I, Kathryn Beerman B.S., hereby submit this original work as part of the requirements for the degree of Master of Arts in Communication Sciences and Disorders.

It is entitled:
The Occurrence of Vowel Errors Across Age Groups in Childhood Apraxia of Speech

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The Occurrence of Vowel Errors Across Age Groups in Childhood Apraxia of Speech

A Thesis Submitted to the Department of Communication Sciences and Disorders College of Allied Health Sciences

in partial fulfillment of the requirements for the degree of

Master of Arts

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Abstract

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The purpose of this study was to determine if there are differences in the number of vowel errors across age groups in children diagnosed with childhood apraxia of speech. The study retrospectively examined the clinical database from the Cincinnati Children’s Hospital Medical Center Interdisciplinary Apraxia Clinic. The participants were divided into three groups: toddler, preschool, and school age. Vowel errors were counted using the raw scores on three sections of the Kauffman Speech Praxis Test: pure vowels, vowel-to-vowel movement and consonant-to-vowel movement. It was found that age did not play a significant role in the number of vowel errors present across the age groups.
Acknowledgements

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Chapter 1

Introduction

Apraxia of speech is a disorder thought to impair the processes of planning and programming the motor movements of speech (Shriberg, Aram & Kwiatkowski, 1997). It can occur developmentally in children, or as a result of an acquired brain injury in adults. A review of the literature indicates a lack of previous work in which the results of clinical assessments for children with childhood apraxia of speech (CAS) are compared. The core characteristics of CAS, as defined by the American Speech-Language-Hearing Association (2007), include inconsistent errors on consonants and vowels in repeated production of syllables or words, lengthened and disrupted coarticulatory transitions and inappropriate prosody. It has also been shown that these characteristics may change with task complexity, severity of involvement and age (American Speech-Language-Hearing Association, 2007).

Diagnosis of CAS remains poorly understood (Teverovsky, Bickel, & Feldman, 2009), and difficult to achieve because of the multitude of symptoms that it presents (Davis, Jacks, & Marquardt, 2005). The proper differential diagnosis, however is key to implementing the appropriate treatment, because children with CAS often present many secondary deficits that may impact learning and daily living (Gillion & Moriatry, 2007; Lewis, Freebairn, Hansen, Iyengar, & Taylor, 2004; Teverovsky, Bickel, & Feldman, 2009).

A potential diagnostic criterion for CAS includes vowel errors (Davis et al., 2005). However, it is known that the core articulatory patterns of CAS do improve with age (Gillion & Moriatry, 2007), so the validity of this diagnostic marker may decrease as
the child’s age increases. Because this topic has not been explored in-depth, this study will examine three types of vowels, across three age groups, to determine the results and implications to the following research questions:

Research question 1: *Are there differences in the number of pure vowel errors by age group?*

Research question 2: *Are there differences in the number of vowel-to-vowel movement vowel errors by age group?*

Research Question 3: *Are there differences in the number of consonant-to-vowel movement vowel errors by age group?*
Chapter 2

Review of the Literature

Diagnosis of Childhood Apraxia of Speech

CAS was first widely described in the United States by Rosenbek and Wertz (1972) as developmental apraxia of speech. At that time the authors reported that a commonly diagnosed disorder in children included expressive aphasia; however the description of this disorder included complete understanding, inability to imitate oral movement and an inability to imitate sounds, which relate to the motor aspects of speech, rather than the language aspects.

CAS presents with many varying deficits of speech including motor planning aspects with groping features, incorrect prosody, vowel and diphthong errors, consonant errors and difficulty imitating sounds and words (Shriberg et al, 1997). Because of the wide range of presenting features, the ability to differentiate between phonological disorders and CAS has been questioned (Shriberg et al., 1997). It may be especially hard to differentiate between CAS, speech disorders and phonological errors in young children because of the difficulty eliciting a connected speech sample. The American Speech Language Association (2007) provides the following definition for the diagnosis, treatment and study of CAS:

*Childhood apraxia of speech (CAS)* is 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)

Studies however, have continued to question the exact diagnosis of CAS. The diagnostic markers have remained controversial with only a few studies attempting to explain the origin and nature (Shriberg et al., 1997; Grigos & Kolenda, 2010; Davis et al., 2005). CAS is defined by a symptom cluster. Studies have described different diagnostic criteria, and have stated that not all of the markers are present or may be present to varying degrees (Shriberg et al., 1997). There is also some debate in the underlying origin of CAS, with theories defining CAS as a deficit in motor planning, output processes, selection-retrieval processes, or a prearticulatory sequencing deficit (Shriberg et al., 1997).

In 2007, the American Speech-Language-Hearing Association released a technical report about CAS which included discussion of the core characteristics, assessment, and treatment. They identified three main features; inconsistent errors on consonants and vowels in repeated production of syllables or words; lengthened and disrupted coarticulatory transitions; and inappropriate prosody (American Speech-Language-Hearing Association, 2007). These features are known as the core characteristics which are also reported to change depending on task complexity, severity of involvement, and age.

The reported prevalence of CAS has been questioned and currently there are no sound figures or estimates on the number of children with a diagnosis of CAS (American Speech-Language-Hearing Association, 2007), but based on individual clinic referral and study data, we see an increase in the number of children diagnosed. Delaney & Kent (2004), in a study of diagnostic outcomes for an estimated 12,000 to 15,000 children
referred with speech delay from 1998-2004, found that 516 (3.4%–4.3%) of these children were diagnosed as having suspected CAS.

The age of onset for CAS is acknowledged to be early in speech development (Shriberg et al., 1997). It is known that prevalence rates of CAS vary with age, which may be partially caused by the variation of symptoms across age (Lewis et al., 2004). It is reported that articulation errors may decrease with years of speech therapy, however, patients may continue to have difficulty articulating novel or complex words throughout school age and adolescence (Lewis et al., 2004).

**Developmental and Academic Implications of Childhood Apraxia of Speech**

It is important to accurately diagnose and treat CAS as early as possible due to the impact it may have on development and learning.

*Language Development*

It was found that children diagnosed with CAS also present with receptive and expressive language problems associated with the speech sound errors as a core characteristic of the disorder (Lewis et al., 2004). These difficulties persist throughout school age, and where an individual diagnosed with CAS may show improvement in these areas, it is not as significant as the gains made by those with a speech disorder or those with a speech/language disorder (Lewis et al., 2004). It is important to keep these language deficits in mind when treating or diagnosing a child with CAS so a comprehensive therapy plan can be developed.
**Academic Environment**

Reading and spelling difficulties are often seen in children diagnosed with CAS, with an increased risk for persistent spelling and reading disorders (Gillon & Moriaty, 2007). These difficulties negatively impact academic success, therefore correct diagnosis and treatment of children with CAS needs to occur in order to begin therapy with those children as soon as possible (Gillon & Moriaty, 2007; Lewis et al., 2004). The integration of phonological awareness into both reading interventions and speech therapy has been shown to help those with CAS overcome these difficulties (Gillon & Moriaty, 2007). This type of combined therapy will help to improve academic scores and overall life skills.

Other functional characteristics are also present throughout childhood for children diagnosed with CAS. The functional problems most reported by parents in addition to communication include: focus, vestibular function, temperament, fine hand use, and learning to write (Teverovsky et al., 2009). These difficulties should be taken into account when diagnosing and treating children who present with the core characteristics of CAS in order to provide a comprehensive diagnosis and appropriate treatment options.

**Fine Motor**

Fine motor function is another area that may be affected when a speech sound disorder, such as CAS, is present (Newmeyer et al., 2007). In a study examining 32 preschool age children with severe speech-sound disorder, Newmeyer et al. (2007) found that abnormal oral-motor imitation skills were associated with below-average fine motor performance. If a child presents with a severe speech-sound disorder, such as CAS, a fine
motor screening may identify other difficulties such as writing and self-care skills, which should be taken into account when diagnosing and treating children with CAS.

**Sensory Processing**

Another aspect associated with CAS is sensory processing. Newmeyer et al. (2009) found that there was a significant difference in the sensory processing of the 38 children with CAS tested when compared to same age peers. Differences were noted in auditory, visual, touch and multi-sensory processing. It may be important to include an occupational therapist to assist both in diagnosis and treatment of any sensory processing deficits.

**Vowel Errors and Distortions in Childhood Apraxia of Speech**

Vowel errors are considered a possible differentiating feature of CAS (Marquardt, Jacks, & Davis, 2004), and few studies have examined the persistence of vowel errors (Davis et al., 2005; Grigos & Kolen da, 2010). Examining the persistence of vowel errors and distortions may provide important diagnostic information when evaluating a child suspected to have CAS.

In normally developing speech, a complete vowel inventory, or the ability to pronounce all vowels, is present by approximately 24 months of age, with accuracy improving until, and becoming largely accurate by, three years of age (Davis et al., 2005). This normal inventory and accuracy is not present as early in children with CAS (Davis et al., 2005; Grigos & Kolenda, 2010; Marquardt et al., 2004; Nijland et al., 2002).
Grigos & Kolenda (2010) studied articulatory control in one 3-year child diagnosed with CAS. They followed the child for 8 months measuring kinematic parameters including jaw velocity and stability along with phoneme errors and consistencies on the words “Mom”, “Bob” and “Pop” and then compared them to the measures of 3 children with normally developing speech. The study found that there were many differences among the child with CAS and the other children including smaller and slower oral closure. The study also noted the number of consonant and vowel errors over this time. The vowel errors were variable and in the 8 trials, ranged from 0 to 25%. However, it should be noted that only one vowel was observed and only one subject under the age of 4 was included, therefore the results should be reviewed with caution.

Davis et al. (2005) studied 3 children diagnosed with CAS over a course of 3 years to examine how vowel inventory and accuracy changed, along with how vowel accuracy is related to vowel inventory and how it is affected by complexity. The study tested the children once a year and viewed patterns of vowel accuracy and inventory in spontaneous speech. The children were 4;6, 5;6, and 5;10 when the testing began. The study found that children diagnosed with CAS had a complete vowel inventory along with an equal proportion of use when compared with typically developing grade-school children. However, the accuracy remained lower than what was expected for typically developing children and persisted as late as 8 to 9 years of age, even with intensive therapy. The overall accuracy in trial 1 was 61-75% increasing to 71-85% accuracy in trial 3, demonstrating a moderate increase across the 3 years. Because this study examined only three cases for only 3 years, a larger scale study would be necessary to
establish a more accurate interpretation of vowel errors related to age in children diagnosed with CAS.

Other studies of articulation within CAS also showed the inconsistencies of vowel and consonant targets (Marquardt et al., 2004; Nijland et al., 2002); however, the focus of these studies was not directed specifically toward vowels, but towards the overall speech variability in a child diagnosed with CAS. Both Marquardt et al. (2004), with 3 subjects diagnosed with CAS, and Nijland et al. (2002) with 9 subjects diagnosed with CAS, found that inconsistencies within the articulation patterns of children with CAS were present in vowels and consonants throughout their studies.

A need still exists to investigate the number of vowel errors of children diagnosed with CAS using a larger subject pool across multiple age groups in order to better understand vowel errors in these children.
Chapter 3

Methods

This study is retrospective, using a large database compiled at the Cincinnati Children’s Hospital Medical Center (CCHMC). The database includes background and clinical information on children seen in an interdisciplinary clinic established to effectively identify children with CAS.

Participants

Participants for this study were seen in the interdisciplinary clinic between 2003 and 2007. The clinic was established in 2003 in order to accommodate the increase in the number of children referred to the CCHMC Division of Developmental and Behavioral Pediatrics for suspected CAS. All participants evaluated through this clinic, completed a standardized evaluation protocol by a team that included a developmental pediatrician, an occupational therapist and a speech language pathologist.

Standardized tests were given by 1 developmental pediatrician, 1 of 3 occupational therapists, and 1 of 2 speech language pathologists. In order to establish inter-rater reliability, the KSPT was given by only two speech language pathologists over the course of the data collection. The two speech language pathologists initially scored and compared results for 2 children then discussed scoring differences and determined a consistent manner for future administration and scoring. They met again after six months of the initiation of the database and repeated this process in order to ensure that the speech testing continued to be scored and conducted consistently.
The clinical team met following each of the evaluations to compare results and determine if a clinical diagnosis of CAS was appropriate. In determining the diagnosis, they looked for the following characteristics: oral scanning or groping, difficulty maintaining the same motor-speech pattern twice, inability to imitate motor-speech patterns of increased length or complexity, vowel distortions, limited consonant repertoire, and sound errors such as distortions and weak targets. These criteria are from the Kauffman Speech Praxis Test (KSPT) Diagnostic Rating Scale Continuum.

Included in this study were 49 children clinically diagnosed with CAS aged 2;6 to 9;9 who completed sections, 2a (measuring pure vowels), 2b (measuring vowel-to-vowel movement) and 2e (measuring consonant-to-vowel movement) from Part 2 of the KSPT. Excluded from this study were any children that may have secondary conditions affecting vowel production, including children with cranio-facial anomalies, children with a hearing loss and children with any muscular disorder including cerebral palsy.

**Procedure**

After being seen in the clinic, demographic data, family history, past medical history and standardized tests were entered into a Microsoft Access database. The results from the KSPT protocols were then converted into a Microsoft Excel spreadsheet for analysis. The demographic data, family histories and past medical histories were compiled by the developmental pediatrician along with a physical examination. The standardized tests included fine motor testing, language testing and speech production.

The tests were chosen by the evaluators dependent on the age and development of the child. Test for fine motor were given by the occupational therapist and may have
included: the Peabody Developmental Motor Scales Second Edition (PDMS-2) or Bruininks-Oseretsky Test of Motor Proficiency Second Edition (BOT-2). Tests for language were given by the speech-language pathologist and may have included: The Preschool Language Scale Fourth Edition (PLS-4), the Clinical Evaluation of Language Fundamentals Fourth Edition (CELF-4), the Peabody Picture Vocabulary Test Third Edition (PPVT-3), the Expressive One-Word Picture Vocabulary Test 2000 Edition (EOWPVT 2000), or the Oral and Written Language Scales (OWLS). Tests examining speech production were also given by the speech language pathologist and may have included: the Kauffman Speech Praxis Test for Children (KSPT), or the Goldman-Fristoe Test of Articulation Second Edition (GFTA-2).

The KSPT raw scores were used for this study. The KSPT is a norm-referenced test developed to determine abnormal speech praxis. The KSPT has four parts; (1) Oral movement, (2) Simple phonemic/syllabic level, (3) Complex phonemic/syllabic level and (4) Spontaneous length and complexity. Parts 1 through 3 include sound, syllable, word and non-word repetition, where the child is asked to repeat after the examiner. The final part includes a spontaneous speech sample. The test is normed for the normal-speaking population of children as well as those children with disordered speech and language; it provides a raw score and standard score for each part.

The test is designed so that each part increases in difficulty; children with severe disorders may only be able to complete the first few sections of the test. Part 1 of the test examines oral movement through imitation. Even if Part 1 is difficult and the child is unable to complete it, Part 2 is still attempted. Parts 2, 3, and 4 are given in that order,
unless the child is no longer able to imitate the target phoneme, syllable, or word, then testing may be discontinued at the end of that part.

**Statistical Analysis**

The participants were divided into three age groups, toddler, preschool, and school age. The toddler group included children age 2;6 to 2;11, the preschool group included children from age 3;0 to 4;11, and the school age group included children age 5;0 to 9;9. Raw scores from the KSPT were taken from the spreadsheet and exported to SPSS (IBM SPSS Statistics 19) for analysis. The groups were then compared using a simple analysis of variance (ANOVA).
Chapter 4

Results

This study examines three types of vowels to assess the number of vowel errors present in each age group. The study was done retrospectively and the participants were divided into three age groups, toddlers (2;6 to 2;11), preschoolers (3;0 to 4;11), and school-aged (5;0 to 9;9). Data was collected on three sections from Part 2 of the KSPT (2a, 2b and 2e) measuring pure vowels, vowel-to-vowel movement and consonant-to-vowel movement. This study answered the following research questions:

Research question 1: Are there differences in the number of pure vowel errors by age group?

Research question 2: Are there differences in the number of vowel-to-vowel movement vowel errors by age group?

Research Question 3: Are there differences in the number of consonant-to-vowel movement vowel errors by age group?

Demographic Data

Two hundred and two participants were entered into the database between 2003 and 2007. Of these participants, 91 were given at least some part of the KSPT and 55 completed parts 2a, 2b and 2e. Of these children, 52 were diagnosed as having CAS. One child was found to have a hearing loss and 2 children had been diagnosed with Cerebral Palsy. After this exclusionary criterion was taken into account, 49 participants were included in this study.
Forty-one of the participants were male (83%) and 8 were female (7%). The average age of the participants was 55.3 months (4 years, 6 months). The toddler group contained 14% of the participants (n = 7), the preschool group contained 57% of the participants (n = 28) and the school-age group contained 29% of the participants (n = 14).

Family history was taken at the time of intake and it was found that one of the children (2%) in the study had an immediate family member diagnosed with CAS. Twenty-two (44%) of the children had a family history of speech delay, and of these 15 children (30%) in the study had an immediate family history of a speech delay.

**Research Question 1: Pure Vowels**

Pure vowels were examined using the raw scores from the KSPT Part 2a. In this section the child is asked to repeat each of the seven pure vowels (/a/ as in *father*, /ʌ/ as in *much*, /u/ as in *boot*, /ə/ as in *eat*, /ɛ/ as in *caught*, /ɛ/ as in *bet*, /ɪ/ as in *hit*) in isolation. The raw score is then calculated and equals the total number correct. On this section, 36 participants (73%) produced all 7 vowels correctly and one of the participants (2%) produced none of the pure vowels correctly. Within the toddler group 94% of pure vowels were produced correctly, in the preschool group 96% of the pure vowels were produced correctly and in the school-age group 90% of the pure vowels were produced correctly (Table 1).

<table>
<thead>
<tr>
<th></th>
<th>Pure Vowels Part 2a</th>
<th>Diphthongs Part 2b</th>
<th>Consonant-Vowel Movement Part 2e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toddler</td>
<td>94%</td>
<td>53%</td>
<td>14%</td>
</tr>
<tr>
<td>Preschool</td>
<td>96%</td>
<td>64%</td>
<td>17%</td>
</tr>
<tr>
<td>School Age</td>
<td>90%</td>
<td>58%</td>
<td>13%</td>
</tr>
</tbody>
</table>
The raw scores of the three groups were then compared using a simple ANOVA (Table 2). The between group significance was .489 (p < .05) indicating that age does not play a significant role in the correct production of pure vowels.

Table 2: Between Group Comparison of KSPT Scores and Age Groups

<table>
<thead>
<tr>
<th>KSPT</th>
<th>F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 2a</td>
<td>.726</td>
<td>.489</td>
</tr>
<tr>
<td>Part 2b</td>
<td>1.142</td>
<td>.328</td>
</tr>
<tr>
<td>Part 2e</td>
<td>.084</td>
<td>.920</td>
</tr>
</tbody>
</table>

Research Question 2: Diphthongs (Vowel-to-Vowel Movement)

Vowel-to-Vowel movement was assessed using Part 2b of the KSPT. In this section the participant was asked to repeat five diphthongs (/aɪ/ as in high, /ou/ as in boat, /æɪ/ as in bake, /au/ as in out, /ɔɪ/ as in boy) in isolation, the raw score was then calculated and equals the total number correct. In this section 31 of the participants (63%) produced all five diphthongs correctly and two participants (4%) produced none of the diphthongs correctly. Within the toddler group 53% of diphthongs were produced correctly, in the preschool group 64% of the diphthongs were produced correctly and in the school-age group 58% of the diphthongs were produced correctly (Table 1).

The raw scores for each of the three groups were then compared using a simple ANOVA (Table 2). The between group significance was .328 (p < .05), therefore, age did not play a significant role in the correct production of diphthongs in CAS.

Research Question 3: Consonant-to-Vowel Movement

Consonant-to-vowel movement was assessed using Part 2e of the KSPT. In this section the participants were asked to repeat 7 simple one-syllable words (do, pay, tie, boo, me,
bye and day). The participants’ response was marked incorrect if any combination of the consonant or vowel was incorrectly produced or omitted. For this study the vowel distortion/replacement category was examined and the total number correct in this category was analyzed. In this section one participant (2%) produced all of the vowels correctly and 33 of the participants (67%) produced none of the vowels correctly. Within the toddler group, 14% of the vowels in the consonant-to-vowel movement were produced correctly, in the preschool group 17% of the vowels in the consonant-to-vowel movement were produced correctly and in the school-age group 13% of the vowels in the consonant-to-vowel movement were produced correctly (Table 1).

The total number correct in the vowel distortion/replacement category was then analyzed using a simple ANOVA (Table 2). The between group significance when comparing the scores was .920 (p < .05). Therefore, age did not play a significant role in the correct production of consonant-to-vowel movement in CAS.

Figure 1: Percent Correct on the KSPT
Chapter 5

Discussion

Summary

This study was conducted in order to examine vowel errors in children diagnosed with CAS across age groups. The study was retrospective and used a previously established clinical database compiled of children diagnosed with CAS. The participants from the database were divided into three age groups, toddlers (age 30-35 months), preschoolers (age 36-59 months), and school-aged (age 64-117 months). Data was collected on three sections of the KSPT (Parts 2a, 2b and 2e) in order to analyze three types of vowel productions and determine if the number of vowel errors differed across age groups. It was found that the number of vowel errors did not vary significantly across age groups.

A strength of this study is the large number of children diagnosed with CAS across all age groups. Also, because only two examiners gave the KSPT over the course of the data collection, and procedures were put into place to insure each were identifying and documenting errors in the same manner, good inter-rater reliability was achieved.

Implications

This study found that between age groups a significant difference does not exist in the production of vowel errors in CAS. Vowel errors have often been stated as one criterion for diagnosis for all ages of children with potential CAS, but few studies have examined the validity of this marker. This study implies vowel errors, especially in
consonant-to-vowel movement, may be used as one of the defining characteristics when diagnosing CAS across all age groups.

This can be especially helpful when diagnosing children in the toddler age group, when it is difficult to elicit a connected speech sample. In this age group looking at the number of consonant-to-vowel movement vowel errors may help in diagnosing CAS. This study also implies that school-age children do not show significant improvement in consonant-to-vowel movement vowel errors when compared to preschool and toddler aged children. Therefore, using vowel errors to assist in diagnosing CAS in older children, especially when looking at consonant-to-vowel movement, is also valid.

Because this study found that consonant-to-vowel vowel errors are a consistent feature within the population of children with CAS, targeting vowel errors in treatment may be necessary in order to improve overall intelligibility. These errors may also present as reading difficulties, because in many instances a vowel replacement or distortion may change the meaning of a word or phrase, making it difficult to understand the child when reading aloud.

Another aspect to consider when examining vowel errors is their effect on prosody. Irregular prosody is one of the defining characteristics of CAS (American Speech-Language-Hearing Association, 2007). If the timing and length of the vowel are incorrect in the production of words, it may affect stress which is considered to contribute to the perception of prosody. Odell, McNeil, Rosenbek and Hunter (1991) examined vowel and prosody production in four adults with apraxia of speech and found that syllabic stress errors were accompanied by vowel misproductions in 71% of disyllabic
words and 74% of trisyllabic words. This implies that the vowel errors, which are present across age groups, may have an effect on prosody.

**Limitations**

The lack of diagnostic criteria for CAS is a potential limitation for this research. The availability of a standard definition of CAS makes it difficult to diagnose children; therefore the participants’ diagnoses, although made by a highly qualified interdisciplinary team, may be questioned. More defined criteria needs to be researched and documented in order to ensure an accurate diagnosis for all children with CAS.

Vowel production is largely affected by dialect (Jacewicz, Fox & Salmons, 2011) and this must also be taken into consideration. The KSPT was normed using children only from southeast Michigan, and the database did not mention the dialects of the participants used. Therefore, children may have dialectical differences that were not accounted for in the study.

This study was conducted retrospectively with participants’ histories inputted into a database prior to this analysis; therefore, the information that was not collected at the time of the appointment could not be used in the study. For example, it is unknown the number of participants that received previous intervention, the type of intervention, or the amount of intervention.

**Future Studies**

The research on CAS is limited; therefore further studies in the area of diagnosis and treatment are needed. A longitudinal study could be conducted in order to see if
treatment and early diagnosis has an effect on the number of vowel errors present in CAS.

This study examined three types of vowels (pure vowels, diphthongs and consonant-to-vowel movement) tested across age groups; another study may be useful in examining if errors within one of the three types of vowels is more indicative of CAS. This study focused on the number of vowel errors, however determining the types of errors that occurred, for example distortions or replacements, can give clinicians a better understanding of the vowel errors in CAS.

Because of the consistency of vowel errors across age groups in CAS it would be beneficial to study the impact of vowel errors on the intelligibility and syntactic meaning of speech. More studies examining the types and effectiveness of targeting vowel errors in therapy would also be beneficial to clinicians attempting to improve vowel errors in patients diagnosed with CAS.

The effects of vowel errors on suprasegmentals and prosody were also briefly mentioned. It may be helpful for clinicians to better understand the correlation of these features in CAS. This type of study could determine whether targeting vowel errors in therapy has a positive impact on prosody in children diagnosed with CAS.
References


