2014

Literature Review of Childhood Apraxia of Speech: Approach on Controversy of Labeling, Diagnosing, and Intervention

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LABELING, DIAGNOSING, AND INTERVENTION

by

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B.A., Indiana University, 2010

A Research Paper
Submitted in Partial Fulfillment of the Requirements for the
Master of Science

Department of Communication Disorders and Sciences
in the Graduate School
Southern Illinois University Carbondale
May 2014

RESEARCH PAPER APPROVAL

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Approved by:

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April 3, 2014

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INTRODUCTION

Childhood apraxia of speech (CAS) is a disorder that has been described and studied for more than four decades. Only in 2007 was there an official report released by a peer-reviewed source describing CAS and recognizing it as an official diagnosis (Ad Hoc Committee, 2007). CAS is most widely accepted as a motor speech disorder under speech sound disorders involving deficits in motor planning that affect ability to produce accurate speech sounds in children. Etiology can be either idiopathic or organic. The purpose of this literature review is to (1) discuss the factors contributing to the controversy around describing and diagnosing CAS, (2) explore a clinically relevant body of information pertaining to diagnosis of CAS, and (3) highlight current research that suggests intervention strategies should target CAS at various stages of development of the individual and the disorder.

DEFINING CHILDHOOD APRAXIA OF SPEECH (CAS)

The term CAS encompasses three different forms of disorder. The first form involves children with apraxia who have known neurological etiologies such as trauma, infections, stroke, etc. The second type of etiology associated with apraxia of speech is a complex neurobehavioral disorder. Finally, apraxia of speech manifests in children with no other known neurological or behavioral disorders. In this latter population, its occurrence is considered an idiopathic neurogenic speech sound disorder. After reviewing 10 years of literature and compiling a list of 50 different definitions from the past last decade, the American Speech-Language-Hearing Association (ASHA) Ad Hoc Committee on Apraxia of Speech in Children (2007) proposed the following definition:

> *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.

Not only does the term CAS cover this broad area of etiologies for apraxia of speech in children, there has also been a considerable amount of terminology dedicated to its diagnosis that has evolved throughout the decades which the term CAS accommodates for as well. For instance, it was once described as a communication disorder characterized by little or no

intelligible speech and labeled as expressive aphasia (McGinnis, 1963; Myklebust, 1952). The description of childhood expressive aphasia was presented by Wilson (1964) as an inability to imitate non-speech motions, such as movement of the tongue, lips, and jaw; inability to imitate speech movements to form word sounds and words; very little or no expressive speech and language confined to one- and two-syllable utterances; intact receptive speech and language; and all in the absence of facial and lingual paralysis. This is closer to how it is described today in the literature. As such, it was also recognized that this description fits more for a motor planning and execution deficit such as apraxia rather than a deficit in central language functioning such as with aphasia. This important distinction supported a clearer approach to intervention, as an approach to intervention for language deficits looks very different than for motor or articulatory deficits.

Finally, terminology went through changes ranging from developmental apraxia of speech and developmental verbal dyspraxia to childhood apraxia of speech or CAS for two reasons: childhood apraxia of speech best encompasses the three previously discussed clinical contexts for the disorder according to the American Speech-Language and Hearing Association (2007), and the term "developmental" was interpreted by service delivery administrators as a disorder that the person will eventually "grow-out-of". This interpretation makes funding and justification for services, outside of school-based or otherwise, difficult to obtain. Although developmental apraxia of speech (DAS) and the term dyspraxia are seen throughout the literature, for the purposes of this report childhood apraxia of speech (CAS) will be used.

DETERMINATION OF DIAGNOSIS

It is obvious from the development of terminology and the recent recognition from ASHA of CAS as an official diagnosis that a grey area exists in the diagnosis of CAS for clinicians and researchers. Also, the paucity of evidence based practice research and literature has made it difficult to report on clear clinical signs for diagnosis. In fact, there has been controversy for decades about CAS as an official diagnosable disorder due to the variability in clinical features reported as being used to diagnose CAS. Forrest (2003) attempted to collect a cohesive set of diagnostic features being used in the field by speech language pathologists (SLP). The 75 SLPs used in the study were all attendees at a one-day continuing-education workshop put on by the Indiana Speech-Language-Hearing Association in February 2000. All participants were asked to complete a survey that included a request for up to three criteria deemed as necessary for the diagnosis of developmental apraxia of speech or CAS.

The responses to the survey included three diagnostic criteria for 67 participants and two criteria for eight participants, for a total of 227 responses. After careful counting and grouping of responses, results revealed that SLPs were using 50 different criteria for diagnosing CAS. Six of the 50 criteria made up 117 of the 227 responses, or just over 50% of the responses. These six criteria included inconsistent productions, groping/effortful productions, general oral–motor difficulties, inability to imitate sounds, increasing difficulty with sound production as the utterance length increased, and poor sequencing of sounds. These six criteria fit with most of the literature from all the way back to Wilson's description in 1964. However, according to this study there are SLPs using other criteria that are not supported by literature. Criteria used that are not supported by the literature included: motor problem for speech with normal movement

for feeding, feeding coordination problems, developmental, and motor weakness. This study

does an adequate job of sampling how CAS is understood as a diagnosis and how

understandable the controversy over CAS as a diagnosis is. It is also important to note that the

wording used for the survey may have prevented respondents from listing additional criteria for

diagnosis.

DIFFERENTIAL DIAGNOSIS OF CAS

The literature also presents a theme on the importance of differential diagnosis of CAS from phonological impairment, and dysarthria. This differentiation is especially difficult in the assessment of children with severe expressive language impairments. Edythe Strand and Rebecca McCauley published an article in the *ASHA Leader* entitled "Differential Diagnosis of Severe Speech Impairment in Young Children." The purpose of the article was to present a look at the clinical process for differential diagnosis in children with severe speech impairments in an attempt to alleviate some of the uncertainty and low confidence felt by SLPs in this area. The authors define, differentiate, and discuss the use of the terms "phonological disorders", "speech sound disorders", "childhood apraxia of speech", and "oral-motor deficits." These distinctions are used frequently in diagnostic reports by SLPs in order to denote levels of impairment (Strand & McCauley, 2008).

The first two terms that Strand and McCauley (2008) discuss are "phonological disorder" and "speech sound disorder." These imply that the child has a linguistic component to his/her disorder. However, these terms are also used to refer to any communication disorder that primarily affects sound production. The authors report "CAS" as a subset of the larger group heading of "speech sound disorders". They discuss that diagnostic reports use "CAS" as a label that emphasizes the child's difficulty in planning and/or programming purposeful voluntary movements for speech. This deficit must manifest in the absence of weakness or paralysis of any speech musculature, thus non dysarthric individuals. Finally, the authors discuss the use of the term "oral-motor deficits" in diagnostic reports. The use of this term can be problematic when used for diagnosing CAS due to it being interpreted as presence of deficits in non-speech

oral movements associated with weakness or paresis of speech musculature. A final critique of many SLPs' diagnostic reports is in describing "weakness" of musculature when there is no actual muscular weakness in a true case of CAS. This is a criterion that if not ruled out, denotes either a comorbid disorder involving dysarthria or that CAS is ruled out.

In general, report writing should be based on quality, thorough assessment of oral-motor functioning, and not written with vague, misrepresenting terminology. Assessment must be informative enough to differentiate whether the individual is experiencing breakdown at the movement planning, movement programming, or movement execution levels. Strand and McCauley (2008) highlight the performance of an individual with CAS compared to other speech sound disorders in order to guide clinicians and researchers to the assessments and observations needed for more accurate diagnosis of CAS. According to these authors, the three most crucial assessments include a sound system assessment, an oral structural-functional examination, and a motor-speech examination. To summarize, these authors associate the following findings with a motor planning disorder, or CAS: individuals who exhibit limited phonemic inventories, vowel and consonant distortions, perception and production of voicing errors, inconsistency of errors over repeated trials, normal range of motion, normal speed and strength, oral nonverbal apraxia, groping for articulatory postures, and increased difficulty of production with increased length and articulatory complexity of utterance. These observations are consistent with the literature and offer a guide that may encourage clinicians to make accurate observations and use appropriate descriptive terms when reporting on findings and diagnosing or ruling out CAS. This article is based on findings from peer reviewed sources such as ASHA journals. Thus it contributes quality information to the resources of practicing

clinicians by suggesting methods of assessment that are readily available and practical for clinical use. Also, the suggestions for clinically relevant diagnostic criteria of CAS presented in this article are consistent with other literature. The difficulty in differential diagnosis outlined by this article has clear clinical implications, including the need to compile a quality report on observations and accurate descriptions of behaviors that contribute to appropriate interventions, if not to the completion of a CAS diagnosis.

RESEARCH IMPLICATIONS OF DIFFERENTIAL DIAGNOSIS

There are also implications for researchers in the article of Strand and McCauley (2008). Studies of assessment and intervention for CAS that include a large sample size are few, far between and at times proved to be low quality samples. Without consistent, accurate diagnostic criteria, it is very difficult for researchers to find a quality size sample of participants that are appropriately diagnosed with CAS. Research to determine diagnostic criteria for CAS that uses samples of subjects who do not actually have CAS complicates the quest for determining accurate diagnostic criteria. According to Davis, Jakielski, and Marquardt (1998), a longitudinal study of 22 subjects with suspected CAS (sCAS) began in 1985. As the individuals' phonological and language skills matured over time, only four continued to be confirmed cases of CAS. Thus, it is very common to see single-case studies or studies with less than five subjects when research covers diagnostic markers and intervention strategies. Also, in many articles the term suspected childhood/developmental apraxia of speech or sC/DAS is commonly found to indicate the possibility of inaccurate diagnosis.

The study conducted by Marquardt, Sussman, Snow, and Jacks (2002) is an example of a study that represents issues of using appropriately diagnosed subjects and differential diagnosis. The purpose of this study was to describe deficits in syllabic perception in relation to DAS (CAS), explore how metalinguisitc tasks can help in differential diagnosis of CAS, and to evaluate the findings with respect to competing theoretical perspectives on CAS.

Participants included six children ages six to eight years. Three were considered to be diagnosed with CAS and three were considered to have normal speech and language development. Each participant underwent pure tone audiometric screening, an oral peripheral

examination of the speech mechanism, and were administered a battery of speech and language tests. All participants were given the Test of Auditory Comprehension of Language (TACL-R), the Peabody Picture Vocabulary Test-Revised (PPVT_R), and the Templin-Darley Screening Test of Articulation (TD). One exception was subject A3 who was instead given the Goldman-Fristoe Test of Articulation (GFTA).

Results revealed that those participants identified as having CAS had percentile rank scores of 9, 8, and 77 on the PPVT-R, 29, 34, and 32 on the TACL-R respectively, 2 and 18 on the TD, and scores of >99% probability of apraxia on the screening test for CAS. Speech intelligibility descriptions were severely unintelligible, moderately unintelligible, and intelligible. Motor speech examination observations in general included full range of movements, difficulty imitating syllable sequences, and difficulty putting tongue behind upper teeth. For the control group the percentile rank scores were 72, 92, and 66 on the PPVT-R, 45, 80, and 86 on the TACL-R, all 50 on the TD, and all <1% probability of apraxia on the screening test for CAS. Speech intelligibility descriptions were all intelligible. Motor speech examination observations were all reported as normal.

Problems may arise when applying the results from Marquardt, Sussman, Snow, and Jacks (2002) to identify other individuals with CAS. The participants identified with CAS for Marquardt, Snow, and Jacks (2002) had scores similar to those of individuals identified as having other motor speech disorders or speech sound disorders such as a phonological disorder (Velleman, 2003). Another characteristic of CAS that has been suggested by Freebairn et al. (2004) is its nature to change in manner of presentation as the individual matures through early grade school. Describing CAS as a transforming disorder adds more evidence to support the

perspective of complexity of diagnosis and intervention for CAS. The purpose of Freebairn et al. 2004) was to examine the distinctions between school age participants diagnosed with CAS and those diagnosed with other speech sound disorders in the areas of speech-language and written skills. Participants included three groups labeled as CAS (n=10), S (n=15), and SL (n=14) that were followed from preschool (age four to six years) into early grade school (age eight to 10). The CAS group included participants diagnosed with CAS by their SLPs and then were evaluated for the purposes of the study to confirm their diagnoses. The S group included participants with isolated speech-sound disorders as determined by a score of less than or equal to 1.25 SD on the Goldman-Fristoe Test of Articulation (GFTA; Goldman & Fristoe, 1998), production of three or more error types on the Kahn-Lewis Phonological Assessment (KLPA; Kahn & Lewis, 1986), a normal peripheral speech mechanism on the Oral and Speech motor Control Protocol (Robbins & Klee, 1987), and scores around average on the Test of Language Development-Primary: Second Edition (TOLD-P:2; Newcomer & Hammill, 1988). The SL group included participants meeting the same criteria as the S group with the exception of lower scores on the TOLD-P:2 compared to those chosen for the speech-sound disorder group in order to distinguish the SL as participants with speech and language impairments. All participants were recruited from community clinics and private practices in the area.

Participants were tested in standard testing environments in two sessions to avoid fatigue: once at preschool age then at school age. The tests used at preschool age included the GFTA, the KLPA, the Multisyllabic Word Repetition (MWR; Catts, 1986), the Nonsense Word Repetition (NWR; Kamhi & Catts, 1986), the Oral & Speech Motor Control Protocol, and the TOLD-P:2: Picture Vocabulary, Relational Vocabulary, Oral Vocabulary, Grammatic

Understanding, Sentence Imitation, and Grammatic Completion subtests. Tests administered at school age, or follow-up, included the GFTA, the MWR, the NWR, the Fletcher Time-by-Count Test of Diadokokinetic Rate (Fletcher, 1978), the Clinical Evaluation of Language Fundamentals – Revised (CELF-R; Semel et al., 1987), the Test of Written Spelling – Third Edition (TWS-3l; Larsen & Hammill, 1994), the Woodcock Reading Mastery Tests – Revised (WRMT-R; Woodcock, 1987): Word Attack and Word Identification, the Wechsler Individual Achievement Tests (WIAT; Wechsler, 1992): Reading Comprehension subtest, and the Wechsler Intelligence Scale for Children – Third Edition (WISC-III; Wechsler, 1991): Performance subtests. Informal observations independent of standardized testing were administered including articulation, prosody, and other metalinguisitc errors. All responses were recorded using a Sony Professional Tape Recorder and on-line transcription. Then responses were re-transcribed by other SLPs for reliability purposes.

Results included a description of the CAS group's outcomes and a comparison of the CAS group to the S and SL groups. The CAS group showed progress in speech performance as evidenced by only 20% of participants performing diadokokentic rates within one SD of norms, and 60% performing within one SD of norms when tested at school age. Also, articulation skills were noted to have improved as evidenced by 80% showing upward movement in percentile ranks, except that all participants demonstrated speech errors in conversational speech. However, language measures for all participants generally stayed at or below a standard score of 85 with the exception of four or fewer participants on each measure, including reading and written measures. In comparison to the S and SL groups, the CAS group's preschool age scores were poorer on all measures than the S group's scores. The SL group's scores were

indistinguishable from the CAS group apart from having higher scores on the oral motor measures (TFS) and the NWR test. At school age assessment, the CAS group performed consistently poorer than the S group on all measures. The CAS group performed poorer than the SL group on the following measures: the NWR task, oral-motor skills (Fletcher Time-by-Count Test), Performance IQ, language measures, and spelling skills (TWS-3). All groups made speech errors in conversational speech. However, the CAS group had more errors than the S and SL groups and involved more atypical errors such as initial consonant deletion, vowel, and voicing errors. The three most common errors for the CAS group: 100% of participants had final consonant deletion errors, 90% had syllable reduction errors, and 80% had liquid simplification errors. In comparison, less than 60% of participants in the S and SL groups had errors including distortion, liquid simplification, consonantal harmony/assimilation, and final consonant deletion. Findings from the WISC-III revealed lower performance for the CAS group on Coding, Block Design, Object Assembly, Picture Completion, and Picture Arrangement. This suggests that the CAS group's language deficits co-occur with deficits in speed of information processing and non-verbal problem solving skills which is supported by evidence discovered in a study by Shriberg et al. (1997a, 1997b).

Results support that CAS is a persistent and severely impacting disorder distinct from other speech or speech-language disorders. Scores of the CAS participants were more closely aligned with those participants having comorbid speech and language deficits than with those in the isolated speech disorder group. This seems contrary to the natural assumption about the motoric nature of CAS and speech disorders. Also, they both fall under the same speech-language disorder category of speech sound disorders (Strand & McCauley, 2008). It is

important to note this similarity when planning for intervention so as not to exclude linguistic elements specific to CAS. This study provides evidence to support the literature on describing CAS as being distinct from other speech sound disorders and revealed evidence to support the perspective that CAS has a language component that puts children with CAS at high risk of developing deficits in academic skills such as reading and writing. This study highlights the need for more research on a population of children who will be falling behind in school, requiring more state and private funds, involving longer periods of therapy, and more intensity of services than children with other speech sound disorders. It should be noted that after intensive therapy, this population is known for limited gains (Dodd, Gillon, & McNeill, 2009). Finally, this study exhibits the transformative nature of CAS in that the CAS group showed signs of improved speech production by school age and maintained or developed language/linguistic deficits as they matured.

Some researchers are heeding the call for research that enables clinicians to start treating these individuals in an effective manner by basing their participants' diagnoses of CAS on the ASHA (2007) statement. Specifically, that CAS is the presence of impairment of motor movements in the absence of neuromuscular deficits. Staying true to this criterion, in addition to the typical criteria, research can better inform intervention.

INTERVENTION WITH CAS

Velleman (2003) reports that some professionals and researchers suggest a motoric

approach to remediation of deficits in speech sound production exhibited by those with CAS.

This suggestion may be in reaction to the idea that the basis of CAS involves deficits in motor

planning. Thus, there is literature to support the effectiveness of treating deficits in motor

planning, such as with CAS, with the use of high numbers of repetition in order to increase the

amount and intensity of practice that motor pathways need to promote reform. The motoric

approach to therapy is directly related to creating new motor pathways (Ballard, 2008). Also,

studies such as the latter by Freebairn et al. (2004) have contributed to the development of

multifaceted interventions that target the motor-planning deficit of CAS and the linguistic

deficits assumed likely to develop or become worse under a CAS diagnosis.

Edeal & Gildersleeve-Neumann (2011) investigate the effectiveness of a high intensity and

high frequency motoric approach versus a moderate level approach specifically for the

intervention of CAS. The study was conducted with two child participants who had a diagnosis

of CAS. They both received treatment using integral stimulation therapy, imitation, choral

speaking, cueing techniques and principles of motor learning. Principles of motor learning

included using blocked practice when learning new sounds before using random practice, and

being sure to have distributed practice over a week versus mass practice just once or twice per

week. Each session employed two different treatment designs: moderate-frequency meaning

eliciting 30-40 productions of the target sound per phase, high-frequency meaning eliciting 100-

150 targets. Additionally, each treatment design was assigned specific speech sound targets.

Targets were selected based on performance on standardized testing, play-based speech

samples and developmental appropriateness of the speech sounds. Productions of target

sounds were elicited during play-based activities at the syllable, word, phrase and sentence

levels according to the treatment guidelines of dynamic temporal and tactile cueing (DTTC) and

integral stimulation. Words and phrases used were chosen based on parent report of frequent

and common words and phrases for the participant. After each phase during a session, a probe

of unfamiliar words (containing the targets focused on for treatment) was administered in

order to monitor each treatment design's effectiveness with generalization of the speech

targets.

Results of this study included measures of percentage productions correct (PPC) for each

treatment design of each session and their probe performance counterparts. Results also

included individual increase in phonemic inventory, PPC, word structure complexity, and

improvement in various phonological processes noted at each participant's pre-treatment

testing. Both participants showed increased intelligibility, reduced processes, and an increased

phonemic inventory over all. A comparison of the high frequency treatment design to the

moderate frequency treatment design, demonstrated an increase in percentage of consonants

correct and some generalization for both designs. However, the high frequency treatment

design demonstrated significantly higher levels of progress for those measures. This finding is

consistent with the motor learning literature (Indermill, 1990; see Mass et al., 2008 for review)

and speech-language pathology literature regarding the treatment of various motor-speech

deficits (see Butalla et al., 2012 for review). Although this study shows support for a motoric

approach to CAS treatment, it must be cautioned that this study included a very limited sample

size, and that not all motor learning theories should be adapted for remediation of speech-

language deficits. The characteristics of CAS do include the basis of a motor learning deficit; however, it is also widely accepted that there is also a linguistic component involved. Thus, motor learning principles cannot be completely compatible with CAS or other deficits involving language (Butalla et al., 2012). All components of a disorder must be carefully considered before developing effective treatment.

There is also support for incorporating linguistic components into motoric approaches in order to implement the increasingly accepted theory that those with CAS have phonological deficits underlying CAS or are at high risk of developing language deficits. In general, recently researched approaches to therapy for CAS typically involve a motoric approach with the dynamic nature of language by focusing on movements from one sound to the next instead of just individual movements of individual sounds. This may be in reaction to research findings highlighting deficits in syllable imitation (Marquardt, 2002) and to the known difficulties with increased length of utterance that those with CAS display (ASHA, 2007).

One study that displays the effectiveness of an integrated speech-motor/language approach was done by Dodd et al. (2009). The purpose of this study was to advance a pilot study initiated by Moriarty and Gillon (2006). The basis behind both studies was to investigate the effectiveness of an integrated phonological awareness approach to the treatment of CAS that involves targeting speech, phonological awareness and letter knowledge. The extended study by Dodd et al. (2009) went on to examine generalization of targets to untrained speaking environments including untrained words, phrases or sentences; spontaneous speaking, and the reading and spelling process. Twelve participants were selected from case loads of SLPs who attended a workshop regarding an assessment battery for the diagnosis of CAS. The assessment

was piloted in the previous study by Moriarty and Gillon (2006) and limits diagnosis of CAS to children who demonstrated deficits in phonological planning, phonetic program assembly, and motor execution levels of speech production. The battery included the Peabody Picture Vocabulary Test: III (PPVT-III), the Bernthall – Bankson Test of Phonology (BBTOP), and the oro-motor and inconsistency subtests of the Diagnostic Evaluation of Articulation and Phonology (DEAP). Further evaluation of CAS characteristics included speech production analysis for percent phonemes correct (PPC), percent vowels correct (PVC), and percent process usage (PPU); and a personal narrative language sample in order to assess prosodic features of connected speech, speech abilities in connected versus single-word contexts, and the presence of groping during connected speech.

After confirmed diagnosis narrowed the sample to 12 participants aged four to seven years, speech targets were selected for each participant based on demonstrated speech error patterns. Intervention was designed to reduce targeted speech error patterns in single words and connected speech, to improve phonemic awareness skills, and to increase knowledge of relationships between letters and their sounds (letter-sound knowledge). Based on the accepted knowledge that treatment progress is generally slow for CAS and that high frequency of opportunities for production of targets is most beneficial for CAS, a cycle of 12 sessions in six weeks was allotted to each of two speech error patterns identified for treatment with a six week intermission from therapy. A control speech error pattern from the participant's assessment results was also monitored before and after therapy to increase reliability that progress was the result of the treatment. The structure of the treatment for each session included tasks for letter–sound knowledge, and phoneme identity, segmentation/blending, and

manipulation incorporated into games with interesting stimuli. Speech production accuracy was targeted by incorporating cueing for correct and incorrect production of sounds in the context of phonological awareness activities and self-monitoring.

Results were reported for progress in trained items, untrained items and pre- and post-measures. For the trained speech probes, it was reported that nine of 12 participants showed improvement for both speech error targets, while one other participant demonstrated improvement in one of the targets. Nine participants demonstrated generalization to spontaneous speaking. Untrained speech probes showed that ten of the twelve exhibited gains in either one or both of the targeted speech errors patterns. Trained phonological awareness probes revealed improvements in both targets for five participants, while three participants improved in one target, and four showed no gains. Untrained phonological awareness probes revealed that eight participants made gains in both targets, while one made progress in one target, and three showed no progress. Finally, pre- and post-measures revealed a significant improvement in all but one assessment, which showed a clinically significant effect, if not marked improvement.

The findings of this study demonstrate that treatment for CAS should not be limited to a motoric approach. This study provides evidence that individuals with CAS can make gains simultaneously in motoric deficits and linguistic areas of deficit that those with CAS are at higher risk for developing than are those with an isolated speech sound disorder (Lewis et al., 2004). In this study, the treatment was able to incorporate motor learning principles such as high frequency of stimuli, with phonological awareness skill building while simultaneously remaining effective for treating the motoric based characteristics of CAS. Limitations of this

study included that the younger participants and those with lower receptive vocabularies benefitted the least from this treatment design. Thus, it is clinically relevant to note that this specific integrated treatment design may be too advanced for participants with very low intelligibility and/or cognition, or may be developmentally inappropriate for younger children who have not begun to develop basic literacy concepts such as segmenting of words. However, this study also carries clinical significance in that is gives therapists of school-aged children a rich alternative to articulation therapy where the intent of therapy is to provide quality academic support and not just intelligible speech. A final short coming of this study is that only those clients suspected of having CAS who also demonstrated phonological awareness deficits according to the research criteria were chosen for the study. This inclusion choice furthers the argument that a firm and consistent diagnostic criteria for CAS is not being followed in research.

SUMMARY

Childhood apraxia of speech is a symptom-complex (Bowen, 2011) and poorly understood motor speech disorder. Many aspects of the history of CAS and studies involving CAS have contributed to its ambiguity. First, there have been numerous attempts to label, define and clinically describe diagnostic criteria for CAS. As a result of the confusions and disagreements surrounding the diagnosis of CAS, over diagnosis in clinical settings using inconsistent criteria has occurred. Finally, inability to accurately diagnose those with CAS leads to poor development of research surrounding the description, diagnosis and intervention of CAS.

Emerging areas of research are developing to advance the understanding of CAS. Promising areas of research include: the study of disorder specific genes and genetic factors contributing to the diagnosis of CAS, the exploration of family histories involving speech-language disorders, the examination of comorbidity of CAS with other diagnoses including Autism Spectrum Disorder, and the emergence of neurocomputational models for mapping brain function of CAS.

The implementation of longitudinal studies that include quality data collection and report writing over time of individuals with sCAS would strengthen understanding of CAS and further our understanding of diagnostic criteria. Studies have only just begun to explore intervention, individuality of CAS, and impact of the disorder at the micro and macro levels of society. These studies contribute to a better understanding of the disorder, therefore contributing to the resources necessary to strengthen the research surrounding CAS.

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Research Paper Title:
Literature Review of Childhood Apraxia of Speech: Approach on Controversy of Labeling, Diagnosing, and Intervention

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