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**COMPARING KNOWLEDGE ABOUT DIFFERENTIAL DIAGNOSIS OF  
CHILDHOOD APRAXIA SPEECH AND PHONOLOGICAL  
DEVELOPMENT BETWEEN COMMUNICATION DISORDERS AND  
SCIENCES GRADUATE STUDENTS**

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COMPARING KNOWLEDGE ABOUT DIFFERENTIAL DIAGNOSIS OF CHILDHOOD  
APRAXIA SPEECH AND PHONOLOGICAL DEVELOPMENT BETWEEN  
COMMUNICATION DISORDERS AND SCIENCES GRADUATE STUDENTS

by

Bayley Eubanks

B.S., Southern Illinois University, 2020

A Thesis

Submitted in Partial Fulfillment of the Requirements for the  
Master of Science Degree

School of Health Sciences  
in the Graduate School  
Southern Illinois University Carbondale  
May 2023

THESIS APPROVAL

COMPARING KNOWLEDGE ABOUT DIFFERENTIAL DIAGNOSIS OF CHILDHOOD  
APRAXIA SPEECH AND PHONOLOGICAL DEVELOPMENT BETWEEN  
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A Thesis Submitted in Partial

Fulfillment of the Requirements

for the Degree of

Master of Science

in the field of Communication Disorders and Sciences

Approved by:

Dr. Valerie Boyer, Chair

Dr. Maria Claudia Franca

Kathryn Martin

Graduate School  
Southern Illinois University Carbondale  
March 30, 2023

## AN ABSTRACT OF THE THESIS OF

Bayley Eubanks, for the Master of Science degree in Communication Disorders and Sciences presented on March 30, 2023, at Southern Illinois University Carbondale.

**TITLE: COMPARING KNOWLEDGE ABOUT DIFFERENTIAL DIAGNOSIS OF CHILDHOOD APRAXIA SPEECH AND PHONOLOGICAL DEVELOPMENT BETWEEN COMMUNICATION DISORDERS AND SCIENCES GRADUATE STUDENTS**

**MAJOR PROFESSOR:** Dr. Valerie Boyer

The purpose of the study was to gather information from current graduate students by a brief in-service on the differential diagnosis of CAS and PD in speech-language pathology pre-professionals. The distinctions between CAS and other speech sound disorders, such as PD, must be made clear to pre-professional SLPs to avoid incorrect diagnosis and inefficient therapy. This research focused on looking at CDS graduate students knowledge regarding signs and symptoms of CAS and PD following a brief-in-service. This research also looked at if there was a different in the reported degree of difficulty in differential diagnosis between CAS and PD following a brief in-service on differential diagnosis, and an overall difference in knowledge following a brief in-service on CAS. Results showed the brief in service was successful overall.

## ACKNOWLEDGMENTS

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## CHAPTER 1

### INTRODUCTION

Childhood apraxia of speech is a speech disorder that begins at birth. A child with this condition has difficulty making sounds correctly and consistently. Apraxia is an issue with one's motor coordination of speech. Phonological development refers to how one can perceive and organize speech sounds within a language, also with developmental onset. Although impaired movement planning and programming are considered to underlie CAS, there are also reports of disrupted development of speech perception, language, and phonology (including phonological awareness) in children with CAS (Murray, McCabe, & Ballard, 2014). To analyze the efficacy of phonological awareness is to improve speech production, phonological recognition, and verbal memory skills.

Research contributes to improving differential diagnosis of CAS and phonological disorder cross-linguistically (Iuzzini-Seigel, Hogan, & Green, 2017). Childhood apraxia of speech (CAS) is difficult to diagnose since there is limited data on details that are used to differentiate CAS from Phonological Disorders (PD). Overlapping speech sound errors and similar timeframe of presentation make differential diagnosis difficult.

Speech-language pathologists are frequently tasked with determining the underlying cause of speech sound difficulties in young children. The SLP will assess the child's oral-motor skills, speech sound development, language, and other characteristics. Because CAS is associated with motor speech planning and PD is associated with language perception and organization, treatment techniques differ between CAS and PD. Appropriate identification of underlying causes of speech sound deficits result in better outcomes when treatment is correctly matched to the child's underlying deficits. When a child goes undiagnosed and does not receive

the correct treatment, the child will most likely experience long term effects. This is an area that needs to be addressed to have more accurate data. More data will lead to more accurate diagnoses. Students enrolled in speech-language pathology programs will complete coursework in speech sound disorders. However, courses are broad with many aspects of speech sound disorders included. Adding a brief training on differential diagnosis for CAS and PD provides an opportunity to strategically target this difficult area to differentiate prior to students beginning their professional careers.



## CHAPTER 2

### LITERATURE REVIEW

#### **Introduction**

A recent 2015 study found that about 1 in 12 children has a disorder related to voice, speech, language, or swallowing (Galluzzi, Bureca, Guariglia, Romani & 2015). Childhood Apraxia of Speech, also known as CAS, is a rare condition that affects 0.1% of the population (Morgan, Murray, Liégeois, 2018). It is characterized by a disruption in the capacity to produce phonemes and syllables accurately and consistently while taking suprasegmental and articulatory factors into account. It is thought that this is caused by poor motor planning, which is also the root of the condition that compromises the ability to construct words and phrases. Planning the sequence of motor actions is necessary for speaking because it involves quick and precise orofacial motions, and a child with CAS struggles to do this task.

Childhood apraxia of speech (CAS) is a rare speech disorder in which a child has difficulty making accurate movements when speaking (Iuzzini-Seigel, Hogan, & Green, 2017). For the individual to communicate accurately, the brain must learn how to move the lips, jaw and tongue in ways that result in precise sounds and words vocalized with normal speed and rhythm. Phonological development (PD) refers to how one can organize sounds during their development. To analyze the efficacy of phonological awareness is to improve speech production, phonological recognition, and verbal memory skills.

Childhood apraxia of speech (CAS) is a type of speech sound disorder (SSD) with features that include deficits in speech sound accuracy, prosody, coarticulatory transitions, and consistency on repeated attempts at words (Preston, Brick, Landi, 2013). The most common signs when detecting CAS include inconsistent errors with consonants and vowels when

producing syllables and words. Groping movements with facial structures, vowel distortions, voicing errors, limited vocalization and sound playing are the most significant characteristics. Some characteristics are seen in most children with speech or language problems.

Current treatments for school-age children with CAS involve a variety of approaches, including integral stimulation, which includes an emphasis on sequencing articulatory gestures in increasingly complex words and phrases with manipulation of auditory and visual cues (Preston, Brick & Landi, 2013). Many children with CAS continue to have persisting speech errors despite treatment (Murray, McCabe, & Ballard, 2014). There continues to be a critical need to study the effects of different treatment approaches for CAS (Preston, 2013). When treating CAS, the most beneficial treatment is focusing on training the individual to model syllables, words, and phrases (Murray, 2014). It is significant for an individual to acknowledge how it looks and feels to produce sounds. A speech language pathologist will use different types of prompts in therapy, such as visual, verbal, and auditory cues. An SLP would work with the child by having them listen to them and watch as he or she mouthed the target word or phrase. There is not one single speech therapy approach that has been the most successful for treating CAS (Murray, McCabe, Ballard, 2014).

CAS is difficult to differentially diagnose from other speech sound disorders because the CAS speech symptoms vary significantly across individuals and throughout development (Iuzzini-Seigel, Hogan, Green, 2017). CAS and PD are both similar and different. Both CAS and PD fall in the same category as speech sound disorders and divide into two smaller groups that include articulation and phonemic disorders (Velleman, 2011). An individual with an articulation disorder understands what sounds need to be produced but phonological disorders often impact the perceptual accuracy of differentiation of phonemes. Phonological disorders are

related to a child having difficulty with understanding the sound system. With a phonological disorder, one has no difficulty making several sounds, but difficulty with when to make the correct sound (Velleman, 2011). While in motor planning disorders, the motoric processes in production are difficult.

Difficulty with coarticulatory transitions is another essential component of CAS. Coarticulation is the overlapping of the articulatory configurations of the various sounds that happens when the articulation of various speech segments influences one another which is something that is seen in children who have apraxia (Iuzzini-Seigel, Allison, Stoeckel, 2022). There are two types of articulation that play a significant role in CAS and the child's speech production. Anticipatory coarticulation is when a feature or characteristic of a speech sound is anticipated (assumed) during the production of a preceding speech sound. Perseverative coarticulation is the prolonged influence of a certain segment that is exercised on one or more segments which follow it in a stream of speech. The normal processes of anticipatory coarticulation and perseverative coarticulation are both disrupted by the motor planning and programming difficulties associated with CAS. Perceptually, it is possible to detect difficulties with coarticulatory transitions between sounds, syllables, and words in children with CAS as a prolongation of sounds or as a sound addition (e.g., schwa insertion) before or after a word or in between sounds in a cluster (Terband, Namasivayam, Maas, Van Brenk, Mailend, Diepeveen, Van Lieshout, & Maassen, 2019).

Clinicians who work with children who have severe speech sound disorders (SSDs) face unique difficulties. Even in the case of generally high language understanding and attention, some nonverbal or barely vocal children may have had extensive therapy with little to no gain during therapy sessions (Strand, 2020). This could be especially true for children with childhood

apraxia of speech (CAS), whose difficulties with sensorimotor planning and programming speech movements have not improved with conventional phonology and articulation treatment methods in the past. Many different therapy modalities have been documented for CAS, however most of them do not directly target the child who has very significant praxis for speaking difficulties.

Childhood apraxia of speech (CAS) has traditionally a disputed clinical entity regarding both the clinical symptoms and underlying disability (Terband, Namasivayam, Maas, Van Brenk, Mailend, Diepeveen, Van Lieshout, & Maassen, 2019). Research has advanced significantly in recent years regarding the clinical criteria for diagnosing childhood apraxia of speech, often referred to as a disorder of speech motor planning and/or programming (Terband, et al, 2019). For example, with this significant research, it could be beneficial for all individuals who are diagnosed with CAS and other significant speech sound disorders. Even though there is slight data on CAS with it being a rare condition, there is no set therapy that is consistent and successful when treating CAS. Acknowledging the most common signs to look for in early detection, understanding the most beneficial treatments with the current research, and defining factors that lead to a misdiagnose of PD to CAS would help impact an individual and their therapist. Finding an appropriate amount of research on these concepts will be useful for SLP's and clients.

The current state of CAS intervention and assessment is scarce due to the lack of research. It is significant to know that CAS is both an over and underdiagnosis, especially with it being a rare disorder. Some children who present with it are not actually diagnosed with it and some children who do not present it are given the diagnosis with CAS. The scarceness of evidence-based practice research and literature has made it difficult to report on clear clinical

signs for diagnosis of CAS. In fact, there has been controversy for years about CAS as an official diagnosable disorder due to the variability in clinical features reported as being used to diagnose CAS. As CAS is a rare disorder, The Kaufman Speech Praxis Test (KSPT) is a norm-referenced, diagnostic test that aids in the recognition and treatment of CAS. This is the only assessment that is specifically designed for CAS. There are other alternatives for evaluations with other speech impairments. The KSPT is simple to administer and score, the KSPT gauges a child's imitative responses to the clinician, pinpoints areas of speech system dysfunction, and suggests a methodical treatment plan. Breakdowns in KSPT correspond to Kaufman Treatment Kit stages of treatment, enabling a smooth transition to therapy.

CAS is difficult to diagnose since there is slight data on details that are used to differentiate CAS from Phonological Disorders (PD). It is difficult to diagnose CAS if a child presents only with symptoms that are found both in CAS and in other types of speech or language disorders. Phonological development is challenging to diagnose when it is concomitant with language disorders when it is unclear and affects a child's ability to develop fluent speech by the time, they are four years old. Children with CAS rarely have vowel errors (Iuzzini-Seigel, Hogan, & Green, 2017). CAS presents with errors that increase as utterance length increases versus phonological presents with consistent errors. In CAS, automatic or well-rehearsed speech can be less difficult whereas in phonological all speech is equally difficult.

Child presenting with CAS signs and symptoms should be evaluated by a speech-language pathologist (SLP) with knowledge and experience. The SLP will assess the child's oral-motor skills, speech sound development, and other characteristics. When a child goes undiagnosed and does not receive the correct treatment, the child will most likely experience

long term affects. This is an area that needs to be addressed to have more accurate data. More data will lead to more accurate diagnoses.

For current state of treatment for CAS is children who are diagnosed with CAS typically use an augmentative and alternative communication (AAC) device at some point and depend on their AAC device. AAC is any form of communication that helps someone who has difficulty speaking to communicate. AAC devices are in a variety of forms including sign language, gestures, pictures, and speech generating devices, which now include tablets with specific apps. For most children with CAS AAC is a connection to communicate, to increase communication abilities and decrease frustration while working to improve speech. For some children who have CAS, their device might could be their main way of communicating with other – long term. Finding the correct device for the child is crucial, and as such thorough AAC examination is required. This is because children with CAS who also have additional speech and language problems may rely on AAC approaches for a longer period. There are several factors that must be considered when choosing the correct AAC device. The child’s motor skills, vision, portability, learning, and the availability of having other communication partners. Teaching AAC to children with CAS has several advantages (Augmentative and Alternative Communication, 2020). The device can aid in lessening frustration caused by a language barrier. When a child demonstrates unwanted behaviors, it is common for children who have trouble speaking to vent their displeasure. Children may also give up altogether in response to communication breakdowns, which can eventually teach them to be passive with an AAC device. Children with CAS can greatly benefit from a well-matched AAC system, whether it be a dynamic device, a low-tech picture-based system, signs, or a combination of all. AAC has a huge impact on language development of a child with CAS. The contribution AAC can make to language

development is equally significant (Augmentative and Alternative Communication, 2020). There are frequently few opportunities for children with CAS to develop a variety of language and social skills. AAC can be the connection between the child and their surroundings.

A strong recommendation for individuals to expand their knowledge on CAS is by taking a 3 three-day course, that is called prompt training and it is only eligible for SLPs. PROMPT training allows the SLP to get feedback on their PROMPTS. This does not require any assessment or treatment planning. An extensive certification process and a series of seminars are required for PROMPT training. When clinicians attend the basic PROMPT course, they are then considered PROMPT trained. Clinicians will then advance to bridging trained status as they complete further training, once additional training is received, clinicians are completely certified. They advance to bridging trained status as they complete further training, and after receiving additional teaching, they are completely certified. PROMPT training is significant for SLPS because this multidimensional approach for speech production disorders that embraces not only the physical-sensory aspects of motor performance, but also the cognitive-linguistic and social-emotional aspects too.

Social media with pre-clinicians is extremely significant because social media plays an important role in individuals daily lives. Professionals who have experience in our field with different disorders may provide pre-clinicians with information that we do not learn as much about in school, such as CAS. It is important to make sure we are constantly learning and expanding our knowledge to make sure the best therapy is provided to patients. With CAS being a rare disorder with little research, not being discussed as much as other disorders in school, it is crucial to find resources in any way possible. This can be done by following social media professionals, reaching out to peers and professors, and researching as much as possible.

## CHAPTER 3

### METHODOLOGY

The purpose of the study was to examine the impact of a brief in-service on knowledge of components of differential diagnosis between CAS and PD with pre-professionals in speech-language pathology. It is important to consider the different characteristics of CAS and PD with the current state of intervention and assessments. It is significant for pre-professional SLPs to be educated on the differences between CAS and other speech sound disorders such as PD to prevent misdiagnosis and ineffective treatment.

This study was intended to address the following research questions.

1. What do CDS graduate students report in terms of the degree of difficulty with differential diagnosis of CAS and PD prior to a brief in-service on differential diagnosis between CAS and PD?
2. What is the change in knowledge regarding signs and symptoms of CAS and PD following a brief in-service with graduate students in CDS?
3. Is there a difference in knowledge of specific aspects of characteristics between CAS and PD following a brief in-service on differential diagnosis?
4. Are there differences between first- and second-year graduate students in reports of difficulty with differential diagnosis and overall change in knowledge before and following a brief in-service on CAS?

#### **Participants**

The participants in this research were first year and second year graduate students enrolled in a communication disorders and science program at a mid-sized, midwestern university. A total of 12 participants were recruited. I chose 12 participants to make it an even



number between the two different groups. 12 also represents approximately 25% of the entire population of graduate students enrolled in the communication disorders and sciences program. By choosing two different groups, group size was even enabling measurement of the difference between knowledge on CAS compared between first year graduate students and second year graduate students who were in externships. There were six first year graduate students and six second year graduate students. Ages of the student clinicians ranged from 21 to 25 years of age. Members from each group were currently enrolled at the time of the research or were previously enrolled in the same graduate-level courses, including a course on speech sound disorders. Recruiting these participants was done by email recruitment and follow-up by text. Participants were placed in a drawing for one, \$30 Amazon gift card following the completion of the study.

## **Materials**

Participants completed both a survey and a knowledge assessment to answer questions to gather demographic information on participants and that related to their knowledge about CAS and PD. Participants completed the forms on Survey Monkey three separate times, twice before the brief training and once after the brief training to measure change in knowledge and familiarity. The survey contained questions regarding demographic information on the participant, participant's level of knowledge, and how CAS and PD may be relevant in their field (Murray, McCabe, Ballard, 2014). The knowledge assessment's purpose was to investigate the differential diagnosis between CAS and PD, the signs and symptoms of both CAS and PD, and current knowledge that pre-professional speech-language pathologists have on CAS and PD (Murray, et. al, 2014). The participants were shown a brief training that was pre-recorded by the researcher, describing the disorders and the key differences between the two and used a PowerPoint presentation. Participants then completed both the knowledge assessment and survey

that assessed their gained knowledge and familiarity of the disorders. To take a part in this research study, participants must have had a way to access the forms on Survey Monkey, including both a device that had access to the internet and a reliable internet connection.

## **Procedure**

The independent variable for this research was the educational training video. The dependent variables were knowledge of differential diagnosis and beliefs regarding differential diagnosis were analyzed using within and between participant designs. I utilized the Desire2Learn platform (D2L) to post the training. Clinicians logged onto the platform and answered the presurvey questions, watched the tutorial, and then answered post survey questions. Participants accessed the knowledge assessment, survey, and the educational training on the D2L platform. Ideally, participants completed the presurvey immediately before they watched the training, and then completed the post survey within 24 hours since they watched the training.

I gathered data from twelve total participants: six in the first year of their graduate school program (Group 1) and six in the second-year graduate school program (Group 2). No matter what group, all participants completed the knowledge assessment and survey, both before and after the training was watched by participants. The tutorial provided information to both groups of graduate clinicians on the differential diagnosis of CAS and PD through a twenty-two slide PowerPoint presentation in lecture style that lasted twenty-one minutes long. The presentation consisted of information about CAS and PD characteristics, the causes of both disorders, treatment for both disorders, and the similarities and differences between the two. Participants were encouraged by speaker throughout the presentation video to take notes for future reference because of the limited research on both disorders and to be used during the post-training knowledge assessment.

The order of assessments taken was not significant, but for the purpose of uniformity, I instructed participants to complete the knowledge assessment first. The knowledge assessment consisted of fifteen true/false and multiple-choice formatted questions of difficulty relating to both CAS and PD. The assessment began with five true/false questions regarding beliefs about the difficulty with differential diagnosis of PD and CAS. Then, clinicians were given ten multiple choice questions to determine their content knowledge on PD and CAS. These specific questions helped assess and determine the participants knowledge they had before and after they watched the tutorial. Each true/false question correct earned 1 point and multiple-choice questions answered correctly earned 2 points, the total score possible was 15. The more points that a participant scored on the knowledge assessment, the more confident they felt in their knowledge and ability to differentiate between CAS and PD.

I created a survey that assessed participants for their feelings of difficulty that related to the disorders. The collected information on the survey of the participant's included their demographics as well as descriptive data. Survey questions were used to collect specifically descriptive, individualized data, and asked the clinicians about their knowledge on differential diagnosis of CAS and PD (Galluzzi, et. al, 2015).

To ensure reliability of recording data from the knowledge assessment, the researcher and faculty advisor both examined data scores. Interobserver agreement was generated by dividing agreements/total number of observations. IOA data percentages were  $12/12 = 100\%$  for pretest and posttest percentages scores. IOA data percentages consisted of  $12/12$  for 100 % for students degree of difficulty scores.

## **Data Analysis**

Each research question is unique in style to gain different types of information. It is important to vary the style of questions to ensure that all data is collected in relation to the subject.

The first research question was a descriptive analysis question, asking participants to rate and describe their individual belief on difficulty of differential diagnosis between CAS and PD. Participants responded to a 5-point Likert rating ranging from extremely familiar to not at all familiar. Response percentages were reported for the total group (n=12) and for each group (n=6). Participants were also offered the opportunity to report on an open-ended prompt to describe their beliefs regarding the most prominent differentiating factor during diagnosis.

The second question required within-subject analysis to compare pre/post knowledge results for the participants. Each participant completed a knowledge assessment prior to the short intervention and following completion of the short intervention. Microsoft Excel was used to analyze data from the group. Means for each group and p value for the corresponding paired t test were utilized to determine if significant change occurred on knowledge assessment following the intervention.

The third question focused on specific change in knowledge of characteristics of CAS and PD following a brief intervention. Participants were asked specifically about eliminating a non-characteristic of each diagnostic category as part of the knowledge assessment. Questions seven and eight were utilized for this data analysis. A total percentage of accuracy for both questions pre-test was compared with a percentage of accuracy posttest. Microsoft Excel was used to analyze data from the group. Means for each group and p values for the corresponding paired t- test were calculated.

The fourth research question was a between-subjects design question, which is evident in terms of compared data between first year and second year graduate students. The purpose of this analysis is to compare knowledge measures between groups both before and after the intervention. Pre-test means were compared using a t-test on Microsoft Excel. Post-test means were compared using a t-test on Microsoft Excel. P values were reported for each test to determine if the groups differed significantly either before or after training.

The aims of this research were to determine the different percentages of students who rate different levels of difficulty, the change of knowledge regarding differential diagnosis following a brief, in-service and differences in knowledge before and after a brief, in-service based on each group.

## CHAPTER 4

### RESULTS

The purpose of the study was to determine how a brief in-service with pre-professionals in speech-language pathology affected their knowledge surrounding differential diagnosis between CAS and PD. To avoid misdiagnosis and poor treatment, it is important for pre-professional SLPs to be informed about the differences between CAS and other speech sound disorders like PD. Training pre-professionals specifically on aspects related to differential diagnosis supports preparation for clinical application.

The diagnosis of childhood apraxia of speech (CAS) is challenging because there is limited information on the specifics that can be utilized to distinguish CAS from phonological disorders (PD). While aspects of both disorders may be present within the same child, many times SLPs are trying to differentiate between the two disorders. If a child only exhibits symptoms that are common to both CAS and other speech or language problems, it might be challenging to diagnose CAS. When phonological development is unclear, it can be difficult to diagnose language issues, and it can interfere with a child's ability to speak fluently. Children who go undiagnosed and who do not receive the proper care are likely to suffer long-term effects. To get more reliable statistics, this area must be improved. Accurate diagnosis can be made possible by additional data.

Results of the current project are presented below based on the research questions created to analyze the effects of a brief, in-service with pre-professionals in speech-language pathology on knowledge. The research questions began with an interest in the incoming beliefs of students regarding the difficulty in differential diagnosis. Research questions two and three both examined the effect of the training using a within participant analysis. Finally, the groups were

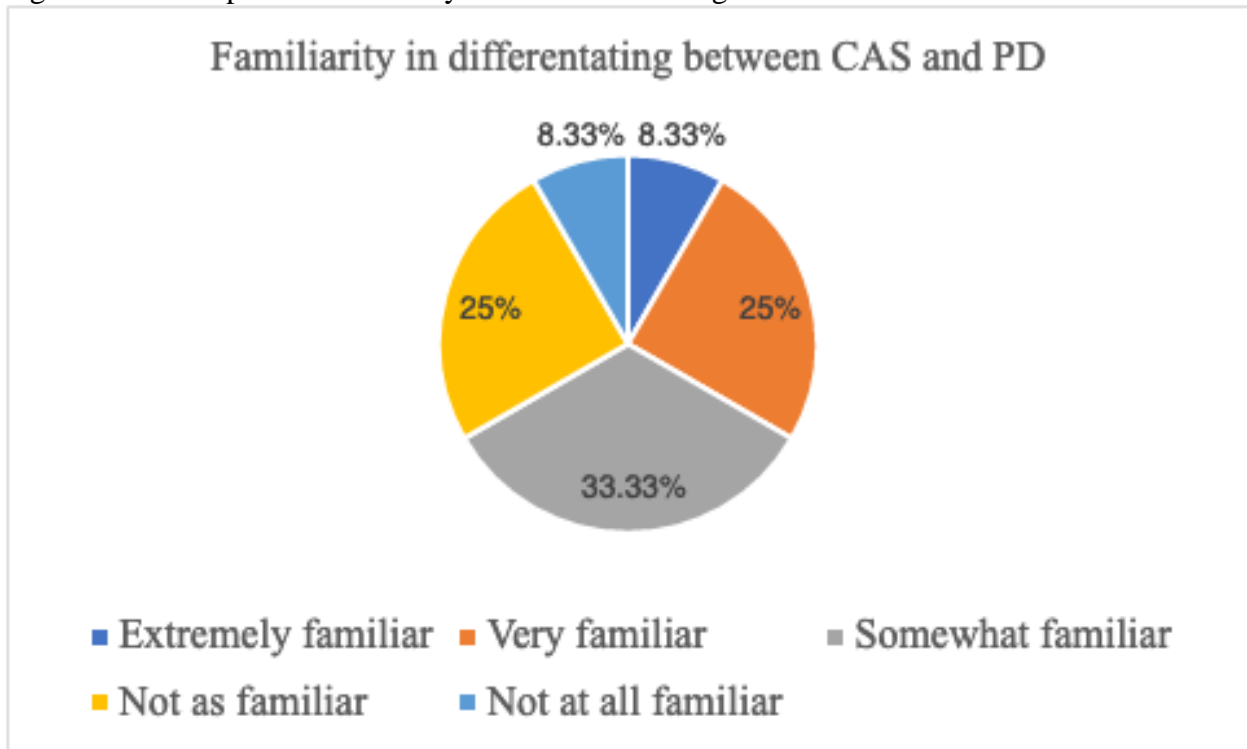
compared to see if any differences in knowledge were present both before and following the brief intervention.

### **Research Question One**

What do CDS graduate students report in terms of the degree of difficulty with differential diagnosis of CAS and PD prior to a brief in-service on differential diagnosis between CAS and PD?

Participants were asked a question on the demographic questionnaire regarding the familiarity in differentiating with CAS and PD. Participants had to choose how familiar they were with differentiating the two disorders. Such as, “Extremely Familiar, Very Familiar, Somewhat Familiar, Not as Familiar, and Not at all Familiar.” Before watching the video, 33.33% of participants responded with the “Somewhat familiar” option, meaning they did not feel extremely confident when differentiating between the two disorders, but they are at least somewhat familiar with the differential diagnosis of CAS and PD. Another 25% of the participants self-reported as “very familiar” with differential diagnosis. Only one participant, a member of the second-year graduate group, self-reported that they felt “Extremely familiar” with the differential diagnosis of both disorders. Less than half the respondents reported lack of familiarity with the differential diagnosis of CAS vs PD. Results of research question 1 are summarized below in Figure 1.

Figure 1: Self-Report of Familiarity with Differentiating CAS and PD



### Research Question Two

What is the change in knowledge regarding signs and symptoms of CAS and PD following a brief in-service with graduate students in CDS?

Results demonstrated significant change in knowledge from the initial knowledge assessment to the knowledge assessment taken after watching the video. All participants increased their score ranging from at least 7 points to 40 points. The average mean from all pretest scores was 65.5%. The average mean from all post test scores were a 90.08%. This showed a 24.58% difference among the overall scores from after watching the brief in-service. The average score received on the knowledge assessments demonstrated that the in-service was effective in increasing knowledge on symptoms of both CAS and PD for participants. A paired t-test was conducted using Microsoft Excel to compare the mean from pre-test to the mean from posttest. The corresponding p-value was 0.0000803, less than .05 established for statistical



significance, and the participants' mean scores were statistically different. Table 1 lists students pre-test and post-test percentages of accuracy of the knowledge assessment.

Table 1: Students Scores on Pretest and Posttest Knowledge Assessment

<b>Student</b>	<b>Pre</b>	<b>Post</b>
1	93	100
2	53	93
3	47	87
4	80	87
5	67	87
6	73	100
7	53	100
8	67	80
9	53	87
10	67	93
11	80	87
12	53	80
<b>Mean</b>	65.5	90.08333
8.03994E-05	<b>p value</b> 0.0000803	

### Research Question Three

Is there a difference in specific aspects of characteristics between CAS and PD following a brief in-service on differential diagnosis?

Results demonstrated significant change in knowledge from the initial knowledge assessment to the knowledge assessment taken after watching the video. Two items on the knowledge assessment were combined for this analysis. The questions addressed specific aspects of differential diagnosis for CAS and PD. Means at pretest were compared to means at posttest using a paired t-test analysis conducted on Microsoft Excel. A p value was generated ( $p = .0000157$ ) that was less than .05, indicating significant change between pre and posttest averages for the group.

There were more errors in CAS knowledge than PD knowledge. This results in that students are more aware and have significant more knowledge about PD than CAS. The inter-observer agreement (IOA) resulted in 12/12 equaling to 100%. Out of the twelve participants,

eight of them only missed one. The eight that only missed one question, it was a question about CAS knowledge. Scores, means, and p values are presented in Table 2 below.

Table 2: CAS and PD Knowledge Recorded on Questions 7 and 8 from the Knowledge Assessment

<b>Student: Question 7 &amp; 8</b>	<b>Pretest Percentage</b>	<b>Posttest Percentage</b>		<b>IOA</b>
Student 1	0	50		12/12=100
Student 2	50	100		
Student 3	50	100		
Student 4	50	100		
Student 5	50	100		
Student 6	50	100		
Student 7	50	100		
Student 8	100	100		
Student 9	50	100		
Student 10	0	100		
Student 11	0	100		
Student 12	50	100		
<b>Mean</b>	41.66667	95.833333		
<b>P value for t test</b>		1.56663E-05		
<b>P value as decimal</b>		0.0000157		

#### Research Question Four

Are there differences between first- and second-year graduate students in reports of difficulty with differential diagnosis and overall change in knowledge before and following a brief in-service on CAS?

Research question four was a between group analysis, comparing the cohorts at pretest and posttest. Differences in groups were not statistically significant meaning that the two cohorts did not differ significantly in their knowledge of differential diagnosis at the onset of the project. They also did not respond to the training in a significantly different way.

Results did not show significant statistical difference between groups with their overall percentage scores. There were not statistically significant differences between groups either prior to or following the brief in service. The p values were different among both groups. Comparing both cohorts on the mean at pretest yielded a p value of .311 which is greater than .05. Comparing both cohorts on the mean at posttest yielded a p value of .623 which is also greater than .05.

Five of the six participants from the first-year graduate students improved pre-posttest scores by 20 points or more. Two of the second-year graduate students increased their scores by 20 points or more. Scores, means, and p values are presented in Table 3 below.

Table 3: Pre and Post Overall Scores and Percentages

<b>Score</b>	<b>Pretest Percentages Group 1</b>	<b>Pretest Percentages Group 2</b>		<b>Posttest Percentages Group 1</b>	<b>Posttest Percentages Group 2</b>
1	53	93		93	100
2	47	80		87	87
3	67	73		87	100
4	53	67		100	80
5	67	53		93	87
6	80	53		87	80
<b>Means</b>	<b>61.1666667</b>	<b>69.833333</b>		<b>91.1666667</b>	<b>89</b>
	<b>P Value</b>	<b>0.311336</b>		<b>P Value</b>	<b>0.623443</b>

Overall, participants reported a bit of familiarity with knowing about differential diagnosis prior to the brief in service. The mean percentages changed by 24.5 points showing change in knowledge regarding CAS and PD knowledge following a brief in-service with graduate students in CDS. Changes were shown from the pre-test to the post-test on the knowledge assessments. This showed that brief training was overall productive in this study. There were in fact no differences between the two groups on knowledge performance either before or after the training.

## CHAPTER 5

### DISCUSSION

This research was aimed to determine the diagnostic success of speech inconsistency for differentiating children with CAS and the impact of brief training on knowledge of differential diagnosis between CAS and PD.

Results of this project indicated that participants reported familiarity with differential diagnosis of CASD and PD. Participants were asked a question on the demographic questionnaire regarding the familiarity in differentiating with CAS and PD. Participants had to choose how familiar they were with differentiating the two disorders using a Likert Scale. Options included extremely familiar, very familiar, somewhat familiar, not as familiar, and not at all familiar.” Before the brief training, 33.33% of participants responded with the “Somewhat familiar” option, meaning they did not feel extremely confident when differentiating between the two disorders, but they are at least somewhat familiar with the differential diagnosis of CAS and PD. Another 25% of the participants self-reported as “very familiar” with differential diagnosis. Only one participant, a member of the second-year graduate student self-reported that they felt “Extremely familiar” with the differential diagnosis of both disorders. Less than half the respondents reported lack of familiarity with the differential diagnosis of CAS vs PD.

Results demonstrated significant change in knowledge from the initial knowledge assessment to the knowledge assessment taken after watching the video. All participants increased their score ranging from at least 7 points to 40 points. The average mean from all pretest scores was 65.5%. The average mean from all post test scores were a 90.08%. This showed a 24.58% difference among the overall scores from after watching the brief. in-service.

The average score received on the knowledge assessments demonstrated that the in-service was effective in increasing knowledge on symptoms of both CAS and PD for participants.

Results showed significant change in knowledge from the initial knowledge assessment to the knowledge assessment taken after watching the video. Two items on the knowledge assessment were combined for this analysis. The questions addressed specific aspects of differential diagnosis for CAS and PD. The impact of these results showed that there needs to be more discussion and adequate research for CAS. These results compare current literature with how scarce research is referring to CAS and the signs and symptoms of CAS. Due to a dearth of research, the current state of CAS intervention and assessment is limited. Knowing that CAS is both an overdiagnosis and an underdiagnosis is important, especially given that it is a rare condition. Some children who exhibit it do not receive a proper diagnosis, and some children who do not exhibit it are given the label of CAS. It has been challenging to report on distinct clinical symptoms for CAS diagnosis due to the dearth of evidence-based practice research and literature. Due to the variation in clinical symptoms reported as being utilized to diagnosis CAS, there has been debate over CAS as an official diagnosable condition for years.

There were more errors in CAS knowledge than PD knowledge. This difference reflects potential challenges in knowledge of CAS that are less prevalent in PD. Students may have more awareness and have more knowledge about PD than CAS. Out of the twelve participants, eight of them only missed one question at posttest out of four questions identified as key characteristics of CAS and PD. The eight that only missed one question; it was a question about CAS knowledge. These results are important because it shows that CAS needs to be discussed more and treated accurately. The inter-observer agreement (IOA) resulted in 12/12 equaling to 100% meaning that there was unanimous agreement between two reviewers of the data.

Results showed that the participants' understanding did not differ significantly if they were a first- or second-year graduate student. Lack of differentiation at the beginning of the study meant that students were at a similar knowledge level beginning the training. The lack of differentiation at the end of the study meant that students benefited from the training in a similar way regardless of their differences in prior experience in the discipline. This demonstrated that the study's brief instruction was generally effective regardless of past experiences. There were no variations in knowledge performance between the two groups before or after the training. This has positive implications for using this brief interventions for different cohort groups with varying degrees of prior knowledge in the area of CAS and/or PD.

### **Limitations and Future Research**

With all research experiments limitations occur. Limitations during this research included having a small number of participants and lack of validity checks from experts on training components. The project recruited a total of twelve participants, six in each cohort. A larger sample size would enhance confidence in statistical comparisons.

Another limitation included the social validity that may have had an impact on clinical decision making by participants. Due to time limitations, the training was not viewed by experts prior to implementation. While the training was created based on peer-reviewed literature in the area of CAS and PD, a group of clinical experts would enhance the validity of the training.

Finally, the project would be stronger with a clinical component. Specifically, a social validity or generalization to clinical decision making would strengthen the project. The brief nature of the project indicates potential clinical impacts based on knowledge changes.

Future research can address these limitations. Having more feedback from experts on childhood apraxia of speech would be important to have different opinions on CAS and PD.

With more participants, it would be helpful to see the difference from the results given. A longer study would be helpful to have say CF-SLP's to answer the same questions to see what CF-SLP's and CCC-SLP's answers are. It would be interesting to see the difference between the two, such as first and second-year graduate students. Future studies could benefit from providing a more in-depth study by using other SLP's and seeing their knowledge to determine the impact based on current and future clients.

### **Implications**

Comparing treatments is a priority, considering the variety of treatments that are becoming effective. Existing research is accessible to conduct clinical practice in the treatment of CAS (Murray, McCabe, Ballard, 2014). The treatments that are most successful are verbal and auditory cues for CAS. Treatment is based on a diagnosis. Existing research is accessible to conduct clinical practice in the treatment of CAS (Murray, McCabe, Ballard, 2014). Research is needed for valid and reliable differential diagnosis of CAS and for understanding which clients benefit the most from each treatment (Murray, McCabe, Ballard, 2014). Phonological awareness intervention also appears to be effective with mild to severe clients with CAS. These statistics could significantly impact an individual with CAS and assist them to improve while being in therapy and for long term (Iuzzini-Seigel, Hogan, Green, 2017). Working with children who have severe speech sound abnormalities (SSDs) presents special challenges for clinicians. Some nonverbal or scarcely vocal children may have had extended therapy with little to no improvement during therapy sessions, even in the case of typically excellent language awareness and attention (Strand, 2020). This may be especially true for children who have childhood apraxia of speech (CAS), who have historically had difficulty with sensorimotor planning and programming speech motions. There are numerous therapy techniques for CAS that have been

reported, however the most of them do not specifically target the child who has substantial praxis for speaking issues.



## CHAPTER 6

### CONCLUSION

This project was designed to demonstrate the effectiveness of a brief intervention on knowledge of differential diagnosis between childhood apraxia of speech (CAS) and phonological disorders (PD). Both disorders impact speech sound production in children, but each has unique characteristics and treatment considerations. Therefore, differential diagnosis is critical to effective intervention.

Participants were asked to provide information prior to the training on their comfort and knowledge of differential diagnosis between CAS and PD. A brief, online training was offered to 12 graduate students. Following the training, the students completed a knowledge assessment. Change between pretest and posttest knowledge scores were compared. Scores were also compared based on previous experience in the discipline by comparing first year graduate students and second year graduate students.

Results showed prior to the short in service, participants generally indicated having some knowledge with the concept of differential diagnosis. Following a brief in-service with graduate students in CDS, the mean percentages changed by over 20 points, indicating a statistically significant change in knowledge on CAS and PD. On the knowledge evaluations, differences between the pre-test and post-test were evident. The results of the study displayed that the study's brief instruction was generally effective. There is a continued need for more effective research and for current and future SLPs to advocate for CAS treatment.

A short training package was effective for knowledge change in a group of participants who generally reported some awareness of the need for differential diagnosis between CAS and PD. There is a need for training on differential diagnosis and training in the graduate program on

specific aspects of differential diagnosis offers an efficient mechanism for creating knowledge change. Future research is needed to determine if this change is consistent with a larger group of participants, and if change in knowledge leads to improved clinical practices. This is a first step in addressing the need for improved knowledge and confidence in differential diagnosis within speech sound disorders.

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## APPENDIX A

### COVER LETTER

Dear Participant:

My name is Bayley Eubanks, and I am a graduate student at Southern Illinois University – Carbondale (SIUC). I am a second-year graduate student in the Communication Disorders and Sciences program. As part of being a graduate student, I am doing a thesis about the differential diagnoses of Childhood Apraxia of Speech and Phonological Development and to see the knowledge between first- and second-year graduate students in the Communication Disorders and Sciences Program. I am examining the difficulty with differential diagnosis and overall change in knowledge following a short in-service on CAS between graduate students. I am inviting you to participate in this research study by taking a demographic survey, knowledge assessment, watching a brief video, and then taking an after-knowledge assessment.

The knowledge assessments and survey will take approximately 10 minutes and watching the video will take approximately 30 minutes, 40 minutes total. The video will cover topics such as how CAS is such a rare disorder, characteristics of CAS and PD, current treatments and assessments of the disorders, and how future clinicians can be prepared to treat the two disorders. You will be entered in a drawing to win a \$30 Amazon gift card. There is no known risk for participating. The risks for participating in this study are low, however, there is also a risk of data breach. The data gathered will be available to myself and my advisor, Dr. Valerie Boyer. To participate you must be 18 years of age. We will ensure confidentiality of personal information; we will take all necessary steps to protect your identity. All research materials must be retained for a minimum of three years. This will be done by including a coding system, in which participants will create their own code. Participants will input this code each time they take the surveys. If you are willing to participate in my research project, please contact me to let me know. Please keep in mind that participation is strictly voluntary, and you may refuse to participate at any time. If you chose to not participate or withdraw, there will bear no penalty, and there will be no effect on grades, class standing, services, or care provided by the university. There are benefits for members participating in this research. By participating in this research, members will learn more about their future career and how important it is to know the significance of CAS and PD.

Thank you for taking the time to assist me in my educational endeavors. The data collected will provide useful information regarding the knowledge of future clinicians about the disorders CAS and PD and differential diagnoses between the two. There are benefits for members participating in this research. By participating in this research, members will learn more about their future career and how important it is to know the significance of CAS and PD.

Sincerely,

Bayley Eubanks, Graduate Researcher  
Email: bayley.eubanks@siu.edu Phone: 618-927-5351

Dr. Valerie Boyer, Faculty Supervisor  
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Rehn Hall 317, Mailcode 4609 Carbondale, IL 62901

This project has been reviewed and approved by the SIUC Institutional Review Board. Questions concerning your rights as a participant in this research may be addressed to the Institutional Review Board Chair, Office of Research Compliance, Southern Illinois University, Carbondale, IL 62901-4709. Phone (618) 453-4534. Email: siuhsc@siu.edu

## APPENDIX B

### INFORMED CONSENT FORM

#### INFORMED CONSENT

I (participant), agree to participate in this research project conducted by Bayley Eubanks, Graduate Student in the School of Health Sciences at SIU.

I understand the purpose of this study is to determine the differential diagnosis between CAS and PD and seeing if there are differences between first- and second-year graduate students in reports of difficulty overall change in knowledge following a short in-service on CAS.

I understand my participation is strictly voluntary and may refuse to answer any question without penalty. I am also informed that my participation will last approximately 40 minutes.

Participants may withdraw at any time if they choose to do so. Any data submitted will not be included in the research if you withdraw or counted for. You may email myself or Dr. Boyer if you choose to withdraw.

I understand questions or concerns about this study are to be directed to Bayley Eubanks, who can be reached at 618-927-5351 or bayley.eubanks@siu.edu or her advisor, Dr. Valerie Boyer, at 618-453-8283 or valboyer@siu.edu.

I have read the information above and any questions I asked have been answered to my satisfaction. I agree to participate in this activity. I understand a copy of this form will be made available to me for the relevant information and phone numbers if I want a copy.

I consent to participate and have my responses quoted directly but anonymously. Please print this form and sign it and send it back or any type of electronic signature is fine.

Participant signature and date

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This project has been reviewed and approved by the SIUC Institutional Review Board. Questions concerning your rights as a participant in this research may be addressed to the Institutional Review Board Chair, Office of Research Compliance, Southern Illinois University, Carbondale, IL 62901-4709. Phone (618) 453-4534. E-mail: siuhsc@siu.edu

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Thesis Paper Title:

Comparing Knowledge About Differential Diagnosis of Childhood Apraxia Speech and  
Phonological Development Between Communication Disorders and Sciences Graduate  
Students

Major Professor: Dr. Valerie Boyer