EFFECTS OF A COMBINED TREATMENT WITH DIRECT FEEDBACK ON GENERALIZATION LEARNING IN CHILDREN WITH PHONOLOGICAL DISORDERS

by

TURIA COSTA LOPES

(Under the direction of Maria Adelaida Restrepo)

ABSTRACT

The purpose of the current study was to investigate: (a) the effects of direct feedback during conversation training on generalization of treatment targets to conversational contexts, and (b) the effects of a combined treatment on generalization learning. A variation of an ABA withdrawal single-subject design was used with two children with severe phonological disorders, ages 4:10 and 5:4. Both children received 20 minutes of maximal opposition treatment and 20 minutes of conversation training in each session. The conversation training was divided into two types: one with direct feedback and the other with indirect feedback. Results indicated that conversation training with direct feedback had positive effects on treatment targets during treatment for both children, and on generalization of treatment targets to conversational contexts for one child. Moreover, both children generalized treated sounds across word positions, to untreated words, and within sound classes. One child also generalized across sound classes.

INDEX WORDS: Maximal opposition treatment, Conversation training, Phonological Intervention, Single-subject design, Generalization, Direct feedback

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DEDICATION

This thesis is dedicated, in thankful appreciation for support and understanding, to my beloved husband.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

When discussing the nature of speech disorders, it is essential to understand the distinction between articulation disorders and phonological disorders. Articulation is the planning and execution of articulators (e.g., tongue, lips) to produce speech sounds or phonemes (Fey, 1992). Articulation disorders, therefore, are motor disturbances in the production of phonemes. If a child has a structural deformity, a hearing deficit and/or a neurological impairment, the articulation problem is classified as organic. If a child does not have physiological, physical or neurological deficits, the articulation problem is known as functional (Creaghead, Newman, & Secord, 1989).

Phonology, on the other hand, is the study of “the systems and patterns of phonemes that occur in a language” (Bauman-Waegler, 2000, p. 5). These systems, described in phonology, include phonological processes, defined as the “systematic sound changes that operate across a class of sounds or across sound sequences so that various members of the class are affected similarly” (Ingham, 1988, p. 129). These processes are simplifications of phonemes that are more manageable for the child to produce than the adult forms (Fey, 1992). Developmentally, children progress from using these natural phonological processes to using the adult form. Children with phonological disorders use phonological processes that are different from those of normally developing children of the same age, or use developmental processes at higher rates or for longer periods of time than similarly aged peers (Bauman-Waegler, 2000).

When a child has a phonological disorder, intervention may help suppress the age-inappropriate process. In phonological intervention, sounds that are involved in a specific phonological process are selected as treatment targets. When a particular sound is treated, generalization across untreated sounds affected by the same phonological process is expected (Bauman-Waegler, 2000; Saben & Ingham, 1991; Weiner, 1981a). In other words, when a particular sound is treated, it is expected that the child will learn a new phonological rule, modify the errored sounds affected by the process, and thus suppress the phonological process.

Treatment Efficacy

Treatment efficacy is defined as the ability of an intervention to promote the desired outcome in an ideal condition, which excludes all factors that could influence the outcome of treatment other than the treatment itself (Frattali, 1998). According to Kendall and Norton-Ford (1982), research on treatment efficacy may focus on one or more questions: what are the effectiveness and/or effects of a given treatment or the efficiency of different treatments? Research on phonological treatment effectiveness addresses whether or not a phonological treatment works; in other words, whether a therapeutic intervention causes a behavior change (Olswang, 1998). Questions about treatment efficiency investigate the comparative effectiveness of two or more treatments, by determining which treatment leads to more significant behavioral changes (Olswang, 1998). Questions about treatment effects focus on generalization issues, investigating the type and extension of behavioral changes that would result from an intervention (Olswang, 1998).

Generalization

Generalization can be defined as "an extension of learning to new situations and stimuli, or to new responses based upon old learning" (Hegde, 1993, p. 171). The ultimate goal of any treatment is to achieve generalization of a treated behavior to conversational contexts outside the treatment setting. Since generalization is an essential part of the treatment process, activities focusing on generalization should be planned and incorporated as part of the overall phonological treatment (Baer, 1981; Elbert, 1989; Stokes & Baer, 1977; Stokes & Osnes, 1989).

Phonological changes can involve generalization of treated sounds to treated sounds across word positions (e.g., teaching the /k/ sound in “cat” and generalizing to “milk”), to untreated words (e.g., targeting the word “cat” and generalizing to “cup”), to more complex linguistic units (e.g., generalizing the /k/ sound at word level to conversational level), and to different settings (e.g., generalizing the /k/ taught in the clinic to the school). Besides generalization within a particular sound, generalization across sounds can also occur. This kind of generalization can occur within sound classes (e.g., generalizing the /k/ sound to another untreated stop sound such as /g/), and across sound classes (e.g., generalizing the /k/ sound to an untreated fricative sound such as /ʃ/). Further, the desired result of any phonological treatment is that improvement in speech intelligibility generalizes to spontaneous speech in different settings, such as school and home, and with different partners such as family members, teachers and peers.

Treatment Approaches

Since the purpose of phonological intervention is to maximize changes and generalization in a child’s phonological inventory, treatment selection is crucial. Several phonological treatment approaches have been cited in the literature and shown to be effective, such as cycles, minimal pair treatment, multiple opposition treatment and naturalistic conversation training.

The cycles treatment involves perception and production training (Hodson & Paden, 1991). The goal of this program is to improve intelligibility in a short period of time (Hodson & Paden, 1991). In this treatment, a child is exposed to more than one phoneme and one phonological process in one cycle. During each cycle, the child will start discriminating the sounds at word level, and then learn how to produce them. Each sound is addressed for a week, and mastery of the sound is not expected. After each cycle, an assessment is administrated to determine whether the sounds have been mastered. If not, another cycle is initiated in which the same sounds will be trained (Tyler, Edwards, & Saxman, 1987).

Minimal pair treatment is another approach that has been used to treat phonological disorders. The purpose of this technique is to teach the child that different sounds represent different meanings. The clinician may contrast a pair of words that differ by one or two distinctive features (i.e., minimal opposition); for example, the word pair “pan-tan” differs only by the coronal feature. The clinician may also select a pair of words that differ by many distinctive features (i.e., maximal opposition); for example, the word pair “lane-cane” differs by the features sonorant, vocalic, coronal, anterior, lateral, high, back, continuant and voiced. In some models of intervention, the pair of words contains the child’s target sound and its substitution, and in others, the pair contains two target sounds (Gierut, 1990, 1991, 1992; Gierut & Neumann, 1992). Further, some models include perception and production training (e.g., Blache, Parsons, & Humphreys, 1981; Tyler et al., 1987; Tyler & Sandoval, 1994), and others include production training only (e.g., Gierut, 1990, 1991; Gierut, Elbert, & Dinnsen, 1987; Gierut, Morrisette, Hughes, & Rowland, 1996; Hoffman, Norris, & Monjure, 1990; Miccio & Ingrisano, 2000; Morrisette & Gierut, 2002; Powell, 1991,1993; Powell, Elbert, & Dinnsen, 1991; Weiner, 1981a). In perception and production training, the child is trained on auditory discrimination of the target sound before the child is trained on production. In production-only training, the child is trained on contrast and production of phonemes, rather than phonetic placement or auditory discrimination training.

In multiple opposition treatment, unlike in minimal pair treatment, the clinician simultaneously contrasts several errored sounds to a sound that is present in the child's inventory. For example, a clinician may target the child's errored sounds on /kip/, /sip/, and /lip/, and contrast them with /tip/ (Williams, 2000). This treatment, therefore, uses larger therapy sets addressing many error patterns, rather than targeting an isolated phonological process. Thus, children with severe to profound phonological disorder may benefit from the Multiple opposition intervention (Williams, 2000).

Naturalistic conversation training has been used with children with language impairment (Camarata & Nelson, 1992; Camarata, Nelson, & Camarata, 1994; Nelson, Camarata, Welsh, Butkovsky, & Camarata, 1996), and with children with phonological disorders (Camarata, 1993; Williams, 2000). This approach consists of naturalistic activities in which the clinician maintains the "integrity of interaction" by not limiting or leading the child's linguistic outputs (Camarata 1993). These activities are designed to provide diverse opportunities for feedback. The clinician provides feedback exclusively for the speech or language targets by giving a correct model immediately after the child's incorrect production without asking for direct imitation or self-correction. For example, if a child says /jos din fu/ for "your green shoes," the clinician would respond "yes, my green shoes."

In an attempt to select the best treatment for maximum generalization, phonological treatment procedures have been studied and compared in the literature. This type of investigation is critical to determine which procedure leads to more significant changes in the sound system than another.

Minimal opposition versus cycles. Tyler et al. (1987) investigated the difference in treatment effects between minimal opposition and cycles treatment in 4 children with moderate to severe phonological disorders, ages 3:1 to 5:1. Two children received minimal opposition treatment and two children received cycles treatment. In the minimal opposition treatment, the children first discriminated the sounds in isolation and then in single words. During production training, both children produced the target sounds at the word level by imitation and then spontaneously. Minimal pairs were not used until the children could produce the target sound in single words correctly. At the minimal pair level, the children were required to produce the target sounds at the word level, and then at the sentence level. In contrast to minimal opposition, in the cycles treatment the children worked on one phonological process for three weeks. The children worked on target sounds to facilitate elimination of each process. In each session, the clinician used an "auditory bombardment" task that was designed to increase the child's awareness of the target sound. After the auditory bombardment, the children produced the target sounds at the word level imitatively, then spontaneously, and then at the sentence level spontaneously. The results of the study indicated that all 4 children in both treatment groups demonstrated sound generalization to untreated sounds within sound classes. Tyler and colleagues attributed the results to the fact that they chose the procedure that was more appropriate for each child. Children who presented only a few inappropriate phonological processes or one specific prevalent process were assigned to the minimal opposition treatments. On the other hand, children with a variety of inappropriate phonological processes and unintelligible speech were assigned to the cycles treatment group. Because the children were not randomly assigned, the results do not allow us to make any inferences regarding which is the best treatment. Further research with children who have similar characteristics, and who are randomly assigned to different treatment groups, may indicate which treatment approach leads to broader generalization.

Language versus phonological treatment. Some researchers have suggested that higher linguistic levels, such as syntax, may influence lower linguistic levels, such as phonology. In other words, intervention focusing on syntax may facilitate phonological development. To test this hypothesis, Hoffman et al. (1990) investigated the impact of language treatment on phonological performance. They studied 2 2-year-old children with moderate phonological impairments. One child received whole language intervention focusing on narrative production by retelling a story to a puppet, while the other child received phonological intervention using a minimal opposition treatment. Both children demonstrated similar improvements on sound generalization to untreated words within sound class, but the child who received the language treatment also improved language skills. However, Hoffman et al. studied only 2 children, indicating the need for further replication.

In contrast to the above study, Fey, Cleave, Ravida, Long, Dejmal, and Easton (1994) provided 5 to 10 months of grammatical intervention using focused language stimulation to target grammatical skills. Six children received treatment through a speech-language pathologist, and 5 children through their parents. A control group of 8 children received a delayed grammatical intervention with the clinician after 5 months to control for maturation effects. After treatment, the gains in grammatical performance for both intervention groups were greater than those for the control group. However, children in the treatment and control groups did not significantly improve phonological production. Therefore, grammar facilitation intervention did not have an effect on the children's phonological production, indicating that there is not enough evidence to conclude that language intervention impacts phonological production.

Combined treatments. Combined treatment approaches have also been used to maximize sound changes. For instance, Williams (2000) combined three different interventions: multiple opposition treatment, minimal opposition treatment and naturalistic conversation training. The author hypothesized that each of the three treatments would address a different phase of the phonological learning process. The child would start organizing the sound system with a multiple opposition treatment, then contrast single sounds with a minimal opposition treatment, and then incorporate the sound changes at a broader discourse level with naturalistic conversation training. Ten children, ages 4 to 6:5, with phonological disorders participated in the study. During the study, the number of the sounds treated for each child ranged from 4 to 16. All the children started the treatment with the phonological multiple opposition treatment. The first phase of multiple opposition and minimal opposition treatments consisted of an imitation task. After a child achieved 90% accuracy in the imitation phase, intervention started at the spontaneous level. A 10-item generalization probe for each target sound in untreated words was used every third therapy session. If the child did not achieve 90% accuracy in the generalization probe, intervention continued at the spontaneous level with additional contrast sets. If the child achieved the treatment criterion of 90% accuracy in this phase, but did not achieve the generalization criterion, naturalistic conversation training started. After the generalization criterion was met, a short conversational sample was obtained to observe target sound generalization to conversational contexts. When a child produced the target sound with at least 50% accuracy, treatment for that sound was ended. The treatment effects for all children were measured by comparing the mean of the pretreatment percentage of correct productions (37%, range 12% to 60%) to the mean of the posttreatment percentage of correct productions (85.1%, range 69% to 99%). Two of the 10 children received intervention with the multiple opposition treatment only because they achieved generalization to all target sounds before the second phase of treatment. One child received multiple opposition treatment and traditional articulation treatment due to the child's motoric difficulties. Another child received multiple opposition and then naturalistic conversation training. Two of the 10 children received multiple opposition treatment and then minimal opposition treatment. Four of the 10 children received the three treatments.

Williams (2000) found that 8 of 10 children required more than one model of intervention to achieve their final level of phonological reorganization. The author suggested that two or more different treatment procedures might be needed for children with at least moderate phonological disorders to organize their sound system. In addition, half of the children in Williams's study required intervention at a conversational level to achieve sound generalization to conversational contexts. She suggested that training at the word level might not be sufficient for children with more severe disorders to achieve sound generalization to conversational contexts. However, the interpretation of treatment effects of the naturalistic conversation training in combination to contrast pair treatments is difficult in this study. There were differences in age, severity, types and duration of treatment between children who did and did not receive the naturalistic conversation training. Further, there were no control treatments to determine whether conversation training was necessary.

A combination of language and phonological intervention has also been used to maximize language and phonological learning. Tyler and Sandoval (1994), for example, investigated the effects of indirect language intervention, direct phonological intervention, and a combination of indirect language and direct phonological intervention in 6 children, ages 3:6 to 4:8, with moderate to severe impairments in both areas. Two of the children received phonological intervention, involving perception and production of sounds with the minimal opposition treatment. Two children received language intervention involving a narrative retelling activity, focused on language facilitation strategies, such as expansion and recasting. The remaining 2 children received the combined approach involving both interventions, which were alternated within a treatment session. These 2 children were exposed to the phonological treatment for 15 minutes. In the remaining 30 minutes of the session, the children were exposed to a story-retelling task that contained multiple exemplars of the target sound. In other words, the target sounds were indirectly addressed at the discourse level. During the indirect language treatments, the clinician, in response to the child’s syntactic/morphological and phonological errors, presented semantic confusions and modeled correct forms for the child. The results suggested that children in the phonology-only group improved in both domains, children in the language-only group demonstrated improvement in that domain only, and the children who received the combined treatment showed a broader improvement in phonology and language. In the combined treatment, the 2 children's percentage of occurrence of phonological processes decreased from 91% to 5%, and from 95% to 25%, respectively. In the phonological intervention, the children's phonological processes decreased from 100% to 10%, and from 100% to 56%. Because the target sounds were indirectly addressed during the indirect language interventions, it is unclear whether the broader improvement in phonology in the combined treatment group was due to the addition of a language intervention or due to the addition of discourse level intervention in general.

In summary, minimal opposition and cycles treatments seem to promote phonological changes and sound generalization. Minimal opposition treatment may be more appropriate for children with few inappropriate phonological processes, and cycles treatment may be more appropriate for children with a variety of inappropriate phonological processes (Tyler et al., 1987). Studies that investigated the effects of language intervention on sound generalization have reported conflicting findings. Further, combined treatments that provide different linguistic levels for target sound production seem to facilitate generalization of treated sounds to untreated words (Tyler & Sandoval, 1994; Williams, 2000). Finally, it has been suggested that training at the word level may not be sufficient for children with severe phonological disorders to achieve sound generalization to conversational contexts (Williams, 2000). Research has suggested that children with severe phonological disorders may need intervention above the word level to impact sound generalization at the conversational level.

Results of the effects of combined treatments mentioned previously are inconclusive. The effects of a naturalistic conversation training combined with a phonological treatment in Williams's (2000) study cannot be determined clearly because the groups differed by age, severity, and treatment duration. Therefore, the effects can be attributed to any of these differences. Further, Tyler and Sandoval (1994) did not use language intervention as a means for sound generalization. The authors investigated the effects of phonological and language treatments on both disordered areas. Moreover, they only assessed sound generalization with word probes, so sound generalization at the conversational level was not reported.

Target Sound Selection

Target sound selection seems to be an important factor to achieve generalization. Criteria used for target sound selection that have been investigated may include, but are not limited to, whether the child has productive phonological knowledge of the sound, the use of developmental sequence of sound acquisition, whether the child is stimulable for the target sounds, and distinctive feature contrasts between targets sounds.

Productive phonological knowledge. The first factor considered in the selection of sounds for treatment relates to how much productive phonological knowledge of the target sound the children have. Researchers have compared target sounds in which a child has most productive phonological knowledge to sounds in which a child has the least productive phonological knowledge. Productive phonological knowledge is defined as "the idiosyncratic, unpredictable properties of a given language that are learned and stored in a speaker's lexicon, along with the rules associating sound with meaning" (Gierut et al., 1987, p. 462). Productive phonological knowledge refers to a child's competence and comprehension about the sound system, including the phonetic and phonemic inventory, distribution of sounds, and the use of phonological rules. For instance, the sounds in which a child has the most productive phonological knowledge are the ones that are produced correctly all the time, and the sounds in which a child has the least productive phonological knowledge are those produced incorrectly all the time (Gierut et al., 1987).

Gierut et al. (1987) suggested that the selection of a target sound based on a child's phonological knowledge would influence sound generalization. Six children with phonological disorders, ages 3:7 to 4:6, participated in the study. Investigators determined the children's phonological knowledge of errored sounds by asking each child to tell a story, and to name pictures and objects. All children received minimal opposition treatment consisting of imitative and spontaneous production phases. Three children who received treatment targeting the sounds with the least productive phonological knowledge demonstrated generalization to untreated sounds within and across sound classes. The extent of sound generalization for those children was equivalent across sounds with all levels of productive phonological knowledge. Conversely, the 3 children who received treatment targeting the sounds with the most productive phonological knowledge demonstrated generalization only to untreated sounds with the most productive phonological knowledge. Thus, Gierut et al.'s (1987) and previous finding (Williams, 1991) results suggest that targeting sounds that are not in the child's inventory may promote greater generalization learning than targeting sounds in the child's inventory.

Developmental sequence of sound acquisition. The recommendation of teaching the sounds acquired first by normally developing children because they are easier to learn than sounds acquired later has being questioned by several investigators (Gierut et al., 1996; Powell, 1991; Powell, Elbert, Miccio, Strike-Roussos, & Brasseur, 1998). Gierut et al. (1996), for example, found that working with later-acquired sounds might be more efficient than treating early-acquired sounds. Gierut et al. (1996) described two studies, one involving a within-subject comparison of phonological changes and the other involving an across-subject comparison. In the first study, 3 children were taught one early- acquired and one later-acquired sound. Both sounds were introduced in every therapy session. The children's productions were measured by a word probe containing all sounds elicited by a spontaneous picture-naming task. The 3 children demonstrated greater accuracy in the productions of the treated sounds that were later-acquired than those that were early-acquired.

In the second study (Gierut et al., 1996), 3 children received treatment on one later-acquired sound, and the other three children received treatment on one early-acquired sound. After treatment, there was no quantitative difference between the accuracy of productions of early-acquired and later-acquired sounds. All children showed similar degree of generalization to untreated sounds within the sound class. However, there were differences between groups in generalization to untreated sounds across sound classes. The children who were taught later-acquired sounds produced untreated sounds across sound classes with 30% to 50% accuracy on generalization probes. By comparison, children who were taught early-acquired sounds showed minimal generalization, producing untreated sounds with a maximum of 10% accuracy on generalization probes. The small sample in both studies indicates the need for further replication, although preliminary data suggest that treating later-acquired sounds leads to greater generalization than treating early-acquired sounds.

Rvachew and Nowak (2001) further investigated the effectiveness and the effects of the developmental sequence of sound acquisition as well as phonological knowledge when selecting target sounds. Forty-eight preschool-age children with moderate to severe phonological disorders participated in this study, and were randomly assigned to two groups: (a) children who received treatment targeting sounds with the most phonological knowledge and early-acquired, and (b) children who received treatment targeting sounds with the least phonological knowledge and later-acquired. Two sounds were targeted for each child for 6 weeks and then each child was reassessed. After the assessment, two new sounds were targeted for another 6 weeks. Treatment consisted of seven steps: imitated syllables, imitated words, spontaneous words, imitated patterned sentences, and spontaneous sentences. Each child moved to the next step after obtaining a score of 8 correct productions in 10 attempts. The authors found that children who received treatment targeting sounds with the most phonological knowledge and early-acquired achieved greater competency in the sound production, moving to more complex treatment steps than children who received treatment targeting sounds with the least phonological knowledge and later-acquired. However, there were no differences between the two groups on the following generalization measures: a phonological knowledge profile using an imitative task and the percentage of consonants correct score from a speech sample. Therefore, the results of this study suggest that learning early-acquired sounds associated with more phonological knowledge facilitate sound production in the initial stages, but it has no impact on generalization measures. In contrast, other studies suggest that later-acquired sounds lead to greater sound generalization than early-acquired sounds (Gierut et al., 1996; Powell, 1991; Powell et al., 1998), and targeting sounds that are not in the child's inventory promote greater sound generalization than targeting sounds in the child's inventory (Gierut et al., 1987; Williams, 1991).

Stimulability. Stimulability refers to the child's ability to accurately produce a misarticulated sound during imitation tasks (Powell et al., 1991). Whether a child is stimulable for the target sounds has been found to impact the extension of phonological change in the study of generalization. Evidence suggests that treatment of nonstimulable sounds may promote more generalization than treatment of stimulable sounds (Powell et al., 1991; Powell, 1991). Powell (1991), for example, investigated sound generalization in a 5-year-old child who received minimal opposition treatment in which a nonstimulable sound was targeted. A 54-item probe was used to assess generalization to untreated sounds within and across sound classes. The results of this study showed that the child acquired the target sound, and generalized to untreated sounds within the sound class. However, this study was a case study, and thus it should be replicated with a larger sample and a control group.

In a second study, Powell et al. (1991) investigated the relationship between stimulability and generalization of sounds in a single-subject multiple-baseline design, using an across-behavior analysis. In this study, 6 children with phonological disorders, ages 4:11 to 5:6, were exposed to minimal opposition treatment. Each child was taught to produce /r/ and another sound not present in the child's phonetic inventory. Two children received treatment for stimulable sounds, 2 children for nonstimulable sounds, and 2 children for one stimulable and one nonstimulable sound. Children who received treatment for stimulable sounds achieved generalization to all treated sounds, to untreated stimulable sounds, and, in the case of one child, to an untreated nonstimulable sound. On the other hand, children who received treatment for nonstimulable sounds did not demonstrate accurate productions to treated sounds during generalization measures. Only one child generalized to untreated nonstimulable and stimulable sounds. The authors suggested that stimulable sounds may improve without direct treatment, whereas nonstimulable sounds may only improve with direct treatment. However, the findings of this study did not support this conclusion, indicating that further studies on stimulability are necessary.

Distinctive feature contrast. Several investigators have examined the number of distinctive features in the sounds contrasted in word pairs during minimal pair treatment. Research suggests that treatment of phonemes differing by many distinctive features promotes greater phonological change than treatment of pairs differing by one or two feature contrasts (Gierut, 1989, 1990, 1991, 1992; Gierut & Neumann, 1992, Pereira & Mota, 2002). For example, Gierut (1990) examined whether maximal opposition treatment (i.e., many feature contrasts) leads to more phonological changes than minimal opposition treatment (i.e., few feature contrasts). Three 4-year-old boys received both minimal and maximal opposition treatments with two independent sound pairs presented randomly in each therapy session. After working on one sound pair, the clinician introduced a 10-min playing activity, and then introduced the second sound pair. Gierut used two different word probes consisting of untreated sounds elicited by a spontaneous picture-naming task to evaluate sound changes for each type of contrast treatment. The percentages of correct productions of treated sounds of all 3 children were greater under the maximal opposition treatment then under the minimal opposition treatment. To illustrate, on the final treatment probe, one child achieved 43% accuracy on the maximal opposition treatment and 14% on the minimal opposition. All children also demonstrated expansion of their inventory to one, two or three new untreated sounds after maximal opposition treatment. On the other hand, under the minimal opposition condition, only one child expanded his posttreatment inventory to one new sound. Subsequent studies (Gierut, 1991, 1992; Gierut & Neumann, 1992, Pereira & Mota, 2002) have supported Gierut's (1990) findings, suggesting that maximal opposition treatment may provide greater phonological changes than minimal opposition treatment.

In summary, studies suggest that later-acquired sounds, nonstimulable sounds, and the child's least productive phonological knowledge sounds may only improve with direct treatment, and lead to greater generalization learning. On the other hand, early-acquired sounds, stimulable sounds, and the child's most productive phonological knowledge sounds may improve without direct treatment, and lead to less generalization learning. In addition, treatments that target sound pairs that differ by many distinctive feature contrasts seem to promote greater sound generalization than treatments targeting sound pairs that differ by a few distinctive feature contrasts (Gierut, 1990, 1991, 1992; Gierut & Neumann, 1992, Pereira & Mota, 2002). Therefore, maximal opposition treatment seems to be more efficient and lead to greater generalization learning than minimal opposition treatment.

Generalization Probes

Generalization to a child's natural environment is the ultimate goal of any phonological treatment; therefore, assessment of sound generalization at the conversational level is crucial. Some phonological intervention studies assess generalization in a narrow context, and may thus underidentify the child's speech production. Some investigators use probes that include treated and/or untreated sounds at the word level to assess sound generalization (e.g., Gierut, 1990, 1991, 1992; Gierut & Neumann, 1992; Gierut et al., 1996; Morrisette & Gierut, 2002; Pereira & Mota, 2002; Powell, 1991, 1993; Powell et al., 1991; Tyler & Sandoval, 1994; Tyler et al., 1987; Weiner, 1981a). Others use probes that include a broader context with treated and/or untreated sounds at the sentence level (e.g., Panagos, Quine, & Klich, 1979), while others include conversational samples (e.g., Blache et al., 1981; Fey et al., 1994; Gierut, 1989; Gierut et al., 1987; Hoffman et al., 1990; Matheny & Panagos, 1978; Miccio & Ingrisano, 2000; Rvachew & Nowak, 2001; Tyler & Figurski, 1994; Williams, 2000). However, few studies use conversational samples to assess sound generalization in different settings and with different partners (e.g., Camarata, 1993).

Studies have compared phonological performance from a conversational sample and from a picture-naming task to determine whether a word-level task reflects the child's phonological performance in spontaneous conversation. For instance, Morrison and Shriberg (1992) analyzed children's speech productions using the Photo Articulation Test (PAT) and conversational samples, administered in random order. The authors assessed 61 children, ages 3 to 6 years, with expressive language that ranged from normal to moderately delayed. In the conversational samples, children talked about home and social activities, and in the PAT, children spontaneously named picture cards. In general, the results showed that children produced developmentally later-acquired sounds less accurately in the conversational samples than in the PAT, indicating that the former may be the procedure of choice to assess generalization.

Investigators have also evaluated whether syntactic complexity would affect sound production. For example, Panagos et al. (1979) suggested that the association between syntactic and phonological deficits might be attributed to a limited capacity to manage syntactic complexity during sound production. Seventeen children, ages 4:8 to 6:8, with functional articulation problems were instructed to repeat a series of stimuli that contained the target sound in words and sentences (i.e., noun phrase, simple active affirmative declarative sentence, and passive sentence). The authors found that the children produced the target sound more accurately in simple words than in complex words, or words within a complex syntactic structure. The authors hypothesized that the relationship between phonological and syntactic difficulties is the result of "competing performance demands." According to the authors, the child may not precisely control articulation while producing a sentence because the child has a limited capacity to manage syntactic complexity. These results support findings suggesting that children produce sounds less accurately in connected speech than in single words (e.g., DuBois & Bernthal, 1978; Healy & Madison, 1987; Morrison & Shriberg's, 1992). Although these studies do not deal specifically with generalization, they suggest that correct sound production in a conversational probe may indicate greater skill in sound generalization in a natural environment.

Conversational Level Intervention Promoting Generalization

Since children may produce sounds with less accuracy at the conversational level, phonological treatments should include training at the word and conversational levels to assure generalization of treated sounds to more complex linguistic levels, as has already been suggested in the literature (e.g., Tyler & Sandoval, 1994; Williams, 2000). If the target sound is introduced only at the word level, the child may have more difficulty generalizing at the conversational level because more complex contexts may result in less accurate sound productions (Morrison & Shriberg, 1992; Panagos et al., 1979).

It has also been suggested that the target behavior should be treated in the same or similar condition as the desired generalization setting (e.g., Camarata, 1993; Lincoln & Onslow, 1997; Lincoln, Onslow, Lewis, & Wilson, 1996; Onslow, Costa, & Rue, 1990; Stokes & Osnes, 1989). Sound production should be addressed in a relevant and functional manner, such as in play activities, using stimuli that are part of the child's natural environment. Therefore, naturalistic conversation training can be used to facilitate sound generalization.

Camarata (1993) investigated the effects of naturalistic conversation training on sound production. Two children with speech disorders, ages 3:10 and 4:3, were exposed to a naturalistic conversation training through play activities. During treatment, the clinician respected the child's speech initiations. Materials such as toys and objects containing the target sounds were preselected to ensure diverse opportunities for feedback. Four target sounds were presented to one child and only one sound was presented to the other child, because the latter quitted the program. During training, the clinician used a sound-by-sound approach instead of an across class of errors process approach (e.g., final consonant deletion). The clinician provided indirect feedback exclusively for the speech targets by giving a correct model immediately after the child's incorrect production, without asking for direct imitation or self-correction. Generalization was measured by sampling spontaneous productions in the child's home after two weeks and after nine months following training. All the sounds that were targeted for both children were acquired and produced in conversational contexts, and generalized to the clinic and the children's home.

Although conversation training seems to facilitate sound generalization to conversational contexts, the investigation of the effect of conversation training on generalization learning, including generalization of target sounds across word positions, to untreated words, and within and across sound classes is limited in previous studies (Camarata, 1993; Williams, 2000). In addition, the feedback that has been used during conversational interventions (e.g., Camarata, 1993; Williams, 2000) has differed from feedback used in treatments at the word level (e.g., Gierut, 1999; Gierut & Champion, 2001; Gierut et al., 1996; Hoffman et al., 1990; Miccio & Ingrisano, 2000; Morrisette & Gierut, 2002; Weiner, 1981a).

Direct Feedback

Direct feedback, in the current study, refers to pointing out the child's inaccurate and accurate productions, and asking for correction. Direct feedback is often used to help children acquired sounds at the word level (e.g., Gierut, 1999; Gierut & Champion, 2001; Gierut et al., 1996; Hoffman et al., 1990; Miccio & Ingrisano, 2000; Morrisette & Gierut, 2002; Weiner, 1981a). For example, if the child produces /aɪ/ for "ice" at the word level, the clinician may say "I didn't hear a good /s/, let's try again" or "that was a good /s/."

Gass and Varonis (1994) have suggested that learners should take notice of their problems to have more chance to perceive the gap between what is produced and what should be produced. Thus, in order to generalize the learned behavior to conversational contexts, the child should be aware that the clinician is listening for the target sound during spontaneous conversation (Bauman-Waegler, 2000).

In the phonological disorders literature, direct feedback at the word level has been shown to be effective (e.g., Gierut, 1999; Gierut & Champion, 2001; Gierut et al., 1996; Hoffman et al., 1990; Miccio & Ingrisano, 2000; Morrisette & Gierut, 2002; Weiner, 1981a). For example, Miccio and Ingrisano (2000) used direct feedback for incorrect productions, including correct articulatory gesture instruction and tangible reinforcement for correct productions at the word level during minimal opposition treatment. They studied a 5-year-old child with phonological disorder, and found that, after treatment, the child generalized target sounds to untreated words, across word positions, across linguistic units, and within and across sound classes. Gierut et al. (1996) obtained similar results using direct feedback for incorrect productions and verbal reinforcement for correct productions at the word level during maximal opposition. They studied 6 children, ages 3:5 to 5:6 with phonological disorders, and found that all children generalized to untreated words, and within and across sound classes after treatment. However, these treatments have focused intervention at the word level only, and have not controlled the effect of direct feedback on sound generalization to conversational contexts.

In contrast, at the conversational level, researchers in phonological intervention frequently do not clearly describe which form of feedback is used and when it is used (e.g., Blache et al., 1981; Forrest, Dinnsen, & Elbert, 1997; Powell, 1993; Rvachew &

Nowak, 2001; Tyler et al., 1987; Tyler & Figurski, 1994). The few studies that have described the feedback have used indirect feedback, which refers to giving a correct model after the child's mispronunciation without getting the child's attention to the speech error, or asking for imitation or self-correction. For example, the clinician may say "yes, he put some ice" after the child says /aɪ/ for "ice." Camarata (1993) used indirect feedback at conversational level. The clinician also reinforced correct productions with semantic affirmation by saying, for example, "yes, he did." Camarata found that both children who received conversation training with indirect feedback generalized target sounds productions to conversation at the clinic and at the children's home. Williams (2000) used the same feedback procedures at the conversational level as Camarata (1993) with 5 children with phonological disorders. After treatment, the children generalized target sounds to conversational contexts. Similarly, Tyler and Sandoval (1994) used correct model and "semantic confusions" after the child's incorrect phonological productions in conversation. Two children received the feedback, and they showed generalization to conversational contexts. The question remains, however, whether direct feedback in conversation leads to greater sound generalization than indirect feedback.

In short, direct feedback at the word level has been shown to be effective in phonological intervention studies. At the conversational level, however, studies in phonological intervention have used indirect feedback. Because direct feedback has been shown to be effective at the word level, it is possible that conversation training with direct feedback may promote generalization of the target sound to conversational contexts to a greater accuracy than conversation training with indirect feedback.

Summary

Phonological treatment efficacy has been established and documented across studies. Conversation training, cycles, and multiple opposition treatments have been considered to be effective in improving phonological disorders (e.g., Camarata, 1993; Tyler et al., 1987; Williams, 2000). In addition, there seems to be a significant body of literature that found that minimal pair treatment is effective (e.g., Blache et al., 1981; Gierut, 1989, 1990, 1991, 1992; Gierut et al., 1987; Gierut et al., 1996; Gierut & Neumann, 1992; Hoffman et al., 1990; Miccio & Ingrisano, 2000; Morrisette & Gierut, 2002; Pereira & Mota, 2002; Powell, 1991, 1993; Powell et al., 1991; Tyler et al., 1987; Tyler & Sandoval, 1994; Weiner, 1981a). Minimal opposition and cycles treatments seem to promote phonological changes and sound generalization. Minimal opposition treatment may be more appropriate for children with few inappropriate phonological processes, and cycles treatment may be more appropriate for children with a variety of inappropriate phonological processes (Tyler et al., 1987). Children with severe to profound phonological disorders may benefit more from the multiple opposition intervention because this treatment uses larger therapy sets addressing many error patterns (Williams, 2000).

Research on the effects of target sound selection on generalization learning is not conclusive due to conflicting results, the lack of control groups, and the small number of participants used across studies. It appears, however, that later-acquired sounds, nonstimulable sounds, and the child’s least productive phonological knowledge sounds may only improve with direct treatment, and may lead to greater sound generalization. On the other hand, early-acquired sounds, stimulable sounds, and the child’s most productive phonological knowledge sounds may improve without direct treatment, and lead to less sound generalization (Gierut et al., 1987; Gierut et al., 1996; Powell, 1991; Powell et al., 1991; Powell et al., 1998; Williams, 1991). In addition, minimal pair treatment targeting phonemes that differ by many distinctive features (i.e., maximal opposition) seems to lead to more phonological changes than targeting phonemes that differ by one or two distinctive features (Gierut, 1989, 1990, 1991, 1992; Gierut & Neumann, 1992; Pereira & Mota, 2002).

Restricting attention to the word level during assessment and treatment may not be the best approach to address generalization learning. Conversational probes may be the measure of choice to assess generalization because children appear to produce sounds less accurately in connected speech than in word probes (DuBois & Bernthal, 1978; Healy & Madison, 1987; Morrison & Shriberg, 1992), indicating that greater skills are needed for sound productions in conversational contexts. Furthermore, conversation training seems to promote sound generalization to conversational contexts (Camarata, 1993; Williams, 2000). Further, combined treatments that provide different linguistic levels for target sound production seem to facilitate generalization of treated sounds to untreated words (Tyler & Sandoval, 1994; Williams, 2000).

Research has also shown that treating sound productions at the word level with direct feedback seems to be effective (e.g., Gierut, 1999; Gierut & Champion, 2001; Gierut et al., 1996; Hoffman et al., 1990; Miccio & Ingrisano, 2000; Morrisette & Gierut, 2002; Weiner, 1981a). Learners seem to need to take notice of their problems to have more chance for self-correction (Bauman-Waegler, 2000; Gass & Varonis, 1994). However, as far as we know, no study has addressed whether direct feedback in conversation leads to greater sound generalization to conversational contexts than indirect feedback.

In short, a combined treatment including phonological intervention at the word level and at the conversational level seems to be appropriate for children with phonological disorders if the focus is generalization to untreated words. However, one question still remains. Since direct feedback has been shown to be effective on sound production at the word level, would a conversation training with direct feedback promote generalization of the target sound to conversational contexts to a greater extend than the naturalistic conversation training with indirect feedback?

In the current study, conversation training with direct and indirect feedback was introduced after maximal opposition treatment to facilitate generalization learning. To investigate the effects of direct feedback on sound generalization, conversation training with direct feedback was compared to conversation training with indirect feedback. Direct feedback was used to call the children's attention to the sound errors. The maximal opposition treatment was used for the acquisition of sounds and decrease the use of phonological processes, while the conversation training was used to facilitate the transfer of treated sound productions to conversational contexts.

It was hypothesized that:

1. When children receive the combination of maximal opposition treatment and conversation training with direct feedback, they will generalize (a) target sound production to a greater accuracy and (b) the occurrence of the target phonological process to a lower percentage, to non-treatment conversational contexts with the clinician, than

when they receive maximal opposition treatment and conversation training with indirect feedback.

2. Children who receive a combined treatment consisting of maximal opposition treatment and conversation training will generalize target sound production across word positions, to untreated words, across linguistic units and within and across sound classes.

CHAPTER 2: METHOD

Participants

From seven children who were assessed, two qualified to participate in the study, a boy, MS, and a girl, EM, who were 4:10 and 5:4 (years:month) respectively at the time this study was conducted. Both children spoke only English at home and school, and had received speech therapy prior to their participation in the study. They discontinued speech therapy while participating in the study.

Participant Selection Criteria

Each child met the following entry criteria: (a) at least moderate to severe phonological disorder measured with the phonological deviation score (39 points, 0=normal) on the Assessment of Phonological Processes-Revised (APP-R) (Hodson, 1986); (b) a score of lower than 65% (at least moderate-severe) in the Percentage of Consonants Correct (PCC) (Shriberg & Kwiatkowski, 1982) calculated from a 10-minute conversational generalization probe; (c) normal hearing, determined by a standard audiometric screening (ASHA, 1985); (d) normal oral and speech motor ability, determined by the Oral-facial Examination Form screening (Shipley & McAfee, 1998); and (e) residency in a monolingual English-speaking family. Results of pretreatment assessments for each child are displayed in Table 1.

Participant Characteristics

To obtain additional information on the participants, the Structured Photographic Expressive Language Test-II (SPELT-II) (Werner & Kresheck, 1983) was administered to each child, and both children received age-appropriate scores (see Table 1).

Phonological analyses for each child, based on the results of the APP-R, are described below (see Appendix A for more details).

Table 1

Results of pretreatment assessments for both participants

Participants	Age	APP-R[a]	PCC[b]	SPELT-II[c]
MS	4:10	59	28%	51
EM	5:4	56	46%	84

[a]Phonological deviancy score on the Assessment of Phonological Processes Revised (Hodson, 1986). [b]Percentage of Consonants Correct (Shriberg & Kwiatkowski, 1982). [c]Percentile score on the Structured Photographic Expressive Language Test-II (Werner & Kresheck, 1983).

Participant MS

The phonological analysis from the APP-R revealed the following phonological processes: voicing occurred in 6% of opportunities, stopping in 7% of opportunities, vowelization in 33% of opportunities, gliding in 35% of opportunities, fronting in 37% of opportunities, final consonant deletion in 52% of opportunities, and cluster reduction in 95% of opportunities. The analysis by class of sounds indicated that MS did not correctly produce 88% of stridents [s, z, ʃ, ʒ, tʃ, dʒ, f, v], 73% of velar obstruents [k, g], 100% of liquids [l, r], and 10% of glides [w] (see Appendix A for more details).

<u>Participant EM</u>

The phonological analysis from the APP-R revealed the following phonological processes: stopping occurred in 5% of opportunities, devoicing in 6% of opportunities, backing in 11% of opportunities, final consonant deletion in 23% of opportunities, deaffrication in 25% of opportunities, alveolarization in 46% of opportunities, fronting in 58% of opportunities, and cluster reduction in 63% of opportunities. EM also had unusual processes such as cluster addition and the use of sound preference (Bauman-Waegler, 2000). EM substituted /s/ and /z/ for the phonemes /t, k, f, v, ʃ, ʒ, dʒ, θ/. The analysis by class of sounds indicated that EM did not correctly produce 33% of stridents [z, ʃ, ʒ, tʃ, dʒ, f, v], 100% of velar obstruents [k, g], 64% of the liquid /l/ and 38% of the liquid /r/, 37% of nasals [ŋ, m, n], and 100% of glides [w, j] (see Appendix A for more details).

Materials

All the assessment and treatment sessions for MS were conducted in a clinic room at The University of Georgia. All sessions for EM were conducted in her home's living room. Clinicians used stimulus materials relevant for each session, such as games and toys. All sessions were recorded on videotape (JVC Gold t-120 cassettes) using a Panasonic video camera recorder (AG-190-P) located in the room with the children. Data sheets were also used by the clinicians to collect data on-line.

Procedures

The purpose of the study was explained to the parents prior to the initiation of the study, and any questions that they had were answered. Their written informed consent for participating was then obtained, according to the guidelines of The University of Georgia's Institutional Review Board.

Clinicians' Training

Two undergraduate students in speech-language pathology conducted all the assessment and treatment sessions, clinician 1 for MS and clinician 2 for EM. Before treatment started, the clinicians received at least 5 hours of training to learn the treatment and assessment procedures, and to learn how to manipulate experimental conditions (e.g., feedback and instructions). The video of a pilot child (see Appendix B for more details) was also used to provide procedural reliability and training for clinician 1**.** Clinician 2 watched videotapes of MS's sessions to learn the treatment and assessment procedures. The experimenter observed all assessment and treatment sessions, and, when needed, provided feedback for the clinicians to ensure procedural reliability.

Selection of Treatment Targets

One target sound and one phonological process were selected for each child. Phonological processes and sounds were ruled out as possible targets if they occurred or were in error less than 50% of the time. Guidelines for the selection of target sounds were based on a maximal opposition procedure. The children's contrast sounds were selected by identifying a correctly produced sound that differed by as many distinctive features as possible from the errored sounds. Since later-acquired sounds, nonstimulable sounds, and the child's least productive phonological knowledge sounds may only improve with direct treatment and lead to greater sound generalization (Gierut et al., 1987; Gierut et al., 1996; Powell, 1991; Powell et al., 1991; Powell et al., 1998; Williams, 1991), the children's errored sounds that matched at least two of these criteria were selected.

Participant MS

MS displayed Type 1 phonological knowledge (Gierut et al., 1987) for the target sounds [m, n, ŋ, j]. These sounds were produced correctly in all word positions at all times. The sounds [p, b, t, d, dʒ, w] were ranked as Type 2 phonological knowledge (Gierut et al., 1987). These sounds were produced correctly in all word positions; however, a phonological rule such as cluster reduction and final consonant deletion affected production of these sounds. MS did not exhibit Types 3 and 4 phonological knowledge (Gierut et al., 1987). The sounds [k, g, v] were ranked as Type 5 phonological knowledge (Gierut et al., 1987). These sounds were produced correctly in at least one word position, but not all the time. The sounds [f, s, z, ʃ, ʒ, tʃ, l, r, θ, ð] were ranked as Type 6 phonological knowledge (Gierut et al., 1987). These sounds were never produced correctly. MS produced no liquid sounds, no dental sounds, and no [+lateral] sounds. Among the sounds that were not produced during the phonological assessment, MS was stimulable for [f, l] and not stimulable for [s, z, ʃ, ʒ, tʃ, θ, ð, r]. Sound stimulability was assessed using a nonsense syllable task.

MS's phonological processes that occurred more than 50% of the time were cluster reduction with 95% occurrence and final consonant deletion with 52% occurrence. Final consonant deletion was chosen because this process affected more phonemes than cluster reduction**.** The phoneme /s/ was selected because it was not stimulable, was classified as Type 6 phonological knowledge, and was supposed to be mastered at age 8:0 (Sander, 1972). MS's accurate /m/ sound was used as a comparison sound. The /m/ sound differs from /s/ by place of production, manner of production, and voicing. The distinctive feature differences between /m/ and /s/ were [coronal], [nasal], [continuant], [voiced], and [strident], and included a major class distinction [sonorant] (Gierut, 1989, 1990, 1992).

<u>Participant EM</u>

The girl EM displayed Type 1 phonological knowledge (Gierut et al., 1987) for the target sounds [h, s] that were produced correctly in all word positions and were never produced incorrectly. The sounds [p, b, d, l] were ranked as Type 2 phonological knowledge (Gierut et al., 1987). These sounds were produced correctly in all word positions; however, a phonological rule such as cluster reduction, final consonant deletion, alveolarization and fronting affected production of these sounds. EM did not exhibit Types 3 and 5 phonological knowledge (Gierut et al., 1987). The sounds [m, t, n, z, r] were ranked as Type 4 phonological knowledge. These sounds were always produced correctly in at least one word position. The sounds [w, j, f, v, ʃ, ʒ, tʃ, dʒ, k, g, ŋ, θ, ð] were ranked as Type 6 phonological knowledge (Gierut et al., 1987). These sounds were never produced correctly. EM did not produce affricates and glides sounds, dental, postalveolar and velar sounds, and [+high] and [+back] sounds. Among the sounds that were not produced during the phonological assessment, EM was stimulable for [f, v, ŋ] and not stimulable for [w, j, ʃ, ʒ, tʃ, dʒ, k, g, θ, ð]. Sound stimulability was assessed by a nonsense syllable task.

EM's phonological processes that occurred more than 50% of the time were cluster reduction with 63% occurrence, and fronting with 58% occurrence. Fronting was chosen because this process affected more phonemes than cluster reduction. The phoneme /k/ was selected because it was not stimulable, and it was classified as Type 6 phonological knowledge. However, EM refused to work on the /k/ sound; for example, she did not want to imitate the clinician's productions. Therefore, the /ʃ/ sound was selected because it was also not stimulable, was also classified as Type 6 phonological knowledge, and was supposed to be mastered at age 7:0 (Sander, 1972). MS's accurate /l/ sound was used as a comparison sound. The /l/ sound differs from /ʃ/ by place of production, manner of production and voicing. The distinctive feature differences between /l/ and /ʃ/ were [anterior], [lateral], [high], [voiced] and [strident], and included major class distinctions [sonorant] and [vocalic] (Gierut, 1989, 1990, 1992).

Experimental Design

This study was constructed as a variation of an ABA withdrawal single-subject design, specifically A-BC-BD-A for MS and A-BD-BC-A for EM. Each participant was assigned to receive a combined treatment consisting of the maximal opposition treatment (B) and the conversation training in each session. The conversation training was divided into two types: conversation training with indirect feedback, labeled C, and conversation training with direct feedback, labeled D. Counterbalancing the order of the BC and BD phases provided a control for order effects.

Treatment sessions were supposed to take place four times a week, but due to therapy cancellations and parents' schedules, treatment was provided two to four times per week. Each session lasted 50 minutes, and included a 10-min conversational generalization probe followed by a 40-min treatment. The 40-min treatment consisted of 20 minutes of maximal opposition treatment at the word level (B) followed by 20-min of conversation training targeting the sound at the conversational level (either C or D).

Baseline: A Phases

The baseline or A phases were the first and the last phases for each child, and were used to collect data prior to and at the conclusion of the experimental phases. To establish a baseline for subsequent phase changes, the clinician collected 10-min conversational generalization probes until the child's performance stabilized. The 10-min probes in the A phases were at least 5 minutes apart. The clinician calculated the percent correct productions of the target sound and the percentage of occurrence of the target phonological process from all the probes during each session.

Combined Treatment: BC and BD Phases

Both children received the maximal opposition treatment (B), which consisted of two stages: imitation and spontaneous productions. During the imitative stage, each child was instructed to repeat the clinician's verbal model until the child produced the target sound with 50% accuracy in treated words for two consecutive sessions. Phonetic placement cues and auditory discrimination training were not introduced directly. Five picturable maximal pairs were selected for the target sound for each child (see Appendix C). The children played games to ensure diverse opportunities for production, and to maintain their interest and attention; for example, they play with the clinician "Go Fish," memory, bingo, bowling, and board games that contained the maximal pairs.

When the child produced the target sound with 50% accuracy for two consecutive sessions in imitation, the spontaneous stage was initiated. In this stage, the child was asked to name the maximal-pair pictures without the clinician's verbal model. The same five maximal-pair pictures and types of activities used in the imitation stage were used in the spontaneous stage. Different activities were also used: for example, in one game, the clinician picked up the picture the child named (Weiner, 1981a). In another game, the child named a picture and placed it in the pile that contained pictures with the same sound. During all maximal opposition treatment sessions, the clinician gave direct feedback for correct and incorrect productions. For example, after a correct production, the clinician said "that was a good /s/," and after an incorrect production, the clinician said "I didn't hear a good /s/, let's try again."

Both children also received one of two versions of conversation training during the same sessions as the maximal opposition treatment. During the conversation training, the clinician interacted with the child during play activities, providing numerous opportunities to initiate conversation and to produce the target sound at the conversational level. For instance, the clinician used open-ended questions, such as "what is happening?" to encourage the child to verbalize. To ensure that there were diverse opportunities for the child to produce the treated sound, at least 10 toys and objects containing the target sound were preselected. For example, when the target sound was final /s/, the objects for selection included two horses, a mouse, a moose, a goose, grass, lettuce, ice, orange juice and a bus.

During the indirect feedback version of conversation training (C), treatment was based on Camarata's (1993) procedure. The clinician maintained the "integrity of the interaction" by not limiting or leading directly the child's linguistic output. The clinician only provided indirect feedback immediately following the child's incorrect sound production by saying, for example, "yes, he put some ice" if the child said /aɪ/ for "ice." No feedback was provided for grammatical errors. In addition, the clinician reinforced correct sound productions by saying, for example, "yes," "you are right, it is a moose."

No direct requests for imitation or self-correction were made. The clinician only played with the toys and modeled the target sound instead of asking the child to say the word correctly. The clinician only asked the child to repeat when it was pragmatically appropriate; for example, when the clinician could not understand what the child had said. This request for repetition was not directly connected to utterances of the treatment targets.

During the direct feedback version of conversation training (D) the clinician gave direct feedback to all the child's attempts to produce the target sound by saying, for example, "I didn't hear a good /s/, let's try again," or "that was a good /s/." The clinician also asked for imitation if the child failed to produce the same target sound correctly three times in a row or if the child asked for clarification (e.g., when the child asked how a target sound should be produced).

Phase Changes

The dependent variables for all phase change decisions were the child's percentage of correct productions of the target sound and the percentage of occurrence of the target phonological process, as calculated from the 10-min conversational generalization probes conducted at the beginning of each session. The number of data points in each phase was determined by data trends rather than a predetermined criterion. Phase changes occurred after at least three data points in each phase were stable or the direction and nature of change were clear (McReynolds & Kearns, 1982). The stability criterion was at three data points or more with a variation of not more than 10% (shown on a graph) between points (Hersen & Barlow, 1976).

Data Analysis

In the current study, correct sound production was defined as correct production of the target sound with no articulatory error. The analysis of occurrence of phonological process was based on all sound productions for which the target process could have occurred.

Treatment Data

The treatment data measured target sound productions and process frequency in treatment conditions. The children's percentage of correct productions of the target sound, obtained on-line by the clinician, and the percentage of occurrence of the target phonological process, obtained by the experimenter from videotapes, were calculated for each session of the maximal opposition treatment and of the conversation training. Each child produced at least 80 words with the target sound during each maximal opposition treatment session, and at least 20 words with the target sound during each conversation training session.

Generalization Data

Generalization data were obtained from pretreatment and posttreatment measures: the PCC, the APP-R, and the 20-word probes, and from the 10-min conversational generalization probes in the beginning of each session.

PCC and APP-R. The PCC was obtained by the experimenter from videotapes of one 10-min conversational generalization probe before treatment and one after treatment. It was calculated by dividing the number of correct sound productions by the total number of attempts (correct and incorrect) and multiplying by 100 (Shriberg & Kwiatkowski, 1982). The pretreatment and postreatment conversational generalization probes, from which the PCC was computed, were videotaped and phonetically transcribed by the clinician and the experimenter for MS, and by the experimenter for EM. The APP-R (Hodson, 1986) data were transcribed on-line by the clinician and the experimenter, and analyzed and scored by the experimenter after the session.

Word Probe. The pretreatment and postreatment word probes consisted of 20 picturable words that were designed to elicit spontaneous productions of the target sound for each child in the initial, medial, and final positions. Word probe data were obtained on-line by the clinician and the experimenter independently. The clinician did not provide specific performance feedback or reinforcement during this task, although the clinician reinforced the child for working well and gave stickers at the end of the task. See Appendix D for more details.

Conversational Generalization Probes. Each child participated in 10-min conversational generalization probes with the clinician at baseline and at the beginning of each session to establish baseline data for determining phase changes, and to measure generalization of treatment target productions to conversational contexts in the non-treatment condition and treatment setting. At least 10 age-appropriate toys containing the target sounds with untreated words were used. The percentage of correct productions of the target sound and the percentage of occurrence of the target phonological process were calculated from all 10-minute conversational generalization probes on-line by the clinician. Each child produced at least 20 responses of the treatment target production in each probe.

Reliability

Before treatment started, the clinicians were trained on treatment and assessment procedures (e.g., feedback and instructions). They remained, however, blind to the hypothesis of this study. Videotapes from a pilot child were also used to provide procedural training for one of the clinicians. The experimenter observed all assessment and treatment sessions, and provided feedback for the clinicians to ensure procedural reliability as needed.

Interjudge reliability was assessed by having one or two judges (experimenter and research assistant) watch videotaped sessions. Reliability was assessed for pretreatment and posttreatment data, the percentage of correct productions of the target sound in maximal opposition treatment and in conversation training, and for the percentage of correct productions of the target sound and the percentage of occurrence of the target process in conversational generalization probes. The data obtained by one of the judges were compared to the original data collected on-line by the clinician on a point-to-point basis. Agreement was noted when a judge and the clinician identified each sound production as correct or incorrect. The intrajudge reliability was assessed by having the clinician rewatch videotaped sessions, and the data were compared to the original data collected on-line. No interjudge or intrajudge reliability data were computed for the percentage of occurrence of the target process in maximal opposition treatment and in conversation training.

Participant MS

Treatment data. The mean interjudge agreement between the clinician and the experimenter for the percentage of correct productions of the target sound in maximal opposition treatment was 98%, ranging from 94% to 100%, calculated on 64% of the session data. The mean intrajudge agreement for the percentage of correct productions of the target sound in maximal opposition treatment was 99%, ranging from 97% to 100%, calculated on 41% of the session data. The mean interjudge agreement between the clinician and the experimenter for the percentage of correct productions of the target sound in conversation training was 99%, ranging from 98% to 100%, calculated on 38% of the session data. Intrajudge agreement for the percentage of correct productions of the target sound in conversation training was not computed.

Pretreatment and posttreatment data. The pretreatment and posttreatment data were computed from the SPELT-II, the PCC, the APP-R, and the 20-word probes combined. The mean interjudge agreement between the clinician and the experimenter for the pretreatment and posttreatment data was 99%, ranging from 96% to 100%, calculated on 100% of the data. Intrajudge agreement for pretreatment and posttreatment data was not computed.

Conversational generalization probes. The mean interjudge agreement between the clinician and the experimenter for the percentage of correct productions of the target sound and the percentage of occurrence of the target process was 98%, ranging from 95% to 100%, calculated on 78% of the probes. The mean interjudge agreement between the clinician and the research assistant for the percentage of correct productions of the target sound and the percentage of occurrence of the target process was 90%, ranging from 76% to 100%, calculated on 36% of the probes. The mean intrajudge agreement for the percentage of correct productions of the target sound and the percentage of occurrence of the target process was 98%, ranging from 97% to 100%, calculated on 23% of the probes.

Participant EM

Treatment data. The mean interjudge agreement between the clinician and the experimenter for the percentage of correct productions of the target sound in maximal opposition treatment was 96%, ranging from 92% to 100%, calculated on 87% of the session data. The mean interjudge agreement between the clinician and the research assistant for the percentage of correct productions of the target sound in maximal opposition treatment was 97%, ranging from 94% to 99%, calculated on 26% of the session data. The mean intrajudge agreement for the percentage of correct productions of the target sound in maximal opposition treatment was 95%, ranging from 91% to 98%, calculated on 26% of the session data. The mean interjudge agreement between the clinician and the experimenter for the percentage of correct productions of the target sound in conversation training was 97%, ranging from 94% to 100%, calculated on 82% of the session data. The mean interjudge agreement between the clinician and the research assistant for the percentage of correct productions of the target sound in conversation training was 98%, ranging from 95% to 100%, calculated on 27% of the session data. The mean intrajudge agreement for the percentage of correct productions of the target sound in conversation training was 96%, ranging from 95% to 96%, calculated on 27% of the session data.

Pretreatment and posttreatment data. The pretreatment and posttreatment data were computed from the SPELT-II, the PCC, the APP-R, and the 20-word probes combined. The mean interjudge agreement between the clinician and the experimenter for the pretreatment and posttreatment data was 99%, ranging from 96% to 100%, calculated on 63% of the data. Intrajudge agreement for pretreatment and posttreatment data was not computed.

Conversational generalization probes. The mean interjudge agreement between the clinician and the experimenter for the percentage of correct productions of the target sound and the percentage of occurrence of the target process was 98%, ranging from 90% to 100%, calculated on 67% of the probes. The mean intrajudge agreement for the percentage of correct productions of the target sound and the percentage of occurrence of the target process was not computed.

CHAPTER 3: RESULTS

Results for both participants are presented in Figures 1-5. The figures present data about each child's percentage of correct productions of the target sound and the percentage of occurrence of the target process calculated from the 20-min maximal opposition treatment, the 20-min conversation training, and the 10-min conversational generalization probes.

Participant MS

MS's phases were completed in eight sessions during a period of 20 days. The intervals between sessions ranged from 1 to 5 days. MS's results are summarized below.

Treatment Data

Treatment session data were obtained during the maximal opposition treatment and during the conversation training. The data are displayed in Figure 1.

Maximal Opposition Treatment

In the first treatment session, final consonant deletion occurred with a frequency of 4%, and this level was maintained throughout the treatment sessions. MS produced final /s/ with 0% accuracy in the first treatment session (100% of productions were lateralized). In the second session, his correct final /s/ production increased to75%, with 25% of productions lateralized. These levels were maintained until the sixth session, when MS's correct production of final /s/ increased to 90% (10% of productions were lateralized). His correct production of final /s/ kept increasing, reaching 100% in the last treatment session, and his lateralization kept decreasing, reaching 0% in the last treatment session.

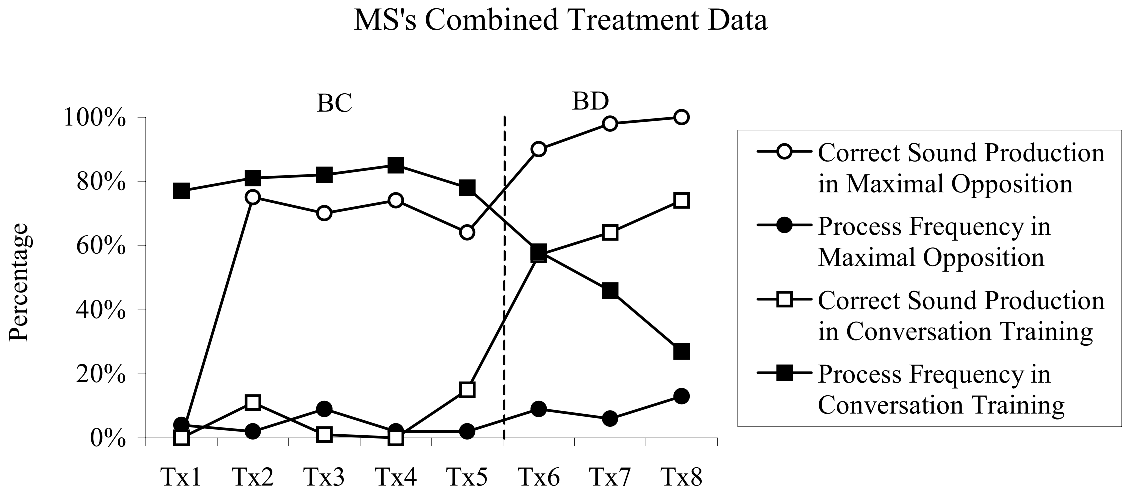

Figure 1. MS's percentage of correct final /s/ production and percentage of final consonant deletion in maximal opposition treatment and in conversation training.

Conversation Training

In the first session of the conversation training portion of the phase BC, in which indirect feedback was provided, MS's produced final consonant deletion in 77% of opportunities and produced final /s/ with 0% accuracy. These levels remained stable throughout this phase. In the sixth session, the BD phase was initiated, in which direct feedback of the target sound /s/ was included in the conversation training. MS's correct final /s/ production rose from 15% in the fifth session to 57% in the sixth session, and to 74% in the last treatment session. In addition, the percentage of occurrence of final consonant deletion decreased from 78% in the fifth session to 58% in the sixth session, to 27% in the last treatment session.

Conversational Generalization Data

Conversational generalization data were collected from 10-min conversational generalization probes during baseline and in the beginning of each session during treatment phases. These data are displayed in Figure 2.

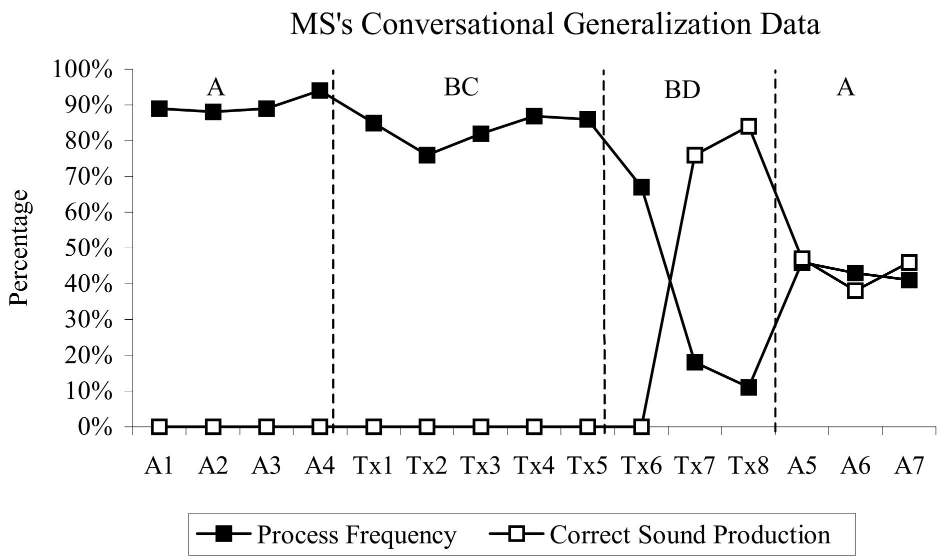

Figure 2. MS's percentage of correct final /s/ production and percentage of final consonant deletion from 10-min conversational generalization probes in the baseline (A) and the treatment phases (BC and BD).

Baseline

MS did not produce final /s/ correctly in the baseline conversational generalization probes before treatment. His correct final /s/ production was 0% in all four baseline probes, indicating that they were stable. Final consonant deletion occurred with frequencies of 89%, 88%, 89%, and 94% consecutively in the baselines, also indicating that they were stable.

Combined Treatment: BC and BD Phases

BC phase. During this phase, in which indirect feedback was used during conversation training, MS's correct final /s/ production remained at 0% in the conversational generalization probes. Final consonant deletion in these probes decreased from 94% before treatment to 85% after the first treatment session, and remained stable for the remaining sessions in this phase.

BD phase. In the sixth treatment session, direct feedback of the target sound /s/ was introduced during conversation training. MS's correct final /s/ production remained at 0% until the seventh treatment session, in which he produced final /s/ with 76% accuracy in the conversational generalization probes. In the last treatment session, he produced final /s/ with 84% accuracy. MS's final consonant deletion process, as measured in the conversational generalization probes, decreased from 86% at the end of the BC phase, to 67% in the sixth treatment session to 11% in the last treatment session. At the conclusion of the BD phase, baseline conversational generalization probes were again collected to determine whether the apparent increase in correct final /s/ production and reduction in the percentage of occurrence of final consonant deletion would be supported when treatment was withdrawn.

Return to Baseline

As expected, when treatment was withdrawn, MS's correct final /s/ production decreased from 84% at the end of BD phase to 47%, 38% and 46% consecutively in the three baseline probes after treatment. As expected, also, his percentage of occurrence of final consonant deletion increased from 11% at the end of BD phase to 46%, 43% and 41% consecutively in the three baseline probes.

Generalization Learning: Posttreatment Measures

Untreated Words and Across Word Position

Based on the word probes results (see Appendix D for details), MS generalized the treated sound to untreated words. MS's correct /s/ production in the word probes rose from 0% accuracy before treatment to 30% accuracy after treatment. In the word probe after treatment, he correctly produced /s/ in the medial position in 29% of opportunities and in the final position in 80% of opportunities. MS did not generalize the final /s/ to the initial word position.

Sound Classes

Based on the APP-R results prior to and after treatment (see Appendix A for details), MS added the untreated sounds /f, z, ʒ, ð/ to his inventory. Therefore, he generalized within sound classes by correctly producing these untreated fricatives, but he did not generalize across sound classes. The treated feature [+continuant] seemed to impact the acquisition of the new sounds. MS also generalized word-final productions to untreated words with the treated sound /s/, as well as with untreated sounds /z, v, f, p/. MS did not produce any of these sounds in the word-final position in the APP-R prior to the treatment. In the APP-R after treatment, MS produced /v, p, f/ in the final position with 100% accuracy, /s/ with 50% accuracy, and /z/ with 33% accuracy. The treated place feature [+anterior] seemed to impact generalization of /s/ treatment to /s, z, v, f, p/. The manner feature [+continuant] seemed to impact generalization to /s, z, v, f/, and the voice feature [-voice] seemed to impact generalization to /s, f, p/. The child did not generalize word-final productions of untreated /ʃ, ʒ, tʃ, θ/.

Participant EM

EM's phases were completed in eight sessions during a period of 17 days. The intervals between sessions ranged from 1 to 3 days. EM's results are summarized below.

Treatment Data

Data were collected from the treatment probes obtained during maximal opposition treatment and during the conversation training. The data are displayed in Figure 3.

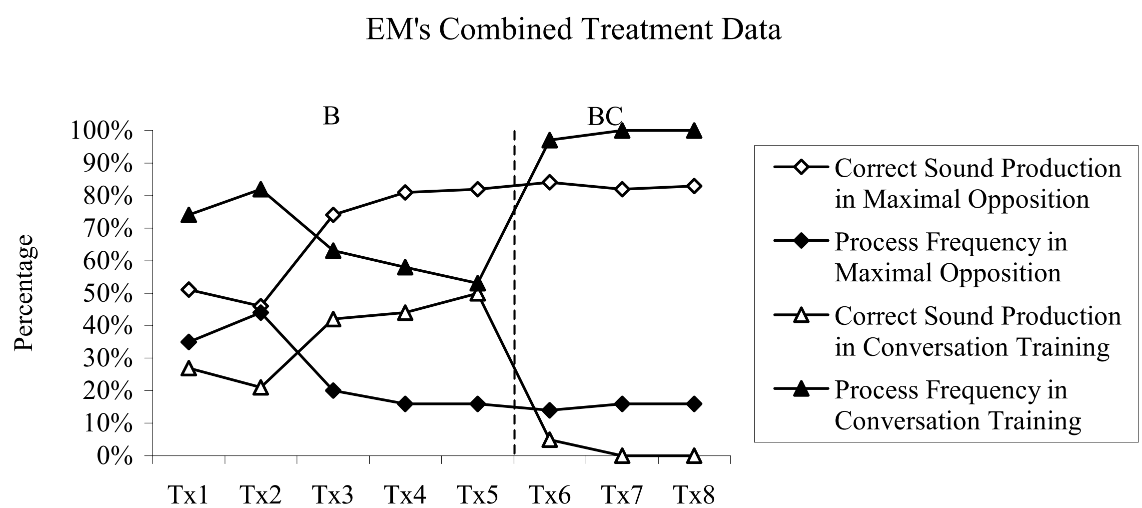

Figure 3. EM's percentage of correct /ʃ/ production and percentage of fronting in maximal opposition treatment and in conversation training.

Maximal Opposition Treatment

In the first session, EM produced /ʃ/ with 51% accuracy at the single word level. Her correct /ʃ/ production decreased to 46% in the second session, but it increased again in the next sessions, reaching 83% in the last treatment session. In the first session, fronting occurred in 35% of opportunities. In the third session, the percentage of occurrence of fronting started decreasing, reaching 16% in the last session.

Conversation Training

In the first treatment session of the conversation training portion of the BD phase, in which direct feedback was used, EM produced /ʃ/ with 27% accuracy, it decreased to 21% accuracy in the second treatment session, and it increased again in the next three sessions, reaching 50% accuracy in the fifth session. In addition, in the first treatment session, fronting occurred in 74% of opportunities, it increased to 82% in the second session, and it decreased again in the next three sessions, reaching 53% in the fifth session. In the sixth session, the BC phase was initiated, in which indirect feedback was used. EM's correct /ʃ/ production decreased from 50% in the fifth session to 5% in the sixth session, to 0% in the last session. In addition, the percentage of occurrence of fronting increased from 53% in the fifth session to 97% in the sixth session to 100% in the last treatment session.

Conversational Generalization Data

Conversational generalization data were collected from 10-min conversational generalization probes during baseline and in the beginning of each session during treatment phases. These data are displayed in Figure 4.

Baseline

EM produced /ʃ/ in the baseline conversational generalization probes with 0% accuracy, indicating that they were stable. Fronting occurred in 80%, 81%, and 79% of opportunities consecutively in the baseline probes, also indicating that they were stable.

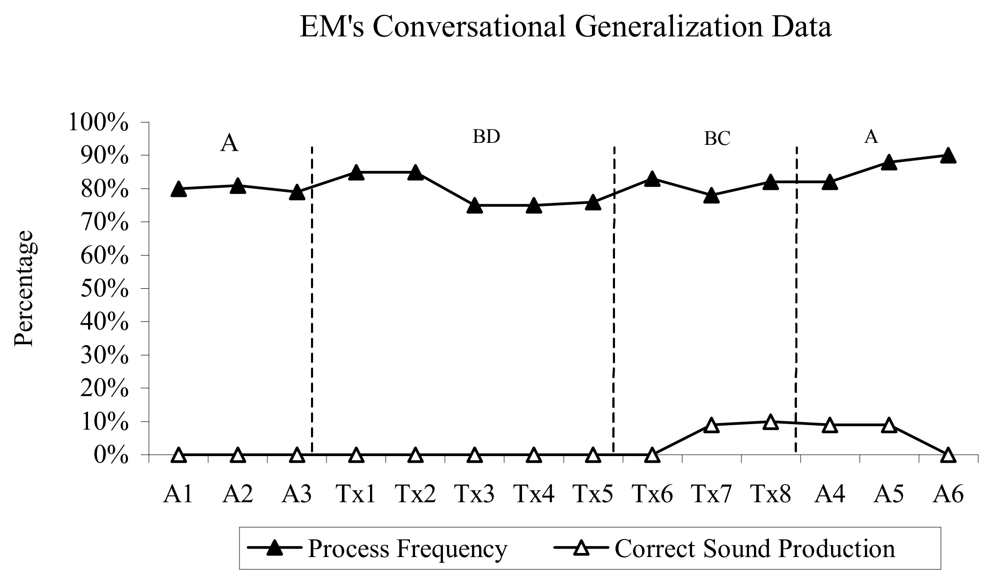

Figure 4. EM’s percentage of correct /ʃ/ production and percentage of fronting from 10-min conversational generalization probes in the baseline (A) and the treatment phases (BD and BC).

Combined Treatment: BD and BC Phases

BD phase. During this phase, in which direct feedback was used during conversation training, EM’s correct /ʃ/ production remained at 0% in the conversational generalization probes. In the first treatment session, she produced fronting process in 79% of opportunities, and this level remained stable throughout the BD phase.

BC phase. In the sixth treatment session, indirect feedback was used during conversation training. EM's correct /ʃ/ productions were 0%, 9% and 10% consecutively in this phase. Since there was a minimal change in the data trend level, EM's /ʃ/ productions were considered to be stable.

Return to Baseline

When treatment was withdrawn, EM's correct /ʃ/ productions were 9%, 9% and 0% consecutively in the three baseline probes after treatment. She produced fronting process in 82%, 88% and 90% of opportunities consecutively in the baseline probes.

Generalization Learning: Posttreatment Measures

Untreated Words and Across Word Position

Based on the word probes results (see Appendix D for details), EM generalized the treated sound to untreated words in all word positions from 0% accuracy before treatment to 15% accuracy after treatment. In the word probe after treatment, she correctly produced /ʃ/ in the initial and final positions in 14% of opportunities in each word position, and in the medial position in 17% of opportunities. Therefore, she produced /ʃ/ in all word positions, but with a low percentage.

Sound Classes

Based on the APP-R results prior to and after treatment (see Appendix A for more details), EM added the untreated sounds /f, k, w, j/ to her inventory. Therefore, she generalized within and across sound classes by correctly producing the untreated fricative

/f/, the untreated stop /k/ and the untreated glides /w, j/. The treated feature [+continuant] seemed to impact the new sounds /f, w, j/ acquisitions, and the treated feature [+high] and [-anterior] seemed to impact the new sounds /k, w, j/ acquisitions. In fact, [+high] sounds were not present in EM's inventory prior to treatment.

Comparisons Across Participants

Severity Level of Phonological Disorder

As shown in Table 2, MS's APP-R phonological deviation scores decreased from 59 pretreatment to 50 posttreatment; both scores indicate a severe phonological disorder. His PCC score, collected from the baseline probe before the treatment, was 28%. This percentage is representative of a severe phonological disorder (Shriberg & Kwiatkowski, 1982). In the baseline probe after the treatment, MS's PCC score rose to 64%, which indicates a moderate to severe phonological disorder (Shriberg & Kwiatkowski, 1982). Similarly, EM's APP-R phonological deviation scores decreased from 56 pretreatment to 50 posttreatment; both scores indicate a severe phonological disorder. Her PCC score, collected from the baseline probe before the treatment, was 46%. This percentage is representative of a severe phonological disorder (Shriberg & Kwiatkowski, 1982). After treatment, EM's PCC score rose to 58%, which indicates a moderate to severe phonological disorder (Shriberg & Kwiatkowski, 1982).

Table 2.

Pretreatment and posttreatment measures of generalization learning

Subjects	APP-R[a]		PCC[b]		Word-Probe	
	Pre	Post	Pre	Post	Pre	Post
MS	59	50	28%	64%	0%	30%
EM	56	50	46%	58%	0%	15%

[a]Assessment of Phonological Processes Revised (Hodson, 1986). [b]Percentage of Consonants Correct (Shriberg & Kwiatkowski, 1982).

Production at the Conversational Level

For both children, conversation training with direct feedback resulted in a lower percentage of occurrence of the target processes in treatment conditions than conversation training with indirect feedback, as shown in Figure 5. MS's percentage of occurrence of final consonant deletion during conversational training decreased from 78% in the fifth session to 58% in the sixth session, immediately after the direct feedback was introduced. In addition, his percentage of occurrence of final consonant deletion of /t/ decreased from 80% during conversation training with indirect feedback to 33% during conversation training with direct feedback. His percentage of occurrence of final consonant deletion of /k/ decreased from 50% during conversation training with indirect feedback to 22% during conversation training with direct feedback. MS also produced final /p/, which was not produced at this word position in the APP-R before treatment, in the seventh session.

EM's percentage of occurrence of the target processes during conversation training with direct feedback was also lower than during conversation training with indirect feedback. Her percentage of occurrence of fronting increased to 53% in the fifth session to 93% in the sixth session, immediately after the direct feedback was removed during conversation training. However, there was no evident change in fronting of sounds other than /ʃ/ during conversation training with direct and indirect feedback.

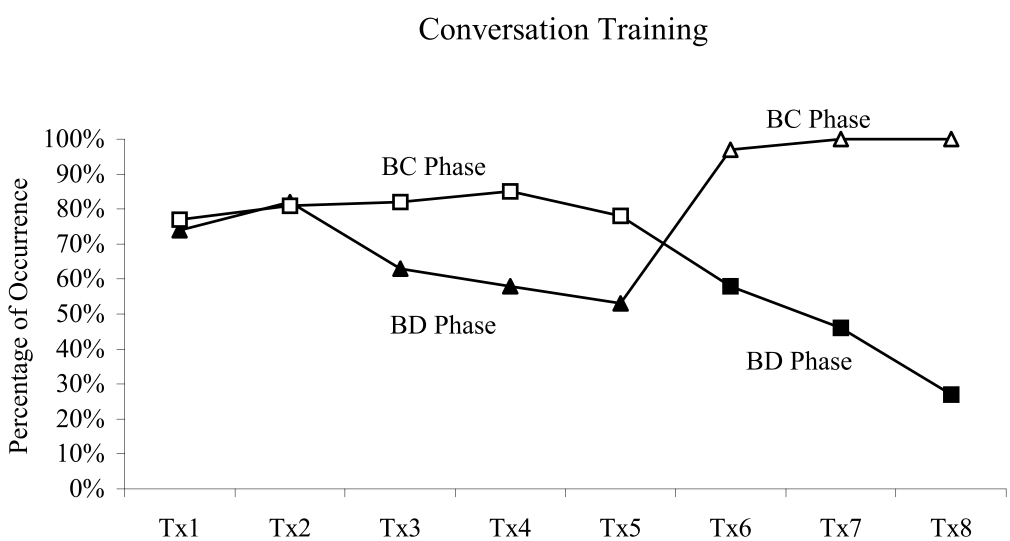

Figure 5. Percentage of occurrence of target process for MS (squares) and for EM (triangles) in conversation training with indirect feedback (open) and with direct feedback (solid).

CHAPTER 4: DISCUSSION

Effects of Direct Feedback

In the present study, it was hypothesized that when children receive maximal opposition treatment and conversation training with direct feedback, they generalize target sound productions to greater accuracy and the occurrence of the target process to lower percentages in conversational contexts than when they receive maximal opposition treatment and conversation training with indirect feedback. The findings of this study partially support this hypothesis. The combined treatment with direct feedback impacted generalization to conversational contexts for one child. MS generalized final /s/ productions and decreased the percentage of occurrence of final consonant deletion to conversational contexts in conversational generalization probes only after direct feedback was introduced during the conversation training. These results suggest that conversation training with indirect feedback may not be sufficient to promote generalization to conversational contexts in children with severe phonological disorders. Further, for both children, we found that conversation training with direct feedback had a positive effect on correct productions of the target sounds and on the percentage of occurrence of the target processes during conversation training in treatment conditions.

The current findings regarding direct feedback support previous suggestions that direct feedback at the word level may have positive effects on children's productions during phonological treatment (Gierut, 1999; Gierut & Champion, 2001; Gierut et al., 1996; Hoffman et al., 1990; Miccio & Ingrisano, 2000; Morrisette & Gierut, 2002; Weiner, 1981a). To the best of our knowledge, the current study is the first one to investigate the effects of direct feedback during phonological treatment at the word and the conversational levels. In contrast, it seems that the only type of feedback that has been used at the conversational level in phonological intervention research is indirect feedback. In Camarata's (1993) study, during conversation training, the clinician produced the correct model when the child had an incorrect production, without giving direct feedback. In contrast to our study, he suggested that conversation training with indirect feedback leads to generalization in conversational contexts in non-treatment conditions. Perhaps, in Camarata's study, both children seem to have mild to moderate phonological disorders. It is possible that children with more severe phonological disorders may need direct feedback at the conversational level to achieve sound generalization in spontaneous conversational contexts. Moreover, Camarata did not specify the children's difficulty at the word level, so it is possible that the children only had problems at the conversational level, and therefore had no difficulty generalizing to this level.

Direct feedback has also been effective in other research areas. For example, in the stuttering literature, direct feedback has been used at the conversational level in the same way as in the current study, and has shown to promote generalization of stutter-free speech to conversational contexts (e.g., Lincoln & Onslow, 1997; Lincoln et al., 1996; Onslow et al., 1990). For instance, Lincoln and Onslow (1997) reported long-term outcomes for 43 children between 2 and 5 years of age who received the Lidcombe Program. The Lidcombe Program is a stuttering treatment that consists of verbal contingencies (praise) for stutter-free speech and verbal contingencies (correction) for stuttered speech. The results indicated that all children achieved near-zero levels of stuttering, generalized their stutter-free speech to conversational contexts in different settings, and maintained their near-zero levels for 7 years postreatment. In spite of the similarities between the direct feedback used in the current study and the one in Lincoln and Onslow's (1997) study, in the latter study children received treatment from parents instead of clinicians.

Although the results of one child support our first hypothesis, the results of the other child did not. EM did not generalize under the direct or indirect conditions, possibly because she needed some additional time to assimilate the new sound, suggesting that generalization is a gradual process. The experimental design used in this study could have impacted EM's generalization outcome. Performance change instead of sound mastery was used as the discontinuous criteria. As a result, each participant had only 8 treatment sessions, which contrasts to the treatments in several other studies, where children had more than 12 treatment sessions (e.g., Gierut, 1989; Gierut & Neumann, 1992; Hoffman et al., 1990; Miccio & Ingrisano, 2000; Pereira & Mota, 2002; Powell, 1991; Rvachew & Nowak, 2001; Tyler et al., 1987; Tyler & Figurski, 1994; Tyler & Sandoval, 1994; Williams, 2000). It is possible that a child needs the direct feedback and a minimum number of sessions to be able to generalize to conversational contexts. In fact, although the trend indicated that there was less than 10% variation between scores, it is possible that EM was making smaller gains in generalization, which the cut-off criteria would miss.

One could assume that the treatment length could have been the only factor influencing generalization. However, results showed that the percentage of target sound productions during conversation training for both children in the treatment conditions changed immediately after the direct feedback was introduced or removed, suggesting that direct feedback may also impact generalization to conversational contexts.

Other factors could have affected EM's generalization of treated sounds to conversational contexts in non-treatment conditions. For example, EM had been in speech therapy in the school system for more than two years and still had not mastered any of the treated sounds, which are typically mastered at age 4:0. She also had a negative reaction towards speech therapy that could have resulted in lack of motivation. After repeated production failures, some children may build up a negative reaction towards speech activities, and think that they are incapable of producing certain sounds (Klein, 1996). In addition, sound preference seemed to impact EM's phonemic inventory and intelligibility. Because sound preference is different from phonological processes such as fronting or stopping (Leonard & Brown, 1984; Weiner, 1981b), this condition might have affected EM's phonological system differently, influencing her sound generalization to conversational contexts. In addition, in cases where clinicians have planned a generalization program as part of the phonological treatment, and the child still does not show signs of generalization of sound production in conversational contexts, more practice could be added, and the treatment program could be modified to facilitate generalization.

The generalization process can also be influenced by children's individual learning styles. Some children may generalize treated sounds to spontaneous contexts or to untreated sounds because they may process and identify features of the target sound that are shared among several sounds easily. On the other hand, other children may not generalize sound production that easily. Those children may have limited motoric ability, language disorders or even learning disabilities that involve other components of language and learning processes affecting generalization (Stoel-Gammon & Dunn, 1985).

In short, the present findings support the suggestion that learners appear to need direct feedback to take notice of their problems, and to increase their opportunity for self-correction (Bauman-Waegler, 2000; Gass & Varonis, 1994). Therefore, direct feedback seems to be appropriate for use in treatment programs at the word and conversational levels with children with severe phonological disorders. Further, the current study did not support Camarata's (1993) findings regarding indirect feedback in conversation training. Differences in severity levels in phonological patterns may account for the contradicting results.

Effects of a Combined Treatment

In the present study, it was hypothesized that children who receive a combined treatment consisting of maximal opposition treatment and conversation training would generalize target sound production across word positions, to untreated words, across linguistic units and within and across sound classes. We have found that, after treatment, both participants showed generalization of treated sounds to at least one word position, to untreated words, and within sound classes. One child also generalized across sound classes, and the other across linguistic units. Thus, the results provide partial support to the effect of combined treatment on generalization across sound classes and to conversational contexts in non-treatment conditions. In addition, based on pre and posttreatment measures, both participants improved their percentage of correct productions of the target sound in the single-word probe, their PCC scores, and their APP-R scores.

The current study's findings support previous studies that used combined treatments in that they found that training the target sounds at the word and at the discourse levels improved the children's productions of target sounds, and resulted in generalization of target sounds to untreated words (Tyler & Sandoval, 1994; Williams, 2000). Williams also reported that children who received the combined treatment generalized target sounds to conversational contexts. In her study, half of the children required intervention at the conversational level to achieve the generalization criterion. In addition, the children who received the combined treatment had more severe disorders. Williams suggested that training at the word level may not be sufficient for children with more severe disorders to achieve sound generalization to conversational contexts. Indeed, children in the present study had severe phonological disorders, and the combined treatment seemed effective. However, future studies need to address combined and non-combined treatments to determine their effects on generalization learning.

In spite of the similar results, the comparison between our findings and Williams's (2000) should be interpreted with caution. The design of the combined treatment used in her study differs from that of the current study. In Williams's study, 5 children that received treatment at the word and conversational levels did not receive treatments at both levels in every session. Instead, they received treatments at the word level for a few sessions, and then they received conversation training for more sessions. Furthermore, instead of using maximal opposition treatment at the word level, four of the children in the Williams's study received the multiple opposition and the maximal opposition treatments at the word level. The remaining child received the traditional articulation treatment at the word level.

Although Tyler and Sandoval (1994) also found positive effects of a combined treatment, their treatment design also differed from that of the current study. For instance, they only assessed sound generalization with word probes, so sound generalization at the conversational level, across word position, and within and across sound classes were not reported. Further, Tyler and Sandoval combined phonological and language treatment to investigate their effects on both disordered areas, and they did not use language intervention as a means for sound generalization.

In short, the combined treatment used in our study seems to promote generalization learning in children with severe phonological disorders, although the results only provide partial support to the effect of combined treatment on generalization to conversational contexts and across sound classes. In addition, our results are consistent with previous recommendations (e.g., Stokes & Osnes, 1989) that activities focusing on generalization should be planned and incorporated as part of the treatment, and that treated behavior should be involved in the same or similar condition as the desired generalization setting.

Additional Results

Our findings suggest that maximal opposition treatment promoted improvement of the target sound productions, and decreased the percentage of occurrence of phonological processes at the word level for both children. The children were able to change their sound productions without specific auditory discrimination training or phonetic placement cues. EM, however, needed production practice at the sound and syllable levels before attempting to produce the target sound in words. Her previous therapy profile and negative reaction towards intervention might have a role in EM's performance.

The current findings support previous results that have found that targeting sounds that are nonstimulable, later-acquired, and at the child's least productive phonological knowledge leads to a broad system-wide generalization (Gierut et al., 1987; Gierut et al., 1996; Powell, 1991; Powell et al., 1991; Powell et al., 1998; Williams, 1991). We found that both children generalized target sounds to untreated nonstimulable and stimulable sounds, later- and early-acquired sounds, and their least phonological knowledge sounds. In addition, as mentioned before, both children generalized to untreated sounds within sound classes, and one child also generalized across sound classes.

Limitations and Future Research Directions

Although the results of this study have important implications, they must be interpreted with caution. The small sample of participants limits the degree to which these findings can be generalized, although an attempt was made to use children with similar ages and severity levels. In addition, in order to have experimental control, both children received treatments that were intensive, short and had the same length. However, it is possible that extension of treatment length could have extended generalization across linguistic units for one participant (EM). Therefore, for better generalization results, it seems that the length of treatment could have been adjusted to the child's profile and performance.

Furthermore, in spite of the information gained in this study about the combined treatment, a control group with children who receive phonological treatment at the word level only, for a similar length of time, is necessary to determine the real impact of the combined treatment on sound generalization. In addition, although conversational generalization probes were used throughout the study to measure generalization across linguistic units, other measures at the word level should have been used between BC and BD phases to identify the effect of direct feedback on generalization across word positions, to untreated words, and within and across sound classes.

Another limitation of this study is the shortage of reliability data. No interjudge and intrajudge reliabilities were computed for the percentage of occurrence of the target process in maximal opposition treatment and in conversation training. In fact, these data were not gathered or scored by an independent observer who was blind to the hypothesis of this study.

There is a need for more research on generalization programs in phonological intervention. Further studies need to verify if there is any relationship between the severity level of phonological disorders or age, and the necessity of introducing treatment at conversational level to promote generalization to more complex linguistic units and to different settings. In addition, other studies need to identify individual issues (e.g., language disorders, cognitive disabilities) that may affect generalization learning. Furthermore, studies that investigate the impact of using parents and teachers as part of treatment to maximize sound generalization to conversational contexts are needed. It seems that a treated behavior is best developed in naturalistic contexts if treatment involves people who are part of these contexts (Stokes & Osnes, 1989).

General Conclusions and Clinical Applications

Although generalizing findings from a small sample is limited, the current results contribute to the information available about sound generalization. This study demonstrated the positive effects of a combined phonological treatment consisting of training the target sounds at word and conversational level on two children, as evidenced by sound production improvement, decrease in the use of phonological process, and generalization learning. The findings confirm that generalization planning is crucial, and that targeting the child's productions in conversational contexts is recommended. Before the present study, the use of direct feedback at the conversational level during phonological intervention had not been addressed systematically. The results of the current study suggest that clinicians should point out the children's speech problems during conversation, and ask for self-correction. In other words, clinicians should use direct feedback after correct and incorrect productions. In conclusion, the combined treatment of maximal opposition treatment and conversation training with direct feedback used in this study has potential clinical value in treating children with severe phonological disorders. However, due to the limitations of this study, more research on sound generalization is needed to help identify the conditions under which generalization learning occurs and the degree to which the new behavior is assimilated.

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APPENDIX A: APP-R RESULTS

Participant MS

Pretreatment

basket /bæɪt/	feather /wɛə/	jump rope /dʌmwoʊ/	santa claus /wæntətɔ/	string /tɪŋ/
boats /boʊt/	fish /vɪt/	leaf /vɪ/	screwdriver /dudaɪvə/	sweater /wɛtə/
candle /tænə/	flower /vaʊwə/	mask /mæ/	shoe /vu/	television /tɛbɪən/
chair /tɛə/	fork /wɔk/	mouth /maʊ/	slide /vaɪ/	thumb /wʌm/
cowboy hat /taʊbɔɪhæ/	glasses /dæɪ/	music box /mjubɑk/	smoke /moʊk/	toothbrush /tubʌ/
crayons /teɪən/	glove /dʌ/	nose /noʊ/	snake /neɪ/	truck /tʌ/
three /vi/	gum /gʌm/	page /peɪdʒ/	soap /oʊ/	vase /beɪ/
black /bæk/	hanger /hæŋə/	plane /peɪn/	spoon /pun/	watch /wɑ/
green /din/	horse /hɔɪ/	queen /twin/	square /tɛə/	yoyo /joʊjoʊ/
yellow /jɛoʊ/	ice cubes /aɪtju/	rock /wɑk/	star /tɑ/	zipper /wɪə/

Posttreatment

basket /bæɪt/	feather /wɛðə/	jump rope /dʌmpwoʊp/	santa claus /wæntətɔ/	string /tɪŋ/
boats /boʊt/	fish /wɪf/	leaf /wif/	screwdriver /tudaɪvə/	sweater /wɛə/
candle /tæno/	flower /faʊw/	mask /mæf/	shoe /fu/	television /tɛəbɪʒən/
chair /tɛə/	fork /wɔk/	mouth /maʊ/	slide /waɪf/	thumb /wʌm/
cowboy hat /taʊbɔɪhæt/	glasses /dæɪz/	music box /mjuikbɑk/	smoke /moʊk/	toothbrush /tubʌ/
crayons /teɪən/	glove /dʌv/	nose /noʊ/	snake /neɪk/	truck /tʌk/
three /di/	gum /gʌm/	page /peɪdʒ/	soap /woʊp/	vase /beɪ/
black /bæk/	hanger /hæŋə/	plane /peɪn/	spoon /pun/	watch /wɑf/
green /gin/	horse /hɔs/	queen /kin/	square /tɛə/	yoyo /joʊjoʊ/
yellow /jɛoʊ/	ice cubes /aɪstju/	rock /wɑk/	star /tɑə/	zipper /wɪpə/

Participant EM

Pretreatment

basket /bæstɪt/	feather /stɛɚ/	jump rope /dʌmlo/	santa claus /sænsəsɔz/	string /stɪn/
boats /boʊts/	fish /stɪs/	leaf /lis/	screwdriver /studaɪzɚ/	sweater /sɛtɚ/
candle /sænoʊ/	flower /saʊɚ/	mask /læs/	shoe /stu/	television /sɛləbɪzən/
chair /stɛɚ/	fork /stɔɚ/	mouth /daʊs/	slide /slaɪd/	thumb /sʌm/
cowboy hat /saʊbɔɪhæt/	glasses /dæsɪz/	music box /duzibɑs/	smoke /stoʊ/	toothbrush /susbʌs/
crayons /seɪənz/	glove /dʌ/	nose /doʊz/	snake /sneɪp/	truck /sʌ/
three /si/	gum /dʌm/	page /peɪz/	soap /stoʊp/	vase /beɪs/
black /bæ/	hanger /hæŋɚ/	plane /peɪn/	spoon /stun/	watch /lɑs/
green /din/	horse /hɔɚs/	queen /stin/	square /stɛɚ/	yoyo /loʊloʊ/
yellow /loloʊ/	ice cubes /aɪstu/	rock /lɑ/	star /stɑɚ/	zipper /sɪɚ/

Posttreatment

basket /bæsɪt/	feather /sɛɚ/	jump rope /dʌmploʊ/	santa claus /sænəsɔz/	string /stɪ/
boats /boʊts/	fish /fɪs/	leaf /lis/	screwdriver /srusaɪɚ/	sweater /sɛtɚ/
candle /sænoʊ/	flower /saʊwɚ/	mask /mæs/	shoe /su/	television /tɛləbɪzən/
chair /sɛɚ/	fork /sɔɚ/	mouth /maʊs/	slide /saɪ/	thumb /sʌm/
cowboy hat /saʊbɔɪhæt/	glasses /dæsɪz/	music box /mjuzikbɑks/	smoke /soʊ/	toothbrush /tusbʌs/
crayons /seɪənz/	glove /dʌs/	nose /noʊz/	snake /seɪ/	truck /sʌ/
three /si/	gum /dʌm/	page /seɪz/	soap /soʊp/	vase /beɪs/
black /bæ/	hanger /hæjɚ/	plane /peɪn/	spoon /sun/	watch /lɑs/
green /din/	horse /hɔɚs/	queen /sin/	square /swɛɚ/	yoyo /loʊloʊ/
yellow /leloʊ/	ice cubes /aɪssuz/	rock /lɑk/	star /stɑɚ/	zipper /sɪɚ/

APPENDIX B: PILOT STUDY

Appendix C: Pilot study.

TC, a boy age 4:9, spoke English at home and school as his primary language and had received speech therapy prior to his participation in the study. He discontinued speech therapy while participating in the study. TC received all the assessment and treatment sessions in a clinic room at the University of Georgia.

TC passed a bilateral hearing screening at 20 dBHL (GSI 1717 audiometer) and his oral mechanism functions were adequately for speech production**.** He also received age-appropriate scores on the SPELT-II, in which his percentile rank was 32%.

The phonological analysis from the APP-R revealed the following phonological processes: fronting occurred in 3% of opportunities, final consonant deletion in 13% of opportunities, vowelization in 30% of opportunities, cluster reduction in 45% of opportunities, and gliding in 60% of opportunities. The analysis by class of sounds indicated that TC did not correctly produce 23% of stridents, 27% of velar obstruents, 82% of the liquid /l/ and 100% of the liquid /r/. TC's phonological deviancy score was 34%, which indicates a moderate phonological disorder.

TC displayed Type 1 phonological knowledge (Gierut et al., 1987) for the target sounds [p, b, m, d, n, h, f, v, ʃ, ʒ, tʃ, dʒ, g, ŋ, w, j] that were produced correctly in all word positions at all times. The sounds [t, s, z, k, l] were ranked as Type 2 phonological knowledge (Gierut et al., 1987). These sounds were produced correctly in all word positions; however, a phonological rule such as cluster reduction, final consonant deletion, gliding and fronting affected production of these sounds. TC did not exhibit Types 3, 4 and 5 phonological knowledge (Gierut et al., 1987). The sounds [θ, ð, r] were ranked as Type 6 phonological knowledge (Gierut et al., 1987). These sounds were never produced correctly.

Among the sounds that were not produced during the phonological assessment, TC was not stimulable for [θ, ð, r]. Sound stimulability was assessed using a nonsense syllable task.

Phonological process and sounds were ruled out as possible targets if they occurred less than 50% of the time. TC's phonological process that occurred more than 50% of the time was gliding, with 60% occurrence. Therefore, gliding was chosen as a target. The nonstimulable phoneme /r/ at the word initial position was selected to target gliding because /l/ was stimulable. The phoneme /r/ was classified as Type 6 phonological knowledge and supposed to be mastered at age 6:0 (Sander, 1972). TC's accurate /w/ sound was used as a comparison sound. The /w/ sound differed from /r/ by place and manner of production. The distinctive feature differences between /w/ and /r/ were [consonantal], [vocalic], [coronal], [high], [back], [round], and included a major class distinction [consonantal] (Gierut, 1989, 1990, 1992). The /w/ and /r/ contrast were considered to be a minimal opposition contrast. Since minimal and maximal opposition treatment share the same intervention procedures, the minimal opposition treatment was still used as a pilot study.

TC's phases were completed in four sessions during a period of 16 days. The intervals between therapies ranged from 3 days to 8 days due to therapy cancellations by the parents. TC's results are summarized below.

In the first session, during the 20-min minimal opposition treatment, TC produced initial /r/ with 35% accuracy. His correct initial /r/ productions kept increasing, reaching 79% in the last treatment session.

The treatment data from the 20-min conversation training are displayed in Figure 6. In the first conversation training session with direct feedback, TC produced initial /r/ with 38% accuracy. His correct initial /r/ productions increased to 65% in the second treatment session. TC's correct initial /r/ productions decreased from 65% to 44% in the third session, in which the clinician used indirect feedback, and then to 43% in the last treatment session.

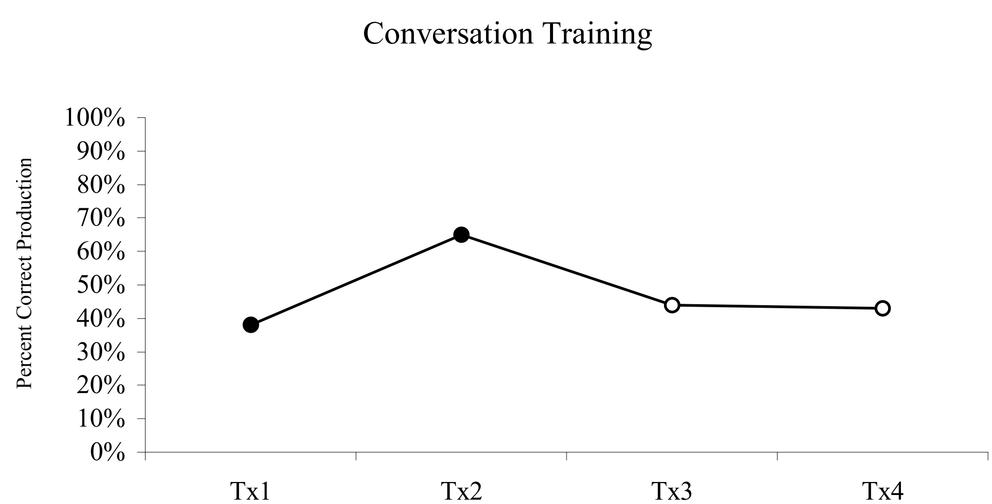

Figure 6. TC's percentage of correct initial /r/ production during conversation training with direct feedback (solid) and with indirect feedback (open).

Generalization data were collected from a 5-min conversational generalization probe in the beginning of each session. The data from these probes during baseline and treatment phases are displayed in Figure 7.

Before treatment, TC never produced initial /r/ correctly. His correct initial /r/ production was 0% in the baselines indicating that they were stable.

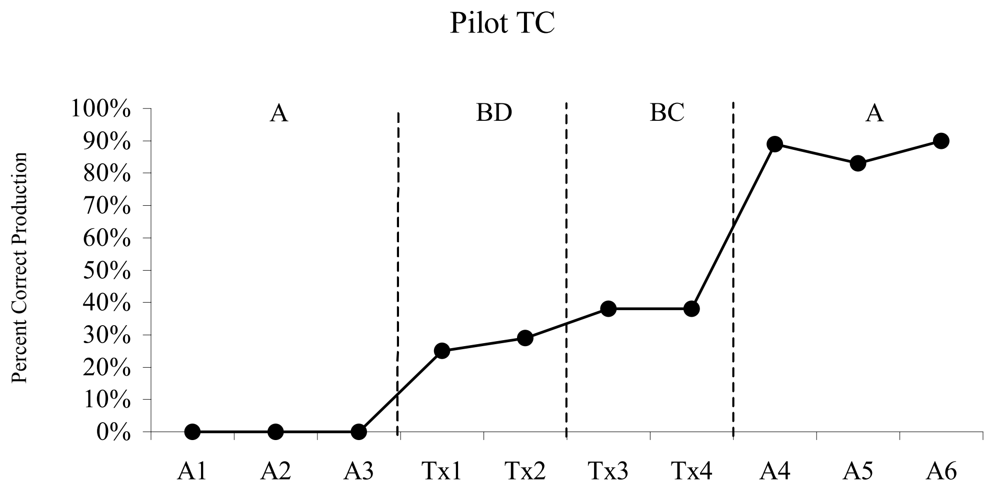

Figure 7. TC's percentage of correct initial /r/ production from 5-min conversational generalization probes in baseline phases (A) and the treatment phases (BD and BC).

In the first treatment session, TC's correct initial /r/ productions increased from 0% to 25%. It kept increasing, reaching 38% in the third session, and remained at 38% in the last treatment session.

Since the direction and the nature of change in the data from conversational generalization probes were clear, baseline probes were again collected. TC's correct initial /r/ productions were 89%, 83% and 90% consecutively in all three baselines.

Generalization learning was determined based on pretreatment and posttreatment measures, and from 5-min conversational generalization probes. TC's PCC score was 77% colleted from the baseline probe before treatment. This percentage is representative of a mild to moderate phonological disorder (Shriberg & Kwiatkoski, 1982). In the baseline probe after the treatment, TC's PCC score increased to 96%, indicating that the child does not have phonological disorder (Shriberg & Kwiatkoski, 1982). Based on the results of word probes, TC generalized productions of initial /r/ to all word positions and to untreated words. His /r/ productions rose from 10% accuracy before treatment to 90% accuracy after treatment. He also generalized treated sound to untreated words in conversational contexts (see Figure 7).

The results suggest that direct feedback is crucial to promote generalization to conversational contexts. TC only produced initial /r/ at the conversational level with a percentage of occurrence higher than 60% on treatment probes during conversation training with direct feedback. He also produced /s/ at the conversational level with a high percentage of occurrence during the baseline probes after treatment. The mother mentioned that she started correcting TC's /r/ productions in the previous days of the baseline probes. Although these findings indicate that direct feedback promotes generalization, the use of direct feedback with TC in the clinic and at home was not experimentally controlled.

The experimenter made some changes in the assessment and treatment procedures before starting the experimental procedures for the other participants. First of all, the 5-min conversational generalization probes were extended to 10 minutes due to the lack of time to elicit at least 20 responses of the target sound during the pilot experiment. In addition, for the other participants, the percentage of occurrence of the target phonological process was obtained from conversational generalization probes and treatment probes for a more complete analysis of changes on the participants' phonological system. Furthermore, during the first session of the minimal opposition treatment, the clinician did not contrast the meaning of the pair words. The word meaning confrontation is an essential condition for an effective minimal pair treatment. Therefore, during the maximal opposition treatments with the two other participants, the clinician confronted the different meanings of the maximal-pairs in the first session. Also, the APP-R was conducted before and after treatment with the two participants to better identify generalization learning. The last change was to control the use of direct feedback of the target sound with the other children during conversation training to better investigate its effects on target sound production in conversational contexts.

APPENDIX C: MAXIMAL-PAIRS

Participant MS

dice-dime

/daɪs/-/daɪm/

worse-worm

/wɝs/-/wɝm/

rice-rhyme

/raɪs/-/raɪm/

toss-tom

/tɔs/-/tɔm/

lace-lame

/leɪs/-/leɪm/

Participant EM

shake-lake

/ʃeɪk/-/leɪk/

shot-lot

/ʃɑt/-/lɑt/

ships-lips

/ʃɪps/-/lɪps/

shock-lock

/ʃɑk/-/lɑk/

push-pull

/pʊʃ/-/pʊl/

APPENDIX D: WORD PROBES

Participant MS

Pretreatment

sock	/wɑ/	ice cream	/aɪtkim/
sun	/wʌn/	dancing	/dɑŋ/
santa	/wæntə/	pencil	/pentoʊ/
sand	/wæn/	eraser	/ɪoʊ/
sandwich	/bænɪ/	icing	/aɪŋ/
cereal	/wɪoʊ/	bus	/dʌ/
sitting	/wɪtɪŋ/	dress	/dɛ/
singing	/wɪŋkɪŋ/	mouse	/maʊ/
glasses	/dæ/	horse	/hɔ/
dinosaur	/daɪnəɔʊ/	house	/haʊ/

Posttreatment

sock	/wɑk/	ice cream	/aɪtim/
sun	/wʌn/	dancing	/dɑŋ/
santa	/wæntə/	pencil	/penioʊ/
sand	/wæn/	eraser	/ɪreiə/
sandwich	/wænwɪ/	icing	/waɪsɪŋ/
cereal	/wɪoʊ/	bus	/bʊ/
sitting	/wɪtɪŋ/	dress	/dɛs/
singing	/wɪŋgɪŋ/	mouse	/maʊs/
glasses	/dæɪs/	horse	/hɔs/
dinosaur	/daɪnəɔʊ/	house	/haʊs/

Participant EM

Pretreatment

shoe	/su/	brushing	/bʌsɪ/
sheep	/sip/	flashlight	/sæsaɪt/
shaving	/seɪ/	tissue	/sɪsu/
shampoo	/sæmsu/	fish	/sɪs/
sugar	/sʊə/	dish	/dɪs/
shoulder	/səʊlə/	toothbrush	/susbʌs/
shower	/saʊə/	hairbrush	/heəbrʌs/
cashier	/sæsɪə/	eyelash	/aɪlæs/
fishing	/sɪsɪŋ/	radish	/læɪs/
washing	/lɑsɪŋ/	leash	/lis/

Posttreatment

shoe	/ʃu/	brushing	/sʌsɪŋ/
sheep	/sip/	flashlight	/sæsaɪt/
shaving	/seɪvɪŋ/	tissue	/tɪsu/
shampoo	/sæmsu/	fish	/fɪʃ/
sugar	/sʊə/	dish	/dɪs/
shoulder	/səʊlə/	toothbrush	/susbrʌs/
shower	/saʊə/	hairbrush	/heəbrʌs/
cashier	/sæsɪə/	eyelash	/aɪlæs/
fishing	/fɪʃɪn/	radish	/rædɪs/
washing	/wɑsɪŋ/	leash	/lis/