ABSTRACT

CONCURRENT TREATMENT AS A MOTOR-SKILL APPROACH FOR CHILDHOOD APRAXIA OF SPEECH (CAS)

The purpose of this study was to determine if concurrent treatment would be effective and efficient in treating CAS. Concurrent treatment is a treatment program that takes the speech task hierarchy and randomizes it so that all tasks are worked on in one session. Previous studies have shown the treatment program to be effective and efficient in treating phonological and articulation disorders. The program was adapted to be used with children with CAS. A multiple-baselines-across-subjects research design was used and probes of generalization to untaught words were administered every fifth session. Three children, ranging in age from 4 to 6 years old, were the participants. All participants showed progress during the study. The results obtained from this study suggest that concurrent treatment can be adapted for use in treating speech disorders associated with CAS.

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CONCURRENT TREATMENT AS A MOTOR-SKILL APPROACH FOR CHILDHOOD APRAXIA OF SPEECH (CAS)

by

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APPROVED

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CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

Treatment programs that have been used in treating CAS have minimal empirical evidence supporting them. Linguistic and motor-skill learning programs are available with all showing slow progress (Moriarty & Gillon, 2006; Rosenbek, Lemme, Ahern, Harris, & Wertz, 1973; Strand & Debertine, 2000; Strand & Skinder, 1999). Concurrent treatment is a program that has been used to successfully treat children with phonological and articulation disorders but has yet to be administered to children with more complex speech sound disorders, such as CAS (Kerber, 2005; Price, 2005; Resciniti, 2007; Skelton, 2004; Skelton & Funk, 2004). There is recent and still emerging research in the use of motor learning centered treatment approaches for treating apraxia of speech in adults (Knock, Ballard, Robin, & Schmidt, 2000; Maas et al., 2008; Rosenbek et al., 1973). Some of these studies are also randomizing the presentation of tasks and seeing positive results (Knock et al., 2000; Maas et al., 2008; Rosenbek et al., 1973).

In order to expand the generality of a treatment program, it is important to determine if it can be used with multiple disorders and also to continue to replicate research in order to demonstrate that the results are consistent among different researchers, participants, settings, and situations.

Defining and Characterizing CAS

Childhood apraxia of speech (CAS) is a disorder that has been difficult to define and apply specific diagnostic criteria to. After years of confusion and possible over diagnosing of the disorder, the American Speech-Language-Hearing Association (ASHA) has attempted to end this dilemma. ASHA (2007) has defined CAS as:
a neurological childhood (pediatric) speech sound disorder in which the precision and consistency of movements underlying speech are impaired in the absence of neuromuscular deficits (e.g., abnormal reflexes, abnormal tone). CAS may occur as a result of known neurological impairment, in association with complex neurobehavioral disorders of known or unknown origin, or as an idiopathic neurogenic speech sound disorder. The core impairment in planning and/or programming spatiotemporal parameters of movement sequences results in errors in speech sound production and prosody. (pp. 3-4)

Despite the official definition provided by ASHA, a list of specific diagnostic markers and characteristics to assist in determining if CAS is present still does not exist. Three features that appear to be consistent in determining if a problem with planning and sequencing is present are “inconsistent errors on consonants and vowels in repeated productions of syllables or words, lengthened and disrupted coarticulatory transitions between sounds and syllables, and inappropriate prosody, especially in the realization of lexical or phrasal stress” (ASHA, 2007, p. 4). Deficits in expressive language abilities are often associated with CAS, possibly secondary to CAS and the verbal output difficulty this causes. A difference in expressive and receptive skills is often seen, as are deficits in reading, writing, and spelling (ASHA, 2007; Hall, 2007a; Lewis, Freebairn, Hansen, Iyengar, & Taylor, 2004; Ruscello, 2008).

One often discussed characteristic of CAS is consonant and syllable use. Jacks, Marquardt, and Davis (2006) did a longitudinal study in which they analyzed consonant and syllable use in three children exhibiting CAS between the ages of 4.5 and 7.7 years. The results revealed session-to-session, as well as with-in session variability of correct consonant and syllable use. These
participants omitted and substituted sounds more often than any other type of sound error with final consonants being omitted more often than other word positions. Simple monosyllables were produced correctly more often than more complex syllable shapes but were still inconsistent.

Jacks et al. (2006) found that “observations in this longitudinal study of three children with CAS are consistent with previous findings of consonant errors but also suggest error patterns similar to those found in younger typically developing children” (p. 438). The authors suggest that omission errors may be a factor in the difficulty with more complex syllables more so than sound errors themselves. It was recommended that research in the area of treatment be implemented including syllabic awareness and construction (Jacks et al., 2006). Hall (2007b) also describes the speech characteristics of CAS. Characteristics such as inconsistent errors, omissions, and substitutions are described in reference to speech sounds. Other speech characteristics include deficits in prosody and difficulty in sequencing sounds and syllables (Hall, 2007b). Timing deficits have also been suggested as a diagnostic marker for CAS. Peter and Stoel-Gammon (2005) compared two children diagnosed with CAS to two typically developing children matched by age. The results of this study demonstrated that the children with CAS exhibited timing deficits in speech tasks more so than their typically developing peers.

Regarding the possible etiology of CAS, the most recent research in the localization of the affected chromosomes involved in CAS suggests a 4q:16q translocation (Shriberg, Jakielski, & El-Shanti, 2008). The authors studied three siblings that exhibited CAS along with other conditions that represent chromosomal abnormalities. Similar breakpoints on chromosomes 4 and 16 were found for all three participants. It was discovered that the father was the carrier
of this abnormality (Shriberg et al., 2008). It is apparent that much more research is needed in this area of study.

**Treatment of CAS**

Efficacy of treatment for CAS is scarce and much needed. Minimal current research is available in this area. A few treatments that were used for adults with acquired apraxia of speech have been adapted for use with children with CAS. Moriarty and Gillon (2006) investigated the use of an integrated phonological awareness intervention with three children with CAS aged 6 to 7 years old. During this study the authors focused on the effects the treatment had on production of speech as well as phonological awareness. The participants attended therapy three times a week at 45 minutes per session for 3 weeks. Each session involved “identifying phonemes in isolation, identifying initial and final phonemes in words, phoneme segmentation and phoneme blending, and phoneme manipulation with letter grapheme blocks” (Moriarty & Gillon, 2006, p. 723). Two participants showed significant improvement of phonological awareness; one increased from 0% to 91.7% and the other 46.7% to 98.4%. They also showed generalization to untaught phonemes as well as increased trained phoneme manipulation and generalization to untaught words. The third participant did not show much improvement, possibly secondary to his cognitive level. Data from the first two participants is encouraging for the use of phonological awareness intervention for CAS. More research is needed (Moriarty & Gillon, 2006).

One common treatment for CAS is *integral stimulation*. Strand and Skinder (1999) suggest “an appropriate treatment would offer a hierarchically organized sequence of stimuli for practice of specific movement gestures for speech
production” (p. 113). Integral stimulation is a motor approach to teaching speech sounds that was originally used for acquired apraxia of speech and has since been adapted for CAS.

Integral stimulation focuses largely on repetitive tasks. The more opportunities the child has to motorically practice the speech movements the better. The authors adapted the *Eight-Step Task Continuum* used by Rosenbek et al. (1973) with adults with apraxia of speech to use with children presenting CAS (Strand & Skinder, 1999). Integral stimulation utilizes two types of imitation tasks: direct in which the child imitates the clinician’s production immediately after the oral presentation and time-delay in which the clinician says the desired target and has the child wait before imitating (Ruscello, 2008).

Strand and Debertine (2000) researched the efficacy of integral stimulation for treatment of CAS. One 5-year-old girl with motor planning deficits, and therefore suspected CAS, was treated using integral stimulation. Five stimuli were used in the sessions that were held four times a week at 30 minutes per session. Much improvement was seen during treatment adding support to this treatment approach. The authors suggested that more research be done in order to provide more empirical evidence for the treatment approach as well as to determine the best methods of implementation (e.g., feedback schedules, number of stimuli, responses per session) (Strand & Debertine, 2000).

Other approaches with less efficacy and research behind them have also been used in the treatment of CAS. Approaches include the use of nonspeech tasks and may consist of tactile-kinesthetic facilitation, rhythmic and melodic facilitation, and gestural cueing (Ruscello, 2008). It is now becoming more common to pursue alternative and augmentative communication (AAC) forms in order to assist children with severe motor speech disorders, like CAS, in
communicating. It has been shown that AAC may not only give the child the ability to communicate more effectively, but may also assist in promoting the development of speech production (DeThorne, Johnson, Walder, & Mahurin-Smith, 2009).

Because motor-program approaches are recommended in the treatment of CAS (Strand & Skinder, 1999), it is important to discuss the typical parts of a motor-learning-based approach. Motor learning, as defined by Schmidt and Lee (2005), is “a set of processes associated with practice or experience leading to relatively permanent changes in the capability for movement” (p. 302). Factors that are often incorporated into motor-program approaches consist of individualized and intense treatment, a focus on repeating the desired movements, systematically moving through tasks in an easier to harder fashion, the manner in which the movement sequences are introduced (easy to hard), auditory discrimination, inclusion of self-monitoring skills, utilizing more than one sensory modality, manipulation of prosody, and incorporating compensatory strategies (Hall & Jordan, 2007).

Concurrent Treatment

While most motor planning approaches suggest the typical easy-to-hard hierarchy of treatment tasks (Hall & Jordan, 2007; Ruscello, 2008), the concurrent treatment approach takes a different method in sequencing administration of these tasks. Concurrent therapy is a motor-skill approach that takes all speech tasks (syllables, words, phrases, sentences, and conversational speech) and incorporates them in a randomly intermixed fashion as opposed to the traditional easy-to-hard task organization (Skelton, 2004). Prior to the start of treatment, time is spent on teaching correct responses to presented tasks. The
participant is taught how to correctly respond to each task (syllable, word, phrase, sentence, story-telling). Words not containing the target sounds are used during this process. Once baselines are established treatment is started. During the establishment phase, participants are taught correct production of the target sound in one word. The target sound may be taught in the initial position, final position, or both. If necessary, teaching may begin on isolation tasks. Once the target sound is correctly produced 8 out of 10 times, the sound next to the target sound is added to create a syllable. This process is continued until the participant is able to correctly produce the target sound in the target word with 80% accuracy. The order in which tasks are administered is determined prior to each session, generally through the use of a computer program that uses a random order function to rearrange the treatment tasks. This process is followed until the criterion of 80% accuracy is achieved. Probes are administered in order to assess generalization to untaught words, phonemes, and settings (Kerber, 2005; Price, 2005; Resciniti, 2007; Skelton, 2004; Skelton & Funk, 2004).

The concurrent treatment approach includes tasks that are imitated or evoked presented at the syllable, word, phrase, sentence, and conversation segment or story-telling levels. Stimuli are presented through the use of picture cards that are placed directly in front of the client. A verbal cue is presented with each picture card. On imitated tasks, the client is asked to repeat the clinician. On evoked tasks, the verbal prompt is usually presented in the form of a completion task in which the client finishes the clinician’s sentence with the desired task (e.g., syllable, word, phrase, or sentence). Conversation segments or story-telling tasks are evoked only. Four picture cards are placed in front of the client. The clinician tells a story incorporating the four cards and then asks the client to tell a
different story (Kerber, 2005; Price, 2005; Resciniti, 2007; Skelton, 2004; Skelton & Funk, 2004).

Research behind this concurrent treatment approach is recent and promising. The research has centered on concurrent treatment as a way to treat speech sound disorders. The effects of concurrent treatment on specific speech sound errors, phonological disorders and processes, and generalization to untaught tasks have all been examined through controlled single case research designs (Kerber, 2005; Price, 2005; Resciniti, 2007; Skelton, 2004; Skelton & Funk, 2004).

Skelton (2004) tested the concurrent treatment approach with four 7-year-old children with a single target sound. A multiple-baseline-across-subjects research design was used. The randomly intermixed task sequence approach was used to teach correct production of /s/. This study was designed to “experimentally evaluate the acquisition, generalization, and maintenance effects of Concurrent Treatment” (Skelton, 2004, p. 134). The intermixed tasks consisted of imitated and evoked syllables, words, two-to-four word phrases, sentences, and conversation segments with the target sound in the initial and final positions of words as singletons, clusters, and intervocalics (Skelton, 2004).

Baselines were taken prior to the start of treatment. Accuracy production of all participants ranged from 0% to 2%. The participants achieved an accuracy range of 71.42% to 100% by the end of the treatment sessions and reached the criterion for all exemplar types within four to six sessions.

Generalization to untaught tasks within the clinic setting, generalization to conversation within the clinic setting, and generalization across settings was measured during this study. Two participants achieved generalization to conversation within clinic and also generalization to beyond clinic settings probe
accuracies of above 80% while the other two participants showed minimal generalization. The data reveal that moderate to high generalization may be achieved through the use of concurrent treatment (Skelton, 2004). Also the data in this study revealed that the idea of teaching tasks in an easy-to-hard fashion might not be more successful than randomly intermixing the tasks. The participants showed consistent percentages of correct response rates across treatment tasks throughout treatment showing that suspected difficulty of treatment tasks had little to no impact on a participant’s ability to achieve high accuracy of correct productions (Skelton, 2004).

It was learned from this study that concurrent treatment of speech sounds was effective and efficient represented by the low number of treatment sessions it took to reach criterion as well as the substantial increase in correct production rate from baselines to the first few treatment sessions. It was suggested from this study that more research be done in replicating this study in order to establish a higher level of efficacy. A comparison of the intermixed tasks to incremental (easy-to-hard) tasks is necessary to determine which is more efficient. Further testing of the number of treatment targets that can be taught at one time and the target sounds selected would be beneficial in establishing a successful foundation for this treatment approach (Skelton, 2004).

Skelton and Funk (2004) replicated the previously mentioned study with three children ranging in age from 4 to 6 years old who had been previously diagnosed with a sound-system disorder. The purpose of this study was to “evaluate an application of a randomized variable sequence of tasks utilizing speech-sound practice in different response lengths and word positions (designated the Concurrent Treatment Sequence) resulting in variable practice of presumed easier and harder production tasks” (Skelton & Funk, 2004, p. 5). One
target sound was selected for each participant and treated in the initial and final positions of words (the target for two participants was /s/ and the target for the third participant was /k/). Baselines revealed that participant 1 was 1% to 2% accurate and then finished 47% accurate. Participant 2 started at 0% to 1% correct and ended at 53% correct. Participant 3 started with 0% accuracy and ended with 56% accuracy (Skelton & Funk, 2004).

Two generalization measures were administered: generalization to untaught tasks and generalization to conversational speech. All participants had greater than 60% correct productions on the final probes for untaught tasks. The final probes for conversational speech had an accuracy range of 30% to 50% (Skelton & Funk, 2004).

This study was successful in replicating and revealing similar results to the original Skelton (2004) study. It was shown again that performance on all treatment tasks was equal, with the exception of the conversation segment task, revealing that the idea of teaching easier to harder tasks may not be as necessary as originally thought. This study also shows that the speech sounds can be acquired rapidly when concurrent treatment is used. An increase in correct productions was seen in the first treatment session. The results of this study also show that it may be possible to use this treatment approach on other speech sounds (Skelton & Funk, 2004).

Skelton and Funk (2004) recommended that more research be done investigating the efficacy of the concurrent treatment approach. It was also suggested, again, that a comparison between concurrent treatment and incremental task sequencing be done. It may also be beneficial to replicate this study using a group research design in order to target more participants and to promote more generalization.
Price (2005) investigated if one treatment that followed the presumed easier to harder task order or one that randomly intermixed all treatment tasks, was more effective and efficient than the other. Price used a semi-randomized alternating treatments research design in order to do so. Two boys, both five-years-old with speech sound disorders, were the participants of the study. They both had two target sounds in which one target was treated using concurrent treatment and the other target was treated using incremental treatment.

For Participant 1, the target /s/ was treated using concurrent treatment and the target /r/ was treated using incremental treatment. At the start of treatment, baselines for /s/ averaged 3% and showed an increase of 95% at the end of treatment. Baselines for /r/ averaged 2% and showed an increase of 71% at the end of treatment. For Participant 2, concurrent treatment was applied to the phoneme /k/ and incremental treatment was applied to /l/. Baselines for /k/ averaged 7% and an increase of 92% was observed at the end of treatment. Baselines for /l/ averaged 9% and an increase of 82% was observed at the end of treatment. Participant 1 reached 80% accuracy by the eighth treatment session for the phoneme that was receiving concurrent treatment and did not complete all tasks for the phoneme receiving incremental treatment. Participant 2 completed all tasks for concurrent treatment by the tenth concurrent treatment session and the 15th incremental session for the incremental tasks (Price, 2005).

Session probes and a posttreatment probe were administered during this study. Session probes were administered during the last 5 minutes of each treatment session. During the fourth concurrent treatment session, participant one reached 80% accuracy on single-word probes while single-word probes for incremental treatment never went above 27% until the posttreatment probe when correct productions increased to 53% accuracy. After the seventh concurrent
treatment session, conversational probe accuracy had reached 83% and was maintained at or above this number. Conversational probes remained at 0% accuracy for incremental treatment during session-by-session probes but reached 57% for the posttreatment probe (Price, 2005).

Single-word session-by-session probes for Participant 2 remained above 80% after the third session of concurrent treatment and were reached during the seventh session of incremental treatment. The conversation criterion for concurrent treatment was achieved during the sixth treatment session and during the seventh session for incremental treatment (Price, 2005).

The data from Price (2005) suggested that concurrent treatment was more efficient and effective than incremental teaching, further supporting that randomly intermixed treatment tasks are more beneficial than tasks arranged in order of difficulty from easier to harder. More value was added to the efficacy behind concurrent treatment through this study. Price recommended that the treatment approach should be “applied to speech-sound disorders in special needs populations” (2005, p. 53).

Kerber (2005) used a multiple-baseline-across-subjects research design in order to determine the effects of using concurrent treatment in the treatment of phonological disorders. The participants were four 3- to 6-year-old children with phonological disorders (it is important to note that participant 2 left the study after the 14th session). Four target sounds were selected for each participant for whom baseline measures were taken prior to the start of treatment. Baseline scores were 0% for all participants and targets. The three remaining participants averaged 95.25% correct productions at the end of treatment.

Generalization probes were administered to measure generalization to untaught tasks in the clinic and also generalization of untaught tasks to
conversation within the clinic. Generalization to untaught tasks probes were at 0% accuracy. This increased to 95.67% accuracy at the end of treatment. Conversation probes were administered every five to six treatment sessions and started at 0% accuracy. All participants showed high generalization in achieving 100% accuracy on all tasks except one during final probes (Kerber, 2005).

Overall, the results of this study revealed that concurrent treatment was indeed an efficient and effective approach to treating phonological disorders. It also added efficacy to concurrent treatment as well as generalization across clinicians and target sounds. Kerber (2005) suggested more research in the area of generalization to settings outside of the clinic be investigated. Implementing concurrent treatment for speech sound disorders with children who also have a language disorder was recommended. Also, “an experimental study of Concurrent Treatment with children who present more severe speech disorders (e.g., suspected Developmental Apraxia of Speech) will help to determine further applicability and limitations of this treatment design” (Kerber, 2005, p. 46).

Resciniti (2007) did a study in which she tested the effects of concurrent treatment on generalization across phonemes and settings. Generalization across phonemes and to conversation had been tested in previous studies (Kerber, 2005; Price, 2005; Skelton, 2004; Skelton & Funk, 2004) but generalization to other settings had yet to be a main focus of the study process. A multiple-baseline-across-subjects design was used with three participants between the ages of 4 and 6 years old who had all been determined to exhibit a phonological disorder.

All three participants started out at 0% accuracy during baselines and had established all target phonemes by their sixth treatment session with the exception of participant 1 who was unable to establish the phoneme /z/. The accuracy criterion of 80% was achieved between the 7th and 12th treatment
sessions for all participants, adding support to the efficiency of concurrent treatment. Generalization of taught and untaught phonemes to words and conversation ranged from slight to moderate (33% to 67%). Probe baselines in settings other than the clinic were 0% accuracy for all three participants. Participant 1 showed 100% accuracy in outside settings for two phonemes and 33% for the third phoneme. Participant 2 showed strong generalization at 100% accuracy for one phoneme and moderate generalization of 68% accuracy for the other two phonemes. Participant 3 showed little generalization to other settings. It was suspected that this could have been secondary to the short amount of time that the participant had been receiving treatment (Resciniti, 2007).

This study supported the efficiency and efficacy of concurrent treatment and also generalization across clinicians. Resciniti (2007) recommended that more replication research be done involving concurrent treatment. Specific research questions elicited by the author involved determining if this treatment can be used to treat different types of targets at one time such as “teaching fricatives in unison with clusters or liquids” (p. 56). It was also suggested to implement this treatment approach with a group research design.

**Implications for Further Research**

The concurrent treatment approach has been shown to be effective when used with children with speech sound disorders, but research has yet to be done that investigates the effects of the therapy when used in the treatment of CAS. This study seeks to determine if concurrent treatment will be successful in the treatment of CAS. It also hopes to begin to determine modifications that need to be made when being used with children with CAS and to evoke future research questions involving this treatment with CAS.
Hypothesized Outcomes of Proposed Research

It is expected that concurrent treatment will improve the speech sound productions of the participants. It is also expected that the treatment tasks will need to be modified in order to accommodate the participants with CAS. The data will show improvement on the imitated and evoked syllable, word, and phrase tasks. It is possible that the sentence tasks will reveal lower correct response rates based on the difficulty of the task for a child with CAS. Accuracy criterions may not be met as quickly as in past studies. Generalization probes will reveal that sounds generalized to untaught words. The results may be less positive in generalization to untaught sounds and conversation.
CHAPTER 2: METHODS

Research Design

A multiple-baseline-across-subjects design was used to conduct this study. Participants were selected and multiple baselines were administered in order to obtain stable results and to avoid any threats to internal validity. Participants received repeated baseline measures with treatment beginning at different times to show that no changes in the dependent variable were observed until treatment had begun.

Variables

The independent variable in this study was the implementation of the randomized treatment task approach. The tasks were randomized each session through the use of a Microsoft Office Excel (Microsoft Corporation, 2006) spreadsheet. Imitated and evoked tasks at the syllable, word, two-word phrase, and three-word phrase levels were entered into the spreadsheet and put in order through the use of random number assignment before each treatment session.

The dependent variables in this study were the correct productions of four targeted speech sounds selected for each participant. The investigator determined what was considered to be an incorrect or correct production based on the relationship between the participant’s production and the desired adult model.

Participants

Three participants were selected for this study. Participants were English-speaking children between the ages of 4 and 6 years suspected of exhibiting CAS. All participants exhibited at least 6 of the following 10 characteristics: inconsistent errors, vowel/diphthong errors, increased errors on
longer sequences/multisyllabic words, groping, reduced DDK rates, lengthened and disrupted coarticulatory transitions between sounds/syllables, inappropriate prosody/stress, difficulty imitating, evidence for nonverbal oral apraxia, and the use of simple syllable shapes (E. Strand, personal communication, July 25, 2009).

The hearing of participants was screened using a portable pure tone audiometer administered at 25 decibels hearing threshold level (dB HTL) for the frequencies of 500, 1000, 2000, and 4000 Hertz (Hz). The audiometer and scoring sheet were obtained from the Speech and Hearing Clinic at California State University, Fresno. An oral-peripheral examination was also administered in order to assess the structural integrity and function of the participants’ oral structures. Results were scored on the oral-peripheral examination recording sheet as prepared by the Speech and Hearing Clinic at California State University, Fresno.

The motor production abilities of participants were assessed using the Verbal Motor Production Assessment for Children (VMPAC) (Hayden & Square, 1999). Participants were assessed using the Goldman-Fristoe Test of Articulation Competence-2 (GFTA-2) (Goldman & Fristoe, 2000) in order to determine the sound substitutions that the participants produce and to select appropriate treatment targets for each. It is known from past research (ASHA, 2007; Hall, 2007a; Lewis et al., 2004; Ruscello, 2008) that children with CAS also may exhibit co-morbid expressive language disorders. The Test of Early Language Development (TELD-3) (Hresko, Reid, & Hammill, 1999) was administered in order to assess expressive and receptive language abilities of the participants.

Spontaneous speech and language samples were obtained from all participants. These, along with information obtained from the GFTA-2, were used to create a syllable inventory, phonemic inventory, and to determine mean
length of utterance (MLU) for each participant. The data were used to determine eligibility and treatment targets. The results of standardized tests along with gender and chronological age for each participant are presented in Table 1. The qualifying characteristics of CAS presented by each participant are shown in Table 2.

Table 1. Summary of Participant Characteristics and Assessment Data

<table>
<thead>
<tr>
<th>Qualifying Information</th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>4 yrs., 0 mos.</td>
<td>5 yrs., 6 mos.</td>
<td>6 yrs., 1 mos.</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Goldman-Fristoe (SS)</td>
<td>84</td>
<td>40</td>
<td>&lt;40</td>
</tr>
<tr>
<td>TELD-3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receptive</td>
<td>74%tile</td>
<td>84%tile</td>
<td>74%tile</td>
</tr>
<tr>
<td>Expressive</td>
<td>27%tile</td>
<td>8%tile</td>
<td>1%tile</td>
</tr>
<tr>
<td>VMPAC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Motor</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Focal Motor</td>
<td>70%</td>
<td>69%</td>
<td>61%</td>
</tr>
<tr>
<td>Sequencing</td>
<td>52%</td>
<td>74%</td>
<td>50%</td>
</tr>
<tr>
<td>Connected Speech</td>
<td>53%</td>
<td>40%</td>
<td>4%</td>
</tr>
<tr>
<td>Speech Characteristics</td>
<td>56%</td>
<td>43%</td>
<td>57%</td>
</tr>
</tbody>
</table>

Once it was determined that the child was eligible to participate, the parents were asked to commit to attending two 30-minute sessions per week for a maximum of 36 sessions. Parents signed a consent form, found in Appendix A, for their child giving permission to participate in the study. In signing this consent form, parents agreed to not receive any other speech therapy services throughout the course of the study.
Table 2. Characteristics of CAS Exhibited by Participants

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inconsistent errors</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Vowel/diphthong errors</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Increased errors on longer sequences/multisyllabic words</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Groping</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Reduced DDK rates</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Lengthened and disrupted coarticulatory transitions between sounds/syllables</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Inappropriate prosody/stress</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Difficulty imitating</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Evidence for nonverbal oral apraxia</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>The use of simple syllable shapes</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Clinical Setting and Materials

This study was done at the Speech and Hearing Clinic at California State University, Fresno. Treatment sessions were held in a clinic room with a one-way mirror window for observation. Sessions were held two times a week at 30 minutes per session.

Responses were elicited through the use of stimulus picture cards and a verbal stimulus (e.g., sentence completion). The stimulus cards contained printed color photographs of the target words mounted on 3-inch by 5-inch cards. During the teaching phase 10 words with matching picture cards were used. Another set of 10 words with matching picture cards were set aside to be used during generalization probes. Words consisting of the target sounds in the initial and final positions of words were used.

A token-reinforcement system was used throughout the baseline and treatment phases. Reinforcement during the baseline phase was contingent upon on-task behavior and not upon correct sound productions. Tokens were only given for correct responses during treatment phase. The target amount of tokens to receive a selected prize began at 10 and progressively increased as treatment continued to a maximum of 100. The participant was given the earned prize immediately after obtaining the required number of tokens and then selected a new prize to continue the reinforcement process.

A Sony ICD-P620 recorder was used to record each treatment session for reliability.

Target Behaviors

Target behaviors (correct production of erred sounds) were selected based upon the data obtained from the GFTA-2 and the spontaneous speech sample. Syllable and phonemic inventories also assisted in this process. Four target
sounds were selected. The target sounds /s, z, f, v/ were chosen for all three participants. Each of the participants produced the sounds in error consistently or inconsistently during assessment and baselines phases.

**Definition of Tasks**

The tasks for concurrent treatment consisted of imitated and evoked syllables, words, two-word phrases, and three-word phrases. A list of the treatment tasks can be found in Table 3. The following is a description of the treatment tasks (Kerber, 2005; Resciniti, 2007; Skelton, 2004).

**Imitative and Evoked Tasks**

Imitative tasks began with the researcher presenting the stimulus card on the table in front of the participant and verbally saying the target production. The participant was then asked to imitate what the researcher said. Evoked tasks also began with the presentation of the stimulus card. A sentence completion task was used in that the researcher would start a sentence and the participant would finish using the previously specified target level.

**Syllable, Word, Two-Word Phrase, and Three-Word Phrase Tasks**

During the assessment process it was determined that the participants would not be able to successfully produce sentences and stories, therefore the tasks were modified accordingly. Syllable tasks were presented as imitated tasks. The researcher presented the picture stimulus to the participant and provided the appropriate verbal cue for an imitated response. The same process was taken for word, two-word phrase, and three-word phrase tasks. The verbal cue for evoked word, two-word phrase and three-word phrase tasks consisted of sentence completion tasks in which the researcher provided the beginning of the
sentence and the participant was asked to complete the sentence with the appropriate response length. For example, if the target word was “bed” the carrier phrase might have been “I sleep in a _____” when the desired response length was one word. For a two-word phrase completion task the carrier phrase might have been “I sleep in __ __.” For a three-word phrase completion task the carrier phrase might have been “I sleep __ __ __.”

Baseline Measures

Baseline measures were taken prior to the start of treatment. Baselines consisted of evoked one-word and three-word phrase productions using 20 stimuli for each selected target sound with the exception of /v/ in which 15 stimuli were used. The number of baseline measures administered increased with each participant. A minimum of three baseline measures were taken for the first participant in order to establish a trend in performance.

Treatment Procedures

Task Orientation Training

After the baseline phase was completed, the participants were taught how to respond for each treatment task. Two picture stimuli cards were chosen that represented words not containing any of the target sounds. The required response length and mode for each type of task (e.g., imitated words or evoked three-word phrases) were taught to a criterion of 3 consecutive correct per task.

Teaching Trials for Establishment

Each target sound was established in a single word to a criterion of 8 out of 10 correct productions. The first step was to have the participant imitate the target sound in a word. If incorrect, the target sound in isolation was modeled
and imitatively practiced until produced correctly three out of four times. Then the target sound was imitatively practiced with the next or proceeding sound in the word. When the target sound was correctly produced on 3 out of 4 trials an additional adjacent sound was added. This continued until the entire word was imitatively produced correctly.

**Concurrent Task Sequencing Procedures**

The treatment tasks, as presented in Table 3, were practiced in a randomly intermixed order with the order re-randomized for each session.

**Table 3. Task Presentations**

<table>
<thead>
<tr>
<th>Task Presentations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Syllable imitated- /s/</td>
</tr>
<tr>
<td>2. Syllable imitated- /z/</td>
</tr>
<tr>
<td>3. Syllable imitated- /f/</td>
</tr>
<tr>
<td>4. Syllable imitated- /v/</td>
</tr>
<tr>
<td>5. One word imitated- /s/</td>
</tr>
<tr>
<td>6. One word imitated- /z/</td>
</tr>
<tr>
<td>7. One word imitated- /f/</td>
</tr>
<tr>
<td>8. One word imitated- /v/</td>
</tr>
<tr>
<td>9. One word evoked- /s/</td>
</tr>
<tr>
<td>10. One word evoked- /z/</td>
</tr>
<tr>
<td>11. One word evoked- /f/</td>
</tr>
<tr>
<td>12. One word evoked- /v/</td>
</tr>
<tr>
<td>13. Two words imitated- /s/</td>
</tr>
<tr>
<td>14. Two words imitated- /z/</td>
</tr>
<tr>
<td>15. Two words imitated- /f/</td>
</tr>
<tr>
<td>16. Two words imitated- /v/</td>
</tr>
<tr>
<td>17. Two words evoked- /s/</td>
</tr>
<tr>
<td>18. Two words evoked- /z/</td>
</tr>
<tr>
<td>19. Two words evoked- /f/</td>
</tr>
<tr>
<td>20. Two words evoked- /v/</td>
</tr>
<tr>
<td>21. Three words imitated- /s/</td>
</tr>
<tr>
<td>22. Three words imitated- /z/</td>
</tr>
<tr>
<td>23. Three words imitated- /f/</td>
</tr>
<tr>
<td>24. Three words imitated /v/</td>
</tr>
<tr>
<td>25. Three words evoked- /s/</td>
</tr>
<tr>
<td>26. Three words evoked- /z/</td>
</tr>
<tr>
<td>27. Three words evoked- /f/</td>
</tr>
<tr>
<td>28. Three words evoked- /v/</td>
</tr>
</tbody>
</table>
Baseline words were assigned numbers with the even numbered words being used for teaching trials. A table of the words used for baselines and treatment can be found in Appendix B. Correct productions were continually reinforced with tokens and verbal praise. Corrective feedback was given for every incorrect response. The error correction procedure consisted of four steps incorporating some of the steps used in integral stimulation as described by Strand and Skinder (1999). (1) The clinician said, “I didn’t hear (target phoneme)” and the participant attempted the response again. (2) The clinician modeled the target response and asked the participant to then repeat. (3) The clinician provided a visual cue by mouthing the target response while the participant said it. (4) The clinician and participant simultaneously produced the target response to provide auditory and visual cues. If the participant did not produce the target, the task was discontinued and the next task started. Occasionally a cue as to how to produce the sound correctly was given along with the modeled production. For example, the participants responded well to “keep your teeth closed” when producing /s/ and “don’t stop your sound” when producing all four fricatives.

Participants were also encouraged to monitor their own productions. When the participant would produce the target sound, the clinician would ask if the sound was right or not. The clinician would also pause after the participant’s production in order to allow the participant time to determine if the sound had been produced correctly.

Criterion for Completion of Treatment

The criterion for the completion of treatment was set at 80% for each phoneme across three treatment sessions. Treatment consisted of a maximum of
36 sessions; if the criterion had not been met by this time, treatment was terminated.

**Reinforcement**

Verbal and token reinforcement was presented for on-task behaviors during the baseline phase and for correct responses during the treatment phase. Participants chose a prize from the “prize box” to be used as the back-up reinforcer. Each time 10 tokens were earned; the participant placed a stamp in a box. The number of boxes needed to earn the prize increased progressively throughout treatment. Once enough boxes had been stamped the prize was immediately awarded to the participant and a new one was selected. Tokens were only given for correct responses produced on the first attempt. The criterion to earn the selected prize was set at 1 stamped box and continually increased by 1 throughout treatment to a maximum of 10 boxes or 100 tokens.

For Participant 1, reinforcement consisted of game time. The token reinforcement system was attempted but unsuccessful with this participant. Instead of earning tokens, the participant would earn game pieces. Once all pieces were earned, the game was played. Only games of short duration were used. Towards the end of the study, this participant was able to receive the same reinforcement as Participants 2 and 3.

**Generalization Probes**

Probes were taken to measure generalization across untaught words to determine if the learned behaviors were being transferred to other words.
Probes of Generalization Across Words

Generalization to untaught words containing the taught phoneme at the evoked word and three-word phrase levels was measured every fifth session. The same procedures and stimuli used for baselines were used for probes. Correct responses were scored with a “+” and incorrect responses were scored with a “—”. The experimenter gave feedback for taught words only.

Generalization probes to conversation were not taken as treatment tasks only ranged from syllable to three-word phrases and participants either did not communicate at the conversation level or were unintelligible.

Data Collection

Data was collected throughout each session using the list of randomized treatment targets found in Appendix C. Baselines and probes were recorded on score sheets that were designed for those specific purposes. The responses were scored with a “+” for correct responses and a “—” for incorrect responses.

Reliability

Two graduate students within the speech-language pathology department at California State University, Fresno were used to score 20% of the sessions for each participant. The students were taught how to score responses for the concurrent treatment approach. Agreement between the investigator and the graduate students was determined through the use of unit-by-unit reliability standards. The analysis compared the scores of the graduate student and the investigator for each individual response. The student was present in the room during the session in order to allow for the most accurate scoring. The agreement range from the graduate students’ scores and investigator’s was 93% to 96%, with a mean of 94% agreement.
CHAPTER 3: RESULTS

Concurrent Treatment Results by Participant

The total percent correct for each session for all phonemes taught to each participant results are shown in Figure 1. The data for each phoneme by participant can be found in Figures 2-4. These figures show combined data for each taught phoneme at all task levels.

Baseline measures were taken prior to the start of treatment. Baselines were taken over three sessions for Participant 1, four sessions for Participant 2, and five sessions for Participant 3. Following baseline measures, correct production of the target phonemes was taught during teaching trials. Each target sound was taught in the initial position in one word. Once all four target words were correctly produced 8 out of 10 times, randomized treatment sessions began. All baseline words were assigned a number with the even numbered words being used for treatment.

Participant 1 took one session to establish all four target sounds. His progress was slow at first and inconsistent. He saw an allergist after the 22nd session in which a few allergies were discovered. The week prior to this appointment, no allergy medications were taken. At this point, scores began to rise more quickly and continued to do so after allergies were discovered and lifestyle was changed. Attendance also improved now that he was in better health. Correct productions were still slightly inconsistent from session to session, but at a higher percentage.
Figure 1. Total percent correct across all taught phonemes per participant
Figure 2. Target phoneme production for Participant 1
Figure 3. Target phoneme production for Participant 2
Figure 4. Target phoneme production for Participant 3
Participant 2 spent five sessions establishing all four target sounds. After establishment had been achieved, the participant missed two sessions due to illness. After the initial treatment session, scores for target sounds began to improve with the exception of /z/. The target /z/ was taken out of the treatment sequence on the 7th treatment session as the participant was not correctly producing the sound. The sound was added back in for the 8th treatment session as he could now correctly produce the sound. After this point, correct production of all four sounds increased at a rapid rate. After 14 treatment sessions, 23 total sessions, the criterion for completion of treatment was met.

Participant 3 established all four target sounds after one session. Progress after the initial treatment session was inconsistent at first. After the 16th treatment session, the participant’s correct production of all four sounds became more consistent and steadily increased from there. The researcher and parent agreed to continue beyond 36 total sessions as the participant’s scores were nearing the criterion for completion towards the end of the study. At session 40 the criterion for completion was met and the study was ended. During the study, Participant 3 was receiving speech therapy at her elementary school despite the parent signing the consent form promising not to have the child in treatment. After a review of this participant’s Individualized Education Plan, it was determined that the goals and treatment procedures used at school were substantially different from the targets and procedures of the current study. Further, a review of Figure 1 shows that Participant 3’s progress was similar to the other two participants in the current study. Therefore, it appears the school-based treatment had minimal impact on this participant’s performance during this study; however, influence from the other treatment cannot be completely eliminated as a variable in her performance.
Generalization Probes

Probes of Generalization Across Words

Results for generalization probes administered every fifth session are shown in Figures 5-10. Data for both taught and untaught words are presented for each phoneme for one-word and three-word tasks. The same stimuli used for baselines were presented for probes.

Probe baselines were scored at 10%, 20%, and 15% for the phoneme /s/ one-word tasks for Participant 1. Probe data showed an increase in accuracy for both taught and untaught words with the highest percentage correct being 70% for taught words and 60% for untaught. Probe baselines for /s/ three-word tasks were steady at 10%. Again, an increase in accuracy was seen for taught and untaught words with 70% being the highest percentage for both tasks. Participant 1 showed much improvement for one-word tasks for phoneme /z/. Baselines were at 5% for the second session and 0% for the others. The highest percentage for taught words was 50% and 70% for untaught. Baselines for three word tasks were consistent at 0%. As with the one-word tasks, Participant 1 achieved an accuracy of 50% for taught words and 70% for untaught words.

Baselines for /f/ one-word tasks ranged from 35% to 45% with improvement up to 90% for taught words and 80% for untaught. Baselines for three-word tasks were the same as the one-word tasks. Participant 1 improved accuracy to 60% for taught words and 80% for untaught words. Baselines for /v/ at the one-word level were consistent at 0%. Much improvement was shown on probes with accuracy up to 75% for taught words and 86% for untaught. The three-word task probes were at 0% for two sessions and 6% for one. Accuracy of 75% was achieved for taught words and 86% for untaught words. The probe
scores stated were the highest achieved of all probes administered. Final probe scores were lower than other probe scores as the participant was very distracted on the day they were administered.

Participant 2’s baselines were at 0% for all four phonemes. Probe scores demonstrate the rapid progress made by this participant. Accuracy of 100% was achieved for the phoneme /s/ for one and three-word tasks by the final probe session. Probe scores for /z/ reached 100% accuracy for all tasks with the exception of one-word task taught words reaching 90%. One-word task probes reached 90% for taught and untaught phonemes while three-word task probes reached 100% for taught and untaught words. Scores of 100% were achieved for /v/ for one and three-word tasks for both taught and untaught words.

Baseline scores for /s/ for one word tasks ranged from 35% to 50% with 50% being achieved on only one of the five baseline sessions for Participant 3. Baselines for /s/ for three-word probes ranged from 30% to 45%. The last probe scores reached 100% for all tasks. Participant 3 scored 0% on two baseline sessions and 5% on three sessions for /z/ on the one-word tasks. Taught words reached 70% correct on the last probe and 100% for untaught words. Three-word task baselines were at 0% with one session being at 5%. Taught words reached 70% accuracy and untaught words reached 90%.

Participant 3’s baseline scores for /f/ on one-word tasks ranged from 35% to 45%. Three-word task baselines ranged from 30% to 40% with one session scoring 25% accuracy. Probe scores reached 100% for /f/ on all tasks. The baseline scores for /v/ ranged from 0% to 6% at both one-word and three-word tasks. Scores on the last probe varied. On the one-word tasks, taught words were 38% correct and untaught words were 100% correct. On the three-word tasks, taught words were 50% correct and untaught words were 100% correct.
Figure 5. /s/ and /z/ probes for one and three word tasks – Participant 1
Figure 6. /f/ and /v/ probes for one and three word tasks – Participant 2
Figure 7. /s/ and /z/ probes for one and three word tasks – Participant 2
Figure 8. /f/ and /v/ probes for one and three word tasks – Participant 2
Figure 9. /s/ and /z/ probes for one and three word tasks – Participant 3
Figure 10. /f/ and /v/ probes for one and three word tasks – Participant 3
CHAPTER 4: DISCUSSION

The results of this original study support concurrent treatment as a motor-skill approach to treating CAS. The positive results confirm the efficacy of concurrent treatment, while the use with children with suspected CAS suggests the versatility of the treatment program itself.

Previous treatment programs used for CAS typically follow the easy to hard hierarchy starting with syllables and working up towards sentences and conversation. In contrast, concurrent therapy randomizes this hierarchy so that no one task is repeated back-to-back. Previous studies have demonstrated that concurrent treatment is effective and efficient in treating phonological and articulation disorders (Kerber, 2005; Price, 2005; Resciniti, 2007; Skelton, 2004; Skelton & Funk, 2004). The present study adds another dimension to concurrent treatment’s repertoire.

Comparison to Previous Concurrent Treatment Research

It is difficult to compare this study to previous studies involving the concurrent treatment approach as they were treating different disorders. Past studies worked on tasks ranging from syllables all the way to storytelling. The current study consisted of tasks ranging from syllables to three-word phrases. Other studies selected targets that were maximally different whereas this study selected four fricatives with two being cognate pairs differing in voicing as all three participants had difficulty with voicing during the assessment process.

Participant 2 did show similar progress to participants in studies done by Kerber (2005) and Resciniti (2007) in that he showed rapid progress in acquiring the speech sounds as well as reaching the criterion for completion. This similarity
in results suggests that concurrent treatment may not only be efficient in treating phonological or articulation disorders but also more complex disorders such as CAS.

Past concurrent treatment studies have also focused on generalization. Results from these studies demonstrate that correct sound production carried over to conversation, settings outside of the clinic, and untaught sounds and words (Kerber, 2005; Price, 2005; Resciniti, 2007; Skelton, 2004; Skelton & Funk, 2004). The current study did not assess generalization to anything other than untaught words, as the focus of this study was progress within treatment sessions to determine if it was possible to adapt the treatment program in order to be used with more complex disorders.

**Comparison of Concurrent Treatment to Other CAS Treatments**

Other treatment programs for CAS, such as integral stimulation (Strand & Debertine, 2000; Strand & Skinder, 1999) and the eight-step task continuum (Rosenbek et al., 1973) follow the easy to hard hierarchy. Often starting in isolation and then working up toward syllables, single words, short phrases, sentences, and then conversation. These programs tend to yield slower progress, as criterions must be met before advancing to the next level. Concurrent treatment does the opposite in randomizing the tasks and, in this study, yielding more progress at a faster rate.

Integral stimulation makes use of the eight-step task continuum developed by Rosenbek et al. (1973). In the current study of concurrent treatment, a few of the steps were incorporated into the correction procedures. These steps included the investigator and participant saying the word
simultaneously, the investigator saying the word and the participant repeating, and providing a visual cue without the auditory cue.

Concurrent treatment also differed in target selection from other treatment programs for CAS. Many programs select functional words as opposed to focusing on specific sounds as was done in this study (Ruscello, 2008; Strand & Debertine, 2000; Strand & Skinder, 1999). What is consistent between all of the treatment programs is working on correctly producing sounds when paired with other sounds and in words. Also, repetition has been shown to be a key factor in treating CAS. All treatment programs have incorporated repetition into the treatment plan. Some programs, as suggested by Hall and Jordan (2007), encourage self-monitoring by the clients. The participants in this study were also encouraged to monitor their own productions. Participants 2 and 3 caught onto this quickly and made more progress. This allowed them to judge when their productions were correct and when they needed to be attempted again.

In summary, concurrent treatment has some similarities with other treatment approaches for CAS in that it utilizes repetition, similar modeling techniques, and self-monitoring techniques. In contrast to other treatment programs, concurrent treatment takes advantage of recent research supporting the use of randomized variable treatment procedures, which seem to encourage more efficient progress. CAS treatment plans use the hierarchy and do not move onto a more difficult task until the simpler one has been mastered. Integral stimulation and concurrent treatment are both motor learning approaches to treating CAS but differ widely in the procedures used.
Motor Learning Research and Concurrent Treatment

Although research in using motor-skill approaches for treating CAS is lacking, there is research available that supports the use of concurrent treatment as a treatment approach in general. Emerging literature is supporting the fact that randomized practice may be more beneficial for long-term retention of motor skills (Schmidt & Lee, 2005). In fact, in studies involving adults with apraxia of speech done by Rosenbek et al. (1973), the results suggested that providing constant practice at first may assist the participant in acquiring the speech sound or task, and that variable practice after acquisition may be beneficial in the generalization of the skill. With concurrent treatment, the sounds are established by working on one sound in one context. Once the participant met the criterion set for /s/ at the isolation level, the sound in succession in the target word was then combined with /s/ to form a syllable. This was worked on until mastered and so on and so forth until the entire target word was mastered. Each task was attempted for 20 trials; more or less trials were done depending on the participant’s level of fatigue, before moving onto a different task. Once all phonemes had been acquired in target words, treatment then moved on to variable practice.

In discussing nonspeech motor programs it is supported that when variable practice is randomized it yields positive progress that may not be seen through blocked practice (Maas et al., 2008). As has been demonstrated by concurrent treatment, variable randomized practice has been effective and efficient in treating phonological and articulation disorders, and is now leading toward successful treatment of CAS. In a study by Knock et al. (2000), motor speech skills were taught in both random order and blocked. Both behaviors were acquired at similar rates with random ordered behaviors being more
consistent session-to-session than blocked. As is consistent with other studies, the participants showed greater retention on the behaviors taught in random order.

**Efficiency and Effectiveness of Concurrent Treatment**

**Research Design**

The multiple-baseline-across-subjects research design was used in this study. This design was useful in showing consistent baselines prior to the start of treatment. All participants showed an increase in correct productions once concurrent treatment was implemented. There were a few sounds in which it took up to three sessions to see a substantial increase. Previous studies by Kerber (2005) and Resciniti (2007) showed great increase from baseline to treatment with their participants. It is possible that the slightly slower progress shown in this study may be secondary to the nature of the disorder. The difference from baseline to treatment was significant enough to demonstrate that it was concurrent treatment (the independent variable) that evoked the change in correct productions of the target sounds (the dependent variable). This relationship between the dependent and independent variables shows that concurrent treatment was effective in creating a change in the target sounds.

**Accuracy and Criterion Achievement**

The main focus of this study was to determine if concurrent treatment would be effective and efficient in treating CAS. Participants 1 and 3 showed steady increase in accuracy throughout the study. Participant 2 showed a rapid increase in acquisition and reaching the criterion of completion, which was more consistent with prior studies (Kerber, 2005; Price, 2005; Resciniti, 2007; Skelton,
2004; Skelton & Funk, 2004). Baselines for Participant 1 were consistent between 14% and 17% and scores increased to 44% for all taught phonemes by the second treatment session and remained above 20% for the remainder of the study. After the ninth treatment session accuracy scores increased to above 65% and stayed above there for the remainder of the study. Baselines for Participant 2 were consistent at 0% for all taught phonemes. Scores increased to 10% at the first treatment session and steadily climbed from there reaching 35% at the fourth treatment session and above 80% at the ninth. The criterion for completion was reached on the 12th session. Baselines for Participant 3 ranged between 20% and 34% with only the first baseline session being above 23% for all phonemes. Accuracy increased to 45% at the first treatment session and remained above 80% for total phonemes after the ninth treatment session, with only two sessions as low as 78%.

These results are difficult to compare to those of other studies involving concurrent treatment or other CAS treatment programs, as it is the first time that a treatment of this type has been used with CAS. The results do suggest that concurrent treatment is efficient and effective in treating CAS. The results may have varied slightly session-to-session for some of the participants but overall, progress was made at a fairly quickly rate. Participant 2 reached the criterion for completion in 12 treatment sessions and Participant 3 in 28 sessions. Participant 1 did not meet the criterion for completion but did show significant increase and was beginning to reach the criterion. It is not known how many more sessions would have been necessary for the goal to be reached.
Randomized Difficulty in Task Sequence and Presentation

The results of this study demonstrate that randomized task difficulty did not negatively impact acquisition of target sounds. Although this fact has been demonstrated in past studies in regards to phonological and articulation disorders (Kerber, 2005; Price, 2005; Resciniti, 2007; Skelton, 2004; Skelton & Funk, 2004), it had yet to be demonstrated with suspected CAS. Task difficulty did not impact acquisition as all participants showed progress on all task levels.

These results with suspected CAS suggest that the need to follow the easy to hard hierarchy as previously thought may no longer be as necessary. Concurrent treatment may allow for a more efficient way of treating CAS. By following the hierarchy, treatment plans may require longer treatment time as opposed to randomizing the tasks and working on them all at once. Of course, the randomized variable treatment tasks may not be beneficial for all clients and individual circumstances should always be taken into consideration.

The results also support that randomizing the tasks themselves does not hinder the acquisition of the target sounds. In randomizing the task presentation along with task difficulty, the client is able to practice multiple targets in a range of difficulty levels without being able to predict what is going to be the next target or task. This allows the client to practice tasks in a more diverse manner, which may lead to quicker acquisition of the target behavior and potentially greater retention. Randomizing task difficulty and presentation provides variability throughout the treatment session and provides practice similar to that experienced in daily life as communication in daily situations does not take place in just syllables or just words or just sentences but is a random mixture of all levels.
Limitations

Due to this study beginning during the winter months, there were a few instances of prolonged absences due to illness and vacations. An impact can be seen with Participant 2 in that he missed one week of treatment following the conclusion of the establishment phase. It is not known if accuracy would have been higher on the first treatment session and subsequent sessions had the week break not been taken. Participant 1 also periodically missed sessions due to severe allergies. Attendance and accuracy improved after seeing an allergist. These absences seemed to have minor impacts on the session following the break but scores would increase back to where they had been by the next session.

Another limitation may have been the selected targets. Later developing sounds were selected. Typically, functional words are selected in treatment of CAS and not specific speech sounds (Ruscello, 2008; Strand & Debertine, 2000; Strand & Skinder, 1999). Results were still high in this study, and it is unknown if results would have been even more significant had different targets been selected.

Implications for Further Research

With this study showing positive results in the treatment of CAS, further research is recommended. Research focusing on treating CAS with the use of concurrent treatment is needed to strengthen the efficacy and generality of the treatment program. Also, research in regards to generalization to other settings and sounds within the treatment of CAS should be done, as that was not covered in this study. Language samples could be taken at the end of the study and compared to those taken during the assessment procedures to show if any changes in language skills or MLU were made. Research covering other ways that the treatment program can be adapted in order to be successful with other
disorders would also be important as it could add to the diversity of this treatment program.

More research could also be done in the area of treating phonological and articulation disorders. As was suggested by Resciniti (2007), more research controlling the probes administered in the clinic and other settings could be done in order to further determine the generalization capabilities of concurrent treatment. The majority of research done thus far has been with individual sessions, it would be important to determine if concurrent treatment could be administered in a group setting in order to add to its efficiency. Also, determining the procedures necessary in order to administer in a group setting would be an asset to this program.

Summary

The purpose of this study was to determine if concurrent treatment would be effective and efficient in treating CAS. Results revealed quick increase in target sound production once concurrent treatment was administered. This study was the first to use concurrent treatment in treating CAS. Previous studies have shown that the treatment program is effective and efficient in treating phonological and articulation disorders in children. The addition of this study to concurrent treatment’s growing list of studies adds another dimension to the versatility of the treatment.
REFERENCES


APPENDICES
APPENDIX A: CONSENT FORM
Parental Consent for Child’s Participation in Research Study

Your consent is requested to allow your child, __________________________, to participate as a subject in a research study. The purpose of this original study is to investigate if the concurrent treatment approach will be effective in improving speech production of children with Childhood Apraxia of Speech (CAS). A multiple-baseline-across-subjects research design will be used with three to four participants diagnosed with CAS. Concurrent treatment differs from other motor-program approaches in that it randomly intermixes treatment tasks as opposed to teaching them in a hierarchy of easy-to-hard as other motor-skill approaches do.

The study begins with a speech, language, and motor speech assessment conducted with your child. This will determine if your child meets the requirements to participate in this study. Only children who meet the entrance requirements will actually receive speech therapy through this study. Thus, your consent does not guarantee your child’s participation in the remainder of this study. However, noneligibility for this study does not affect or determine your child’s eligibility for any public school special education program (such as speech therapy).

The study will consist of a series of speech therapy sessions, conducted by Aubrie Hagopian, a graduate student in the Department of Communicative Disorders and Deaf Studies under the supervision of Dr. Steven Skelton. We will use procedures that are common to speech therapy sessions conducted by speech pathologists in everyday clinical practice. These sessions will be held at the Speech, Language, and Hearing Clinic at California State University, Fresno (CSUF). During the first sessions your child’s use of the target sounds will be tested. Each testing session will include (1) use of the target sound in response to pictures and questions, and (2) a conversation with the experimenter. These sessions will be audiotape recorded. The speech therapy session will use standard clinical materials (books, pictures, questions) during which your child will be taught the target sound or sounds. To encourage your child’s learning he or she will be able to earn tokens. These tokens will be exchanged for a small prize at the end of the session. The prizes can include stickers, pencils, pens,
erasers, toy cars, etc. During the course of the study, your child cannot receive other speech therapy services as this may interfere with the results of the study.

It is anticipated that the study will have a maximum of 36 speech therapy sessions. The sessions will be conducted two times a week at 30 minutes per session. Your child will receive ____ baseline sessions and ____ treatment sessions.

There are no known risks involved in the use of the stimuli, materials, and procedures in this study. You and your child’s confidentiality will be strictly protected. A subject number will be assigned to each child, eliminating the use of names and insuring confidentiality. Audiotape recordings of your child’s speech will be labeled only with the appropriate subject number. These tapes will be kept in the investigator’s possession or in a locked office in the CSUF Department of Communicative Disorders and Deaf Studies. The audiotapes will be erased after the completion of the study, unless you give us permission to keep them for future analysis (confidentiality will be maintained as described above). A space is provided at the end of the form for your permission for us to keep the tapes. The results of this study may be published in journals, a thesis, or orally presented to professional or scientific audiences without identifying the child or the family. Audio- and videotapes may be similarly presented without the name of your child.

Participation in this study will involve no cost to you and is entirely voluntary. You may withdraw your consent at any time without penalty or loss of benefits to which your child otherwise is entitled. If your child has been referred for this study through the cooperation of his or her public school, participation, nonparticipation, or withdrawal from this study will in no way affect his or her receiving any special education services as entitled under California State Law. Also, participation does not affect your child’s eligibility for speech therapy services at the CSUF Speech, Language, and Hearing Clinic; it does not affect the child’s position on the “waiting list” at the clinic, if applicable.

The investigators for this study are Aubrie Hagopian and Dr. Steven L. Skelton. If you have any questions, you may contact us at the Department of Communicative Disorders and Deaf Studies, (559) 278.2698 or via email at sskelton@csufresno.edu.
Your signature below shows that you consent to your child’s participation in the study described above. You will be provided a copy of this signed consent form.

Thank you,

Aubrie Hagopian, B.A.

Steven L. Skelton, Ph.D., CCC-SLP
Associate Professor
I consent to permit my child, ________________________, to participate in the study described above.

___ I give permission for the audiotapes to be kept after the conclusion of the study, as described above.

______________________________  ____________________
Parent (or Legal Guardian)    Date

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APPENDIX B: TAUGHT AND UNTAUCHED WORDS FOR TREATMENT AND GENERALIZATION PROBES
### Taught Words

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### Untaught Words

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1= "I didn’t hear (target sound)"
2= Model-Repeat
3= Visual cue
4= Simultaneous repetition
California State University, Fresno

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