) and 98.62% (A.M.), with a mean interrater reliability of 93.25% (individual raters' percentages added together and divided by two). The raters' total syllable counts were also compared to the total syllable counts based on the intrarater tallies. The experimenter's total number of tallies was divided by each rater's total number of tallies. Interrater reliability between the experimenter and the two additional raters was 89.10% (J.B.) and 100% (A.M.), with a mean of 94.55%. A graphic representation of the syllable counts made by each rater for each session demonstrates consistency across raters for each session (see Figure 1).
Legend. Transcript = Syllable count based upon written transcripts.

K.B. = Syllable count based upon intrarater's tallies.

J.B. = Syllable count based upon interrater's tallies.

A.M. = Syllable count based upon interrater's tallies.

Figure 1. Total Number of Syllables Counted by Raters During Random One-Minute Samples of Pre-Session Plus Post-Session Probes.
CHAPTER IV

RESULTS

Phase A

The first three sessions were conducted within the same week and established the baseline condition. The total number of syllables produced by the child during the pre-session probe (first five minutes) for sessions one, two, and three were 59, 32, and 36, respectively. The total number of syllables produced by the child in the post-session probes (last five minutes) were 48, 50, and 29, respectively (see Figure 2). The mean number of syllables for the pre-session probes was 42.3 with a standard deviation of 11.9. The mean number of syllables for the post-session probes was 42.3 with a standard deviation 9.5. The experimenter judged this to be typical of the child's past clinical performance.

![Figure 2. Total Number of Syllables Produced During Pre-Session and Post-Session Probes in Phase A.](image)

Legend. Pre = pre-session probe, Post = post-session probe
Phase B1

Due to scheduling conflicts, phase B1 did not begin until eight days following session three (end of baseline). In phase B1 the child was prompted to participate physically and verbally in the songs, but the IntroTalker was not utilized. The total number of syllables produced by the child in the pre-session probes of sessions four, five, and six were 54, 51, and 18, respectively. The mean number of syllables produced in the pre-session probes was 41 with a standard deviation of 16.3. The number of syllables produced in the post-session probes of each session were 57, 144, and 29, respectively, with a mean of 76.7 and standard deviation of 49 (see Figure 3).

![Graph](image)

**Legend.** Pre = pre-session probe, Post = post-session probe

Figure 3. Total Number of Syllables Produced During Pre-Session and Post-Session Probes in Phase B1.

Phase BC1

In addition to the treatment package of prompted participation in songs presented in phase B1, prompted use of a voice output communication device (the IntroTalker) was added to the treatment package in phase BC1. The child produced 52, 73, and 61 syllables in the pre-session probes of sessions seven, eight, and nine,
respectively. The mean number of syllables produced in the pre-session probes was 62 with a standard deviation of 8.6. The number of syllables produced in the post-session probes of each session were 64, 80, and 90, respectively, with a mean of 78 and standard deviation of 10.7 (see Figure 4).

Legend. Pre = pre-session probe, Post = post-session probe

Figure 4. Total Number of Syllables Produced During Pre-Session and Post-Session Probes in Phase BC1.

Phase B2

Phase B2 was designed to monitor the effectiveness of the treatment package of prompted participation in interactive songs without the augmentative communication device. The total number of syllables produced by the child in the pre-session probes of sessions ten, eleven, and twelve were 105, 66, and 113, respectively. The mean number of syllables produced by the child in the pre-session probes was 94.7 with a standard deviation of 20.5. The number of syllables produced in the post-session probes of each session were 133, 139, and 82, respectively. The mean number of syllables produced by the child in the post-session probes was 118 with a standard deviation of 25.6 (see Figure 5).
Phase BC2

The IntroTalker was added to the treatment package in phase BC2. The total number of syllables produced in the pre-session probes of sessions 13, 14, and 15 were 81, 70, and 103, respectively, with a mean of 84.7 and standard deviation of 13.7. The number of syllables produced in the post-session probes were 135, 128, and 118, respectively, with a mean of 127 and standard deviation of 7 (see Figure 6).

Legend. Pre = pre-session probe, Post = post-session probe

Figure 5. Total Number of Syllables Produced During Pre-Session and Post-Session Probes in Phase B2.

Figure 6. Total Number of Syllables Produced During Pre-Session and Post-Session Probes in Phase BC2.
Overall Findings

Overall findings for the 15 sessions indicate increases in syllable production, despite variability from session to session within treatment phases (see Table 4 and Figure 7). The mean syllable counts further indicate an increase from baseline to each treatment phase, as well as across treatment phases (see Table 5 and Figure 8). This trend exists in pre-session and post-session means, with the exception of the pre-session mean in phase BC2. These results indicate increased syllable production immediately following treatment, as indicated by results of post-session probes, as well as increased syllable production over time, as indicated by increased syllable production in pre-session probes.

In addition to calculating the total number of syllables produced during the pre-session and post-session probes, the difference between the post-session and pre-session probes was also calculated for each session (total number of syllables in post-session probe minus total number of syllables in pre-session probe). This calculation was made because the differences in increases of syllable production appeared to be getting greater over time. Figure 9 demonstrates variable increases in the difference between the two measures over the course of treatment. This trend is further defined using differences of the means (see Figure 10). This increase suggests that the child produced more syllables when provided with adult mediation (i.e., models, prompts, assistance) than he produced on his own. This may have been possible because the clinician focused the child on concepts and interactional strategies within a child-based intervention program and provided support so that he would be more successful with the support than he would be on his own. This approach has been referred to as a mediated experience by Nelson (1993) and is based on Vygotsky's (1978) concept of "zone of proximal development."
<table>
<thead>
<tr>
<th>Session Number</th>
<th>Phase</th>
<th>Pre-Session</th>
<th>Post-Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>59</td>
<td>48</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>32</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>36</td>
<td>29</td>
</tr>
<tr>
<td>4</td>
<td>B1</td>
<td>54</td>
<td>57</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>51</td>
<td>144</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>18</td>
<td>29</td>
</tr>
<tr>
<td>7</td>
<td>BC1</td>
<td>52</td>
<td>64</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>73</td>
<td>80</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>61</td>
<td>90</td>
</tr>
<tr>
<td>10</td>
<td>B2</td>
<td>105</td>
<td>133</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>66</td>
<td>139</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>113</td>
<td>82</td>
</tr>
<tr>
<td>13</td>
<td>BC2</td>
<td>81</td>
<td>135</td>
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<td>14</td>
<td></td>
<td>70</td>
<td>128</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>103</td>
<td>118</td>
</tr>
</tbody>
</table>
Legend. Pre = pre-session probe, Post = post-session probe

Figure 7. Total Number of Syllables Produced During Pre-Session and Post-Session Probes in All Sessions.

Table 5

<table>
<thead>
<tr>
<th>Phase</th>
<th>Pre-Treatment</th>
<th>Post-Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>A</td>
<td>42.3</td>
<td>11.9</td>
</tr>
<tr>
<td>B1</td>
<td>41</td>
<td>16.3</td>
</tr>
<tr>
<td>BC1</td>
<td>62</td>
<td>8.6</td>
</tr>
<tr>
<td>B2</td>
<td>94.7</td>
<td>20.5</td>
</tr>
<tr>
<td>BC2</td>
<td>84.7</td>
<td>13.7</td>
</tr>
</tbody>
</table>
Legend. Pre = pre-session probe, Post = post-session probe

Figure 8. Mean Number of Syllables Produced During Pre-Session and Post-Session Probes in Each Phase.
Figure 9. Number of Syllables Difference in Post-Session Probes Minus Pre-Session Probes in Each Session.

Figure 10. Number of Syllables Difference in Mean Post-Session Probes Minus Mean Pre-Session Probes in Each Phase.
CHAPTER V

DISCUSSION

Trends

As demonstrated by the post-session probes, the total number of syllables produced by the child increased following treatment in each session, suggesting that participation in interactive songs was immediately effective in increasing the verbal output of the child. Increases in the differences between post-session and pre-session probes also suggest that the child's syllable production increased with adult mediation.

In addition, an increase in syllable production over time (as indicated by pre-session probes) suggests that this treatment program, a combination of language and music in song, was effective in increasing the child's verbal output over the course of 15 therapy sessions, as measured in syllables.

Although increases in the mean pre-session and post-session probes were demonstrated in each treatment phase, the data indicates that addition of a component, the voice output communication device, in the BC phases did not contribute to greater increases in syllable production than occurred during B phases. This suggests that the introduction of the IntroTalker was not particularly effective in augmenting the treatment program and increasing the child's syllable production. This was the first time the child was exposed to a voice output communication device. Perhaps the novelty of the device precluded the child from realizing its full benefit. At times he appeared more interested in pushing the buttons to explore the various messages than in using it to take turns in the songs. The phases may also have had interactive effects on one another. One sequence may have led to increases in the following sequence.
A variety of factors may have contributed to the variation in the child's syllable production from session to session. As mentioned previously, scheduling conflicts led to variations in time of day when the sessions began and inconsistencies in the number of days between therapy sessions (see Appendices C and D). Originally the sessions were scheduled for approximately 9:00 a.m. Session three began at 1:00 p.m., session four began at 11:00 a.m., and sessions seven through fifteen began at approximately 4:00 p.m. due to transportation restrictions of the child. He was unable to attend several scheduled sessions because of a family vacation. As a result, the number of sessions conducted per week varied from two to four.

The post-session data point for session five stands out as an aberration. One factor that may account for the unusually high number of syllables produced by the child in the five minutes following treatment in session five is related to his activity at the time of the sample. During the post-session probe, the child was not engaged in play with any of the toys. He was looking out the window and pointing to the parking lot. The majority of the verbalizations produced by the child were perseverations on phrases such as "na nere," "uh uh my mom," and "uh uh bye bye." The repetition of these phrases inflated the syllable count and raised the mean so that it does not appropriately represent the phase.

The total number of syllables produced during the pre-session and post-session probes during session six were lower than expected. Several factors may account for the reduced syllable production. First, session six was separated from session five by five days. In addition, the child demonstrated signs of lethargy. His activity/movement level was lower than usual. He consistently yawned throughout the pre-session and post-session probes. When asked by the experimenter if he was
sleepy, he replied "yeah" and rubbed his eyes. The combination of these factors may explain the low number of syllables produced during session six.

The same toys were available each session. Amount of time spent with each toy varied because the pre-session and post-session probes during play were child-oriented. He selected the toys and was free to change activities at any time. A plastic replica of a McDonald's restaurant "drive-thru" was the most frequently selected toy. The child also frequently chose to play with dolls. A complete list of the toys selected for play during the pre-session and post-session probes of syllable production is provided in Table 6. The items are listed in the order in which they were selected.

Table 6
Toys Selected for Play During Syllable Measurement

<table>
<thead>
<tr>
<th>Session Number</th>
<th>Pre-Session Probe</th>
<th>Post-Session Probe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>dolls</td>
<td>blocks, dolls</td>
</tr>
<tr>
<td>2</td>
<td>McDonald's drive thru</td>
<td>McDonald's, dolls, blocks</td>
</tr>
<tr>
<td>3</td>
<td>dishes, McDonald's</td>
<td>dolls</td>
</tr>
<tr>
<td>4</td>
<td>McDonald's</td>
<td>McDonald's, dolls</td>
</tr>
<tr>
<td>5</td>
<td>McDonald's</td>
<td>McDonald's</td>
</tr>
<tr>
<td>6</td>
<td>dolls, McDonald's</td>
<td>dolls</td>
</tr>
<tr>
<td>7</td>
<td>McDonald's, dolls</td>
<td>dishes, dolls, McDonald's</td>
</tr>
<tr>
<td>8</td>
<td>McDonald's</td>
<td>dishes</td>
</tr>
<tr>
<td>9</td>
<td>dolls, McDonald's</td>
<td>blocks</td>
</tr>
<tr>
<td>10</td>
<td>McDonald's</td>
<td>McDonald's</td>
</tr>
<tr>
<td>11</td>
<td>dolls, McDonald's</td>
<td>McDonald's</td>
</tr>
<tr>
<td>12</td>
<td>McDonald's</td>
<td>McDonald's</td>
</tr>
<tr>
<td>13</td>
<td>McDonald's</td>
<td>McDonald's</td>
</tr>
<tr>
<td>14</td>
<td>McDonald's</td>
<td>McDonald's</td>
</tr>
<tr>
<td>15</td>
<td>McDonald's</td>
<td>McDonald's</td>
</tr>
</tbody>
</table>
Related Clinical Observations

Several observations were noted upon completion of the fifteen therapy sessions. The child's dramatic play skills continued to develop; he began to assume different roles while playing with the McDonald's "drive-thru." The child followed a routine with the McDonald's "drive-thru." He typically greeted the clinician, took her order, prepared the food, collected money, and gave change. However, the routines became more elaborate as the child used speech to take turns, e.g., to comment on size and indicate amount ("ee ee ee"). He also elected to assume the customer role. He ordered by verbalizing and pointing to a picture menu on the "drive-thru." After he received his meal, the child took his meal to the table, sat down and pretended to eat, then came back for a refill of juice. Dramatic play also developed as he interacted with the dolls during activities which included feeding and caring for the doll's "cut."

The child's gross and fine motor skills also continued to improve. He began to imitate movements such as clapping hands and stomping feet and to approximate fine motor movements with his hands in Itsy Bitsy Spider as he made the spider crawl "up the water spout."

The child's attempts for verbal communication included activating the IntroTalker, approximating parts of songs following prompts (occasionally sung syllables but primarily spoken syllables), and calling the clinician's attention by approximating her name for the first time in six months of clinical work with her. The previous clinical work had not included musical activities. An example transcript of the child's syllable production (from pre-session and post-session probes in session seven) is provided in Appendix F. All syllables produced during pre-session and post-session probes were spoken.
The child's adjustment to a new clinician was not a significant factor in this study. The child and experimenter had known each other for ten months and had interacted clinically for six months when the present study began. The child had not demonstrated much improvement in communication skills in past months of clinical intervention preceding this study. Small gains in expressive communication were offset by periods of withdrawal from interaction and regression of skills. When the experimenter interacted with him preceding this study, the child produced few syllables of vocalization/verbalization during whole group and individual therapy activities.

In addition to objective measures of progress, subjective measures (social validation measures) of progress were taken into consideration. The child, his mother, and the experimenter demonstrated satisfaction in the outcome of treatment. The child's mother commented in the final parent conference that the child was saying new words at home every day, including comments on the weather and names of various colors. She also reported increased attempts by the child to verbalize at home. The mother did not express the same concerns and fears about the child's progress and expectations for his future that had been raised in previous treatment interactions.

The child's signs of enjoyment during the sessions, such as smiling and laughing, appeared to be greater than demonstrated in semesters of more traditional play-based therapy that did not include music. The child also increased sustained attention to therapy activities. In previous clinical interactions and in the first few sessions of the present study in which music was a major component, the child attempted to end therapy sessions early by leaving the therapy room. By the end of the fifteen sessions in this study the experimenter had to tell the child when it was time to go home. He often expressed a desire to continue the activity beyond the time. Perhaps the use of music was less threatening to the child than more directive language activities.
The client/clinician relationship between the child and the experimenter continued to develop over time. The child's compliance to therapy activities improved. In addition, demonstrations of affection increased. The child and experimenter teased each other during intervention activities and during play. The child frequently sat down in the experimenter's lap and hugged her. The experimenter was more satisfied overall with this period of clinical interaction than she had been in previous clinical work with the child.

Conclusions

In response to the specific questions posed in this study, the number of syllables produced by a child with agenesis of the corpus callosum and expressive language delay increased with the introduction of a treatment program that encouraged interaction in songs. However, the number of syllables produced by the child did not further increase significantly and meaningfully with the addition of a voice output communication device to the treatment program.

Results from this study indicate that incorporating music into language therapy may be an effective means of increasing verbal output in a child with agenesis of the corpus callosum. Similar treatment programs may be effective with other individuals with agenesis of the corpus callosum and expressive language delays. It is recommended that this study of speech-language therapy that combines language and music in song be replicated in another subject with agenesis of the corpus callosum and severe expressive language delays.

Directions for Future Research

Further analysis of these videotapes may be used to explore the child's communication functions and the variety of phonemes produced. Further study may
also indicate if there is a difference in the child's verbalizations following sung versus spoken utterances by the experimenter.

There is a lack of clinical research reported regarding speech-language intervention for individuals with agenesis of the corpus callosum. Similar research is needed to determine the most effective means of therapeutic intervention for these individuals.
Appendix A

List of Picture Communication Symbols and Corresponding Digitally Recorded Messages
<table>
<thead>
<tr>
<th>Picture Communication Symbol</th>
<th>Digitally Recorded Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>bird</td>
<td>fly to the store</td>
</tr>
<tr>
<td>fish</td>
<td>swim to the store</td>
</tr>
<tr>
<td>rabbit</td>
<td>hop to the store</td>
</tr>
<tr>
<td>snake</td>
<td>crawl to the store</td>
</tr>
<tr>
<td>boy</td>
<td>walking to the store</td>
</tr>
<tr>
<td>spider</td>
<td>spider</td>
</tr>
<tr>
<td>bell</td>
<td>ding ding dong</td>
</tr>
<tr>
<td>cupcake</td>
<td>happy birthday</td>
</tr>
<tr>
<td>farm</td>
<td>E-I-E-I-O</td>
</tr>
<tr>
<td>cow</td>
<td>moo</td>
</tr>
<tr>
<td>pig</td>
<td>oink</td>
</tr>
<tr>
<td>sheep</td>
<td>baa</td>
</tr>
<tr>
<td>horse</td>
<td>neigh</td>
</tr>
<tr>
<td>boat</td>
<td>row</td>
</tr>
<tr>
<td>baby</td>
<td>baby</td>
</tr>
<tr>
<td>monkey</td>
<td>jumping on the bed</td>
</tr>
<tr>
<td>hands</td>
<td>clap your hands</td>
</tr>
<tr>
<td>foot</td>
<td>stomp your feet</td>
</tr>
<tr>
<td>mouth</td>
<td>shout hooray</td>
</tr>
<tr>
<td>star</td>
<td>twinkle</td>
</tr>
<tr>
<td>bus (arrow to wheel)</td>
<td>round and round</td>
</tr>
<tr>
<td>door</td>
<td>open and shut</td>
</tr>
<tr>
<td>window</td>
<td>up and down</td>
</tr>
<tr>
<td>bed</td>
<td>roll over</td>
</tr>
</tbody>
</table>
Appendix B

Total Number of Syllables Produced During Pre-Session and Post-Session Probes in Each Session With Date Listed
Total Number of Syllables Produced During Pre-Session and Post-Session Probes in Each Session With Date Listed

Legend: Pre = pre-session probes,
        Post = post-session probes,
        J = July,
        Au = August
Appendix C

Total Number of Syllables Produced During Pre-Session and Post-Session Probes in Each Session With Time of Day Listed
Total Number of Syllables Produced During Pre-Session and Post-Session Probes in Each Session With Time of Day Listed

Legend. Pre = pre-session probes,
Post = post-session probes,
a = a.m.,
p = p.m.
Appendix D
Instructions to Raters
INSTRUCTIONS TO RATERS

You will be viewing various one-minute segments of videotaped therapy sessions. The child on the tape sometimes produces intelligible words but often produces strings of neutral syllables or unintelligible words (e.g., "uh uh" or "na nere").

Ignore the speech of the clinician and focus upon the child's verbalizations/vocalizations. Tally each syllable produced by the child. Count all vocalizations that demonstrate a spoken initiation or response, but do not include syllables of laughter.

If you are unsure of the syllables for a given segment, you may replay that segment until you are confident that you have accurately counted his total number of syllables.
Appendix E

Word to Songs Used in Treatment Program
Itsy Bitsy Spider

The itsy-bitsy spider went up the water spout
Down came the rain and washed the spider out
Out came the sun and dried up all the rain
And the itsy-bitsy spider went up the spout again

Sammy

This is a story about Sammy, his mother sent him off to buy bread
Sammy didn't feel like walking, he wished he could fly instead so he said
If I was a bird I could fly to the store, fly to the store, fly to the store
If I was a bird I could fly to the store, fly to the store for my mother

This is a story about Sammy, his mother sent him off to buy bread
Sammy didn't feel like flying, he wished he could swim instead so he said
If I was a fish I could swim to the store, swim to the store, swim to the store
If I was a fish I could swim to the store, swim to the store for my mother

This is a story about Sammy, his mother sent him off to buy bread
Sammy didn't feel like hopping, he wished he could crawl instead so he said
If I was a bunny I could hop to the store, hop to the store, hop to the store
If I was a bunny I could hop to the store, hop to the store for my mother

This is a story about Sammy, his mother sent him off to buy bread
Sammy didn't feel like crawling, he wished he could walk instead so he said
I'm glad I'm me and I'm walking to the store, walking to the store, walking to the store
I'm glad I'm me and I'm walking to the store, walking to the store for my mother

Are You Sleeping?

Are you sleeping? Are you sleeping?
Brother John? Brother John?
Morning bells are ringing, morning bells are ringing
Ding ding dong, ding ding dong.
(Repeat)

Happy Birthday

Happy birthday to you, happy birthday to you
Happy birthday, dear____
Happy birthday to you
(Repeat)
Row Row Row Your Boat

Row row row your boat
Gently down the stream
Merrily, merrily, merrily, merrily
Life is but a dream
(Repeat)

Rock-A-Bye Baby

Rock-a-by baby on the treetop
When the wind blows the cradle will rock
When the bough breaks the cradle will fall
And down will come baby, cradle and all

Old MacDonald

Old MacDonald had a farm, E-I-E-I-O
And on this farm he had a cow, E-I-E-I-O
With a moo moo here and a moo moo there
Here a moo, there a moo, everywhere a moo moo
Old MacDonald had a cow, E-I-E-I-O

Old MacDonald had a farm, E-I-E-I-O
And on this farm he had a pig, E-I-E-I-O
With an oink oink here and an oink oink there
Here an oink, there an oink, everywhere an oink oink
Old MacDonald had a pig, E-I-E-I-O

Old MacDonald had a farm, E-I-E-I-O
And on this farm he had a sheep, E-I-E-I-O
With a baa baa here and a baa baa there
Here a baa, there a baa, everywhere a baa baa
Old MacDonald had a sheep, E-I-E-I-O

Old MacDonald had a farm, E-I-E-I-O
And on this farm he had a horse, E-I-E-I-O
With a neigh neigh here and a neigh neigh there
Here a neigh, there a neigh, everywhere a neigh neigh
Old MacDonald had a horse, E-I-E-I-O.

Monkeys on the Bed

There were five little monkeys jumping on the bed
One fell off and bumped his head
Mama called the doctor and the doctor said
No more monkeys jumping on the bed
Monkeys on the Bed--Continued

There were four little monkeys jumping on the bed
One fell off and bumped his head
Mama called the doctor and the doctor said
No more monkeys jumping on the bed

There were three little monkeys jumping on the bed
One fell off and bumped his head
Mama called the doctor and the doctor said
No more monkeys jumping on the bed

There were two little monkeys jumping on the bed
One fell off and bumped his head
Mama called the doctor and the doctor said
No more monkeys jumping on the bed

There was one little monkey jumping on the bed
He fell off and bumped his head
Mama called the doctor and the doctor said
No more monkeys jumping on the bed

If You're Happy and You Know It

If you're happy and you know it clap your hands
If you're happy and you know it clap your hands
If you're happy and you know it and you really want to show it
If you're happy and you know it clap your hands

If you're happy and you know it stomp our feet
If you're happy and you know it stomp your feet
If you're happy and you know it and you really want to show it
If you're happy and you know it stomp your feet

If you're happy and you know it shout hooray, Hooray!
If you're happy and you know it shout hooray
If you're happy and you know it and you really want to show it
If you're happy and you know it shout hooray, Hooray!

Twinkle Twinkle Little Star

Twinkle twinkle little star
How I wonder what you are
Up above the world so high
Like a diamond in the sky
Twinkle twinkle little star
How I wonder what you are
Wheels on the Bus

The wheels on the bus go round and round, round and round, round and round
The wheels on the bus go round and round, all through the town

The door on the bus goes open and shut, open and shut, open and shut
The door on the bus goes open and shut, all through the town

The windows on the bus go up and down, up and down, up and down,
The windows on the bus go up and down, all through the town

Five in Bed

There were five in bed and the little one said
Roll over, roll over
So they all rolled over
And one fell out

There were four in bed and the little one said
Roll over, roll over
So they all rolled over
And one fell out

There were three in bed and the little one said
Roll over, roll over
So they all rolled over
And one fell out

There were two in bed and the little one said
Roll over, roll over
So they all rolled over
And one fell out

There was one in bed and the little one said
Roll over, roll over
So they all rolled over
And one fell out

There were none in bed
Appendix F

Example Transcript of Subject's Syllable Production
**Example Transcript of Subject's Syllable Production**
*Session 7, Phase BC1-1 (July 28, 1994)*

<table>
<thead>
<tr>
<th>Pre-Session Probe (# of syllables)</th>
<th>Post-Session Probe (# of syllables)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huh? (1)</td>
<td>Yeah. (1)</td>
</tr>
<tr>
<td>Here? (1)</td>
<td>Yeah. (1)</td>
</tr>
<tr>
<td>Kay, da hot? (3)</td>
<td>Uh huh. (2)</td>
</tr>
<tr>
<td>Uh oh. (2)</td>
<td>Mm hm. (2)</td>
</tr>
<tr>
<td>In nere. (2)</td>
<td>Na nere. (2)</td>
</tr>
<tr>
<td>Ah ha, ha! (3)</td>
<td>Yeah. (1)</td>
</tr>
<tr>
<td>Ha. (1)</td>
<td>Mm hm. (2)</td>
</tr>
<tr>
<td>Ha. (1)</td>
<td>Uh oh. (2)</td>
</tr>
<tr>
<td>Na ha. (2)</td>
<td>Uh in nere. (3)</td>
</tr>
<tr>
<td>Da ha, ya. (3)</td>
<td>Uh uh me. (3)</td>
</tr>
<tr>
<td>Na ha. (2)</td>
<td>Yeah. (1)</td>
</tr>
<tr>
<td>Da ha. (2)</td>
<td>I ma nere. (3)</td>
</tr>
<tr>
<td>Ee ee ee. (3)</td>
<td>Uh. (1)</td>
</tr>
<tr>
<td>Uh oh. (2)</td>
<td>Mm. (1)</td>
</tr>
<tr>
<td>Nere. (1)</td>
<td>Mm mm mm. (3)</td>
</tr>
<tr>
<td>Um. (1)</td>
<td>Yeah. (1)</td>
</tr>
<tr>
<td>Why? (1)</td>
<td>Yeah, uh huh. (3)</td>
</tr>
<tr>
<td>Uh oh. (2)</td>
<td>Uh uh. (2)</td>
</tr>
<tr>
<td>Yeah. (1)</td>
<td>Uh in nere, ba baby. (6)</td>
</tr>
<tr>
<td>Hi. (1)</td>
<td>Yeah. (1)</td>
</tr>
<tr>
<td>Uh uh, da ow. (4)</td>
<td>Na mom. (2)</td>
</tr>
<tr>
<td>A be be. (3)</td>
<td>Na, na mom. (3)</td>
</tr>
<tr>
<td>Ee! (1)</td>
<td>Na mom. (2)</td>
</tr>
<tr>
<td>Why? (1)</td>
<td>Na mom, na mom. (4)</td>
</tr>
<tr>
<td>Why, why? (2)</td>
<td>Na ha! (2)</td>
</tr>
<tr>
<td>Mm mm, me. (3)</td>
<td>Na mom. (2)</td>
</tr>
<tr>
<td>Yeah, uh uh. (3)</td>
<td>Yeah, na mom. (3)</td>
</tr>
</tbody>
</table>

52 total syllables                                        64 total syllables
Appendix G

Protocol Clearance From the Human Subjects
Institutional Review Board
Date: Sept. 13, 1994
To: Kelly D. Beens
From: Christine Bahr, Acting Chair
Re: HSIRB Project Number 94-08-03

This letter will serve as confirmation that your research project entitled "The effects of interactive songs on the expressive language in a child with severe delays in expressive language" has been approved under the full category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you must seek specific approval for any changes in this design. You must also seek reapproval if the project extends beyond the termination date. In addition if there are any unanticipated adverse or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: Sept. 13, 1995

xc: Warner, SPAA
Date: March 9, 1995

To: Kelly D. Beens

From: Richard Wright, Chair

Re: HSIRB Project Number 94-08-05

This letter will serve as confirmation that the change to your research project "The effects of interactive songs on syllable production in a child with agenesis of the corpus callosum" requested in your memo dated Feb., 27, 1995 has been approved by the Human Subjects Institutional Review Board. This change is:

1. change to the title as it appears above.

The conditions and the duration of this approval are specified in the Policies of Western Michigan University.

You must seek reapproval for any changes in this design. You must also seek reapproval if the project extends beyond the termination date.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: Sept. 13, 1995

xc: Warner, SPAA
BIBLIOGRAPHY


