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Controversial Developmental Apraxia of Speech

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CONTROVERSIAL DEVELOPMENTAL APRAXIA OF SPEECH

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Introduction

The interpretation of developmental apraxia of speech (DAS) is a broad topic that has inconsistent definitions and a lack of agreed standards of severity. Another area that is lacking in the description of DAS is the occurrence of associated diagnosis. This research studies the different productions, some production characteristics and diagnosis of Developmental Apraxia of Speech.

Definition

The overall focus of the definitions of DAS specifies that there is a deficit in the ability to produce intelligible speech. The etiologies that are suspected to cause DAS are the child's development of the phonological rules of their own language, a speech motor deficit, or a combination of the two. "The presence of apraxia of speech usually signifies a pathologic condition affecting the language-dominant hemisphere of the brain" (Brookshire, 2007, p. 602). In speech, DAS is a nonlinguistic sensorimotor disorder of articulation characterized by impaired capacity to program the position of speech musculature and the sequencing of muscle movements (respiratory, laryngeal, and oral) for the volitional production of phonemes and referred to as dyspraxia (Nicolos, Harryman, & Kresheck, 1983). Eighty six percent of children with DAS have at least one family member with speech-language disorder, 59% have at least one affected parent, and there are higher rates of family history than for other speech-sound disorders. The statistics suggests a genetic basis in at least some cases, a prevalence of 1-2 children per

thousand, and that up to 3-4% of children with speech delay are given this diagnosis (Velleman, 2006).

Etiology

The etiology of DAS has been linked to several sources. Being capable of understanding the rules and symbols of language enables us to correctly express ourselves and understand each other when communicating. According to Hall (2000), there are a number of aspects involved in language, including vocabulary, grammar, how we organize information, and the way we use language with other people. Having knowledge of rules and symbols involves understanding vocabulary, grammar, and organization of thoughts in order to produce correct productions that are understandable to a communicating partner. The absence of the ability to organize thoughts and use language rules to produce normal language emphasizes that the disorder can be attributed to a phonological impairment. According to Hall (2000, p.174) DAS is thought to be a difficulty in learning and using the system of "rules" that govern how speech sounds are ordered and used within syllables and words. DAS is considered only one part of a single disorder involving not only speech, but also all aspects of learning and using language. "Most patients, with apraxia of speech also exhibit word retrieval impairments and subtle to moderate comprehension impairments" (Brookshire, 2007, p.603)

Another explanation of DAS is that it is a speech motor control problem. According to Robin (1992), DAS is a motor control problem in which the purposeful production of speech is faulty. "Acoustic and physiological findings carry an

implication that articulation is imprecise, if not inaccurate, in place, manner, and voicing" (Duffy, 2005, p. 324). The underlying problem involves movement control of speech production musculature for speech and non-speech activities. The disorder's motoric nature disallows the child to articulate sounds and it can possibly affect the musculature necessary for swallowing. "An intricate movement of the lips, tongue, jaw, soft palate and larynx accomplishes speech production" Hall (2000, p. 174). Motor activities or movements, such as walking, writing, and talking, involves use of programs within the nervous system. The automatic system of the nervous system allows individuals to make movements smoothly and easily, without having to concentrate or think about the process involved in making such movements. If there were a disturbance to the automatic system of the nervous system, an individual would not be able to make the appropriate movements to articulate due to inaccurate communication between the pathways of the brain and the muscle group needed to make such actions. For example, if children try to say the [p] for pie they may say [b] instead, they would likely be frustrated because they are aware of the message but cannot produce it correctly.

Because both language development and speech motor programming disorder can cause DAS, it is possible that a combination of both can be causes of the disorder. "Although it is unclear at precisely what level of speech production processing the underlying deficit that causes DAS is localized, several production models suggest that the origin can be found somewhere in the transition from phonological code into articulo-motor output, that is, in phonetic planning, motor

programming, or motor execution" (Nijland, Maassen, Muelen, Gabreels, Kraaimaat, & Schreuders, 2003, p.2). The inability to plan the sequential rules needed to create the appropriate order of sounds for speech is suspected to be a symptom for children with DAS. Being able to sequence sounds is enabling the usage of the phonological rules of that language. According to Nijland et al., (2003) DAS is a speech disorder that interferes with the ability to produce intelligible speech due to impairment in sequencing speech sounds, syllables and words. Therefore, this suggests that being unable to sequence sounds to articulate will cause unintelligible speech that is commonly seen in children that are suspected to have DAS. In addition, Nijland, et al., (2003) suggested that children with DAS are impaired in their ability to generate and utilize frames. This means that a child with DAS is aware of the organization that is needed to create intelligible speech but are unable to sequence or organize phonemes into the appropriate language pattern for appropriate motor implementation.

Production Processing

Production is the act of constructing something that requires a level of orderly activities that has to follow specific directions to obtain a product or a goal. Planning how one will execute a behavior or a task can take little effort for some and more for others. Children with DAS have difficulties within their production features such as planning for their required motor ability to produce words of meaning. Inconsistent errors occur on syllable stress, omissions, and coarticulation (Nijland et al., 2003). Children with DAS seem to have difficulties in acquiring and automating

the process of storing and retrieving a speech production plan (Maasent, Nijland, & Meulen, 2001).

Nijland et al., (2002) investigated if coarticulation patterns affected the ability to plan the production of syllables due to their syllable structure. They believed that DAS is a speech disorder that interferes with the ability to produce intelligible speech due to impairment in sequencing speech sounds (Nijland et al., 2002). During this study, the authors randomly selected six children with DAS and six children with normal speaking abilities. All children were tested on spontaneous speech, words, repetitive imitations of phonemes and nonsense words, and short phrases. Results indicated that the coarticulation patterns of children with DAS include slower speaking rate compared with non-DAS speaking children, which shows an indication for delayed development for children with DAS. This study provided evidence that children with DAS have a difficult time planning how to produce speech but they did not prove that coarticulation had an effect on their duration of speech production.

Munson, Bjorum, and Windsor (2003) argued that the sound errors of children with DAS are presumed to be secondary to a wide-ranging problem involving planning and executing speech movements. This suggests that the speech problems are not the only difficulty that children with DAS are facing, but there is another component, which is the planning step. During this study conducted by Munson et al. (2003), five children diagnosed with DAS and five children diagnosed with phonological disorder (PD) were asked to judge whether the stress was on the

initial or final position of nonsense words produced by children with speech sound disorders on audiotape, by repeating the non-word utterances. In addition to this study, they added a perception experiment that required ten graduate students in speech–language pathology to listen and transcribe the stress patterns of non-words produced by the children with speech disorders. They found that the duration and fundamental frequency influenced listener's perception of stress patterns. They found that the production of linguistic stress is impaired in children with DAS resulting in less accurate speech production than the children with PD. In order for the child to produce the intended stress, it takes skill of judgment and planning to repeat what was heard correctly. Munson et al., (2003) stated "there are a number of reasons why the children with DAS were perceived as having less accurate production of stress in the absence of a difference in acoustic measures. First, the judgments of stress in children with DAS might have been affected by their segmental production" (p.200). The children with DAS in this study had less accurate speech production than the children with phonological disorder. Munson et al., (2003) believe that this happens because the errors of the children with DAS seemed nonsystematic which decreased their intelligibility. Additionally, this study mentioned that prior to initiating the experiment both sets of children were tested on their repetition skills. During the test, the examiners found that the two groups repeated consonants and vowels with similar levels of accuracy, and phonemes were repeated with similar levels of accuracy in non-words with different stress patterns. In addition, they found that no participant demonstrated a consistent

repetition error for any of the non-word stimuli (Munson et al., 2003). The results of the test demonstrate that the children with DAS have the same characteristics as the children with a phonological disorder, which make it more difficult to distinguish between the two.

Maasent et al., (2001) stated that if children with DAS have problems in retrieving or building a syllable order, the manipulation of the syllable boundary should have an effect. On the other hand, if these children show difficulties in programming the motor output, only the sequence of speech sounds is relevant. If the child with DAS cannot perform the thought process needed to create syllables, production of the syllable will be a difficult task before it reaches the motoric level. During the motoric level, if the child has difficulties it will affect the order of the outgoing sounds by creating difficulties articulating them. They found that children with DAS have a longer duration in the production of syllables in the initial position rather the final position of words. They found a relationship between accuracy of segments and rate of speech, where decreased rate correlated with increased accuracy. Since the sound in the initial position starts the syllable, the initial sound is the starting point of their thought process that children with DAS find challenging. If children with DAS pass the first sound, the succeeding sounds will be produced correctly. Results indicated that children with DAS were unable to produce any systematic durational pattern and the data did not allow for a determination of the origin of DAS. The authors stated, "Either metrical information in the syllabic

programs is deficient, or the motor system is not capable of planning and executing these subtle temporal differences" (p.148).

Groenen, Maassen, Crul, and Thoonen (1996) believe that developmental apraxia of speech is a disorder of phonological and articulatory output processes. They investigated the relation between the perception and production of speech in the etiology and maintenance of DAS. "Speech perception can be characterized by a series of processes, including a preliminary auditory analysis, further auditory and phonetic feature analysis, and the combination of phonetic features into a phonemic representation" (Groenen et al., 1996, p.470). During the study, they included 17 children with apraxia attending special schools for children with language and speech disorders, and 16 children who attended regular schools. These children were administered tests focusing on the identification and discrimination of resynthesized and synthesized monosyllabic words that differed in place-of-articulation of the initial voiced stop consonants that differed in intensity of the third formant. They hypothesized that the manipulation of the third formant would show a difference in the perception of children with DAS and the children without. The first step of the experiment consisted of Dutch words with the /b/ and /d/ sounds in the initial position and differed in Hz. They first played resynthetic words and then synthetic words to the children on audiotape. The second step of the experiment consisted of synthetic Dutch words with /b/ and /d/ in the initial position. The children were told to identify the stimulus by pointing to one of two pictures, for example a picture of a box, representing the stimulus /balphak/, or a

picture of a roof, representing the stimulus /dalphak/. In addition, they also included false words to test the children's perceptions of the word. The words were stated using different time formants. They found that the children perceptions of the stimuli were about the same as the normal children, but the results from the resynthesized words showed a significant difference. While Groenen et al. (2006) demonstrated the possibility that perception will have an effect of the output process they showed that auditory identification of sound can have an effect on process of speech production. If the children with DAS are not noticing subtle language sounds, it will make it difficult for them to produce it.

Production-vowels

Vowels are formed without constriction of the oral cavity serving as syllable nucleus and are classified by tongue position in the oral cavity. Speech or the creation of words is not possible in the English language without a vowel. Vowels tend to have a longer duration then consonants. "The airstream from the vocal folds to the lips is relatively unimpeded during the production of vowels" (Waengler, 2008, pg. 16). In addition, vowels are termed as tense/lax and open/close. Tense and lax is used to describe the degree of muscle tension used in the tongue to articulate the vowel sounds. Close and open signify the distance of the tongue to the roof of the oral cavity. Although vowels errors are seen less frequently then consonant errors, they still play a part in the speech characteristics of a child with DAS and normal speaking children (Brookshire, 2007, p.604).

According to Duffy (2005) vowel duration does not carry specific linguistic meaning in many contexts, it is difficult to argue that increased vowel duration reflects an underlying linguistic disorder, especially when findings indicate that apraxic speakers follow certain linguistic rules for vowel duration (pg. 322). Apraxic speakers vary vowel duration to signal linguistic contrast even though their vowel durations tend to be longer than in non-apraxic speakers. Apraxic speakers generally reduce vowel duration in segments as the number of segments in an utterance increases. In addition, they decrease interword intervals in sentences relative to interword intervals in word strings, but they are less consistent in doing so; this suggests an impaired mechanism for activating and executing motor plans (Duffy, 2005, pg. 322). Davis, Jacks, and Marquardt (2005) stated that "although vowel errors have been cited frequently as a characteristic feature of DAS, detailed clinical descriptions of vowels patterns in children with DAS are few and no studies have documented the persistence of vowel disorder in children with DAS over time" (p. 250).

Davis et al. (2004) found the results from other studies showed that children with DAS have relatively complete vowel inventories, while others report incomplete vowel inventories. Davis et al. (2004) investigated to find detailed descriptions of vowel inventories and accuracy patterns for children with DAS. Three children between the ages 4;6 and 7;7 were included in a longitudinal study for three years to find out if their vowel inventory changed, if vowel accuracy changed, how vowel accuracy related to vowel inventory, and whether vowel

accuracy was affected by complexity at the word and utterance levels. During the three- year study the children were receiving speech therapy. The results showed that the vowel inventory and accuracy patterns were impaired throughout the study, with the most noticeable deficiency concerning the r-colored inventory. "The finding of essentially complete vowel inventories suggests that these children had the capability to produce almost all vowel phonemes, and that impaired vowel accuracy was not primarily attributable to inability to produce one or more vowel category" (Davis et al., 2004). In addition, this study showed that the children with DAS had a low vowel production level for their chronological age. The data showed that the three children were able to produce vowels accurately at 61 to 85%. Vowels are described as being accurately developed by 36 months in typical children (Davis et al., 2004). The accuracy levels were comparable to children who are developmentally between the ages of two and three years of age. Among the errors made by the children, vowel substitution showed no consistency patterns, but there was a greater tendency for tongue advancement errors than tongue height errors. During the study, they analyzed the relationship between vowel accuracy and frequency of vowel types used in substitution errors. They found that the most vowel errors were classified as vowel substitution or de-rhoticization. In addition, they found that the use of substitution of vowels did not correlate with the accuracy of production. Additionally, they analyzed vowel accuracy related to sentence length and syllable word level. They found that there was no effect on sentence length but that the children with DAS decreased vowel accuracy when the

complexity of the syllables at the word and sentence level increased. Davis et al., (2004) stated that the children showed no obvious pattern of vowel error across the entire length of the study.

This study showed that vowel production errors are inconsistent in children with DAS. Children with DAS will display characteristics and depending on the complexity of the syllable, they will find it more difficult to produce a vowel accurately.

Production- Articulatory Error Patterns

According to Brookshire (2007), "errors are most often on consonants occurring initially in words, predominantly on those phonemes and clusters of phonemes requiring more complex musculature adjustment. In addition, children with DAS produce errors that are exacerbated by an increase in length of words and the linguistic and psychologic "weight" of a word in a sentence"(pg. 604). The symptoms of DAS include frequent and inconsistent errors that are contextually constrained in the articulation of consonants and vowels (Groenen et al., 1986). Velleman (1999) stated that the central concerns are associations between syllable and word structure variables, and that speakers' suprasegmental production patterns. In addition, they stated that syllables in words tend to alternate between strong and weak, creating a rhythmic base for the word. Some words in English violate this alternating pattern, but those that do so in an extreme manner tend to be difficult to pronounce. If there are two or more strong syllables within the same word, strong syllables may have either primary or secondary stress (Velleman,

1999). This process starts to develop early on in a child's development, but errors in this process are seen as difficult and inconsistent in children with DAS.

According to Betz and Gammon (2005), error inconsistency is often cited as a characteristic of children with speech DAS. There are at least three types of inconsistency patterns noted in typically developing children. The first pattern is the inconsistent use of a phoneme based on word position. The second pattern is the inconsistent use of a phoneme based on the lexical target. In addition, the third pattern is the inconsistent pronunciations across multiple productions of the same word, which that are also seen in children with DAS but in inconsistent patterns (Betz & Gammon, 2005). Betz and Gammon (2005) stated that these errors may be because children with DAS may have to create a new plan each time they produce a particular word.

A study by Betz and Gammon (2005) sought out to find a set of procedures for measuring error consistency for children with DAS. They emphasized the need for research with objective, valid measures of the degree to which a child's production is consistent. During this study, they hypothesized that children with functional phonological delay (PD) would produce errors that are more consistent then children with DAS. Three children were involved in this study. One child was diagnosed with DAS, one was diagnosed with functional phonological delay and the other displayed typical delay (TD). Each child was issued the Goldman-Fristoe Test of Articulation, the PD and DAS scored below the 16th percentile, while the TD child scored above. The calculation of the number of errors made was based on the word

level, not the phoneme level using three different formulas to analyze their productions. The first formula measured the amount of errors made by each child. The second formula measured the consistency of error types made by the children. The third formula measured the consistency of the most frequently occurring used errors by each child. This study showed that there was a significant difference between the children with DAS and the children with PD for formula 1, but no significant difference between formula two or three. Since there was a significant difference in formula one, which shows that the children with DAS produce more errors than children with PD, the consistency of errors did not differ, but showed inconsistency. The authors stated that there was no significant difference in formula two and three because error consistency is related not to the presence of DAS, but to the severity of the disorder. According to Betz and Gammon these findings suggest that clinicians may be diagnosing DAS in all children with severe speech disorders (2005). If there were a bigger population to study on the affects of the formulas to measure inconsistency, it will make this study more reliable. Children with DAS should be tested not only in the word position but in a sentence structure also. This will enable SLP's to study the conversational aspects of the consistency of errors produced.

Diagnosis

Diagnosis is the art or act of identifying a disease from signs and symptoms (Webster Dictionary). According to Farlex (2010) diagnosis is the act or process of identifying or determining the nature and cause of a disease or injury through

evaluation of client history, examination, and review of laboratory data. Diagnosis can be made when the client has gone through a thorough examination looking at their signs and symptoms and their etiology. Being able to correctly diagnose a client is essential to adequate treatment provisions for that specific patient. While evaluating clients, one should expect to tailor the evaluation to the client's general diagnosed group, while maintaining the flexibility to alter those emphases if necessary. In addition, of course, one will plan a very different evaluation for a child from the one you would plan for an adult (Tomblin, Morris, & Spriestersbach, 2000). "When a child exhibits a phonological or motor disorder, you will pay close attention to the developmental history and to the caregiver's account of the dynamics in the home relating to the child. You will plan to elicit and analyze more than one speech sample, perhaps one from conversation doing a play period and another from a formalized assessment instrument. You will probably do a screening examination of the oral movements from very young children. Phonological disorders often coexist with language disorders; you will assess language in several domains" (Tomblin, Morris, & Spriestersbach 2000 pg.195).

Diagnosing a child who has speech impairment can be a difficult process. The process is difficult because of the multiple classifications in which children can be placed. The classifications include functional articulation disorder, phonological delay, developing dysarthria, and developmental apraxia of speech (Maassen, Gabreels, & Schreuder, 1999). According to Maassen et al. (1999) for clinicians to facilitate appropriate treatment the speech diagnosis needs to contain a

theoretically based judgment on the deficits underlying the speech impairment. "This clinical perspective calls for a more eclectic system of classifying speech disorders, making use of whatever information is available with respect to etiology, treatment history and educational and psychological variables. Instead of determining to which diagnostic category a particular child belongs, a more individualistic approach is advocated in which, for each particular speech disordered-child, all relevant underlying factors are assessed" (Maassen et al., 1999 p. 2).

Maassen et al. (1999) examined the diagnostic procedures developed to assess motoric involvement in childhood speech disorders. They believed that children with DAS could be differentiated from non-apraxic speaking children on their performance on trisyllabic repetition rate. During this study, the authors used 31 school-aged children divided into two groups called the reference group, which comprised children with DAS and dysarthria. These children demonstrated high rates of speech sound errors, inconsistent error patterns, difficulties in producing articulatory complex sound sequences, and groping behavior. The other group was titled the validation group which included children with mixed disorders and children with non-specific articulation problems. All 31 children were issued a maximal performance task (MPT) to determine the upper limits of the speech-motor capacities of respiration, phonation, and articulation. The MPT consisted of subtasks called maximal sound prolongation, which evaluates the respiratory and phonatory capacities. These tasks included maximal phonation duration (MPD) and maximal

fricative duration (MFD). In addition, the tasks also included stress conditions of speech rate, which are maximal repetition rate of monosyllabic sequences (MRRmono) and trisyllabic sequences (MRRtri), sequencing skills (Sequence) and attempts to produce a correct syllabic sequence (Attempts). During this study, the children were given six trials to produce words that were then audio-recorded, phonetically transcribed, and acoustically analyzed. The study indicated that for the MRRmono group the dysarthric group produced slower monosyllabic sequences than the DAS group and the validation group. The MPD tasks revealed that the DAS reference group was shorter than the validation group. In addition, the Sequence, Attempts, MRRtri and MFD group results showed that the normal speaking children in the validation group produced fast, error free trisyllabic sequences. In addition, the study indicated that the validation group produced higher error-free trisyllabic rates than the DAS and dysarthric group and that the children with DAS produced slower repetitions then the other children. The MFD task showed that the children with DAS produced shorter MFD then the children with dysarthria and the validation group. The author stated that the application of the MRRmono and MPD yields a sensitivity of 89%, which suggests that MRRmono and MPD are accurate measures to detect children with moderate to severe dysarthria. In addition, the authors also stated that there were similar results for the children with DAS and that the sensitivity for applying sequence, MRRtri, MFD and Attempts is 100% in detecting DAS. The MPD task showed no significant difference between the groups. Overall, the study indicate that the use of MPT is a good tool to use during a

diagnostic procedure. In addition, the study indicated that slow monosyllabic repetition rate is a sign of dysarthric characteristics and the difficulty with sequencing is a sign of DAS. The MPT task allows the clinicians to distinguish between functional articulation disorder, phonological delay, developing dysarthria, and developmental apraxia of speech, because of the sensitivity and specificity rate of the task that proved their accuracy (Maassen et al., 1999).

Forrest (2003) suggested that the existence of DAS as a distinct disorder continues to be debated, with some reports suggesting that the disorder is subsumed under the category of phonological disorder or as a motor-based etiology. In addition, she stated that DAS is classified as a speech acquisition problem. The author referred to several studies to find out what the differential diagnoses of DAS were. She found that one study concluded that when listeners were asked to evaluate stress production by children with DAS and their normally speaking peers, children with DAS were perceived to be less accurate and there was no significant difference in the stress production patterns compared with children with non-apraxic articulation. One difference the author found was that the lexical stress errors were perceived to produce inappropriate stress and syllable omission. Also during her investigation, she listed three characteristics of DAS. The list suggested that the children with DAS must demonstrate motor, cognitive, and linguistic disturbances.

Forrest (2003) investigated the criteria that speech language therapists (SLPs) used to classify a child as having DAS. She believed that children were being

misdiagnosed with DAS. The participants in her study included 75 SLPs who worked with school-aged children who attended a workshop. During the workshop the SLPs were asked to write down in ten minutes three characteristics that they felt were necessary to diagnose a child as having DAS. She found that out of the 75 participants 67 of them provided three criteria that would lead to a diagnosis of DAS. The other participants only listed two criteria leading to the diagnosis of DAS. The author found that the participants identified DAS using 50 different characteristics. In addition, she found that the most frequent signs used to diagnose DAS are inconsistent productions, groping/"effortful productions" (pg.378), oral motor difficulties, inability to imitate sounds, increasing difficulty with sound production as the utterance length increased, and poor sequencing of sounds. While Forrest (2003) demonstrated that SLPs did not have a definite symptom or sign to identify DAS, she found that their views were consistent with the research literature she studied. She stated that there is no standard for the definition of the term DAS because she found there was little agreement between the SLPs characteristics used to diagnose DAS. Forrest (2003) stated that many of the responses indicated a characteristic of DAS as inconsistent production. She stated that inconsistent production could have multiple meanings. Foster came up with definitions showing, DAS as inconsistent across repetitions, production of a single sound, or produced differently in isolation versus conversation speech. The presence of groping behavior and motor difficulties were also characterized as a sign of DAS in her study (Forrest, 2003). She believes that in order to diagnose a child with DAS groping

behaviors and motor difficulties are two signs needed for an accurate diagnosis, because these are signs of phonological planning, phonetic programming, and oromotor control. The research by Forrest (2003) shows that there is still a need for additional research on the criteria needed to diagnose DAS.

Clinicians and researchers use a wide collection of clinical measures to assist in decision making about diagnosis, treatment planning, and assessment of progress. According to McCauley and Strand (2008), these measures include informal probes, published checklists, standardized tests, and elicited samples of behavior. Measures can be considered standardized tests when they specify standard procedures for administration and interpretation. For a test to be well developed and considered to be standardized it must show evidence of validity and reliability. Validity is to show that the test is testing what it intended to test. Reliability is getting similar results every time the same test is presented to an individual. McCauley and Strand (2008) believe that a critical review of the content and psychometric characteristics of tests for children with motor speech disorders is necessary and overdue. "Reviewing a test's psychometric characteristics entails critically evaluating evidence that the test functions as intended for the purposes and populations for which it was originally developed and is currently used. As part of such review, evidence of reliability is evaluated as a necessary prerequisite for validity: A less reliable test is necessarily a less valid one" (McCauley & Strand, 2008, pg. 81).

High psychometric standards cause three challenges, including limited understanding of the nature of speech motor disorders in children, the changing manifestations of these disorders at different stages of children's development, and the difficulties associated with devising performances tests for young children (McCauley & Strand, 2008). Because of the lack of consensus, there is no gold standard for distinguishing the different childhood development disorders. The three challenges that authors have when making a test stated by McCauley and Strand (2008) are there is an absence of gold standard of a test's diagnostic accuracy using metrics from clinical epidemiology that are used in speech-language pathology. In addition, they believe that the challenge that are authors are facing is the changing nature of children's motor speech disorders over time. Thirdly, authors are challenged because of the difficulty in producing performance task to analyze the non-speech and speech oral functions, in which behavior samples are elicited and evaluated.

McCauley and Strand (2008) investigated to examine the content and psychometric characteristics of tests designed to assess speech and non-speech oral motor function in young children. They believe that there are sporadic well-developed standardized test that are available for assessing speech and non-speech oral function in speech of children. The authors found 22 tests to examine that were published between January 1990 and July 2006 through publishing catalogs, the Health and Psychosocial Instruments database (HaPI), and the Buros Institute's Test Reviews Online. The tests that were selected for review had to show they were

standardized, included young children who were school age, addressed nonverbal oral nonverbal and verbal motor speech functions or both, and were available in July 2006 through a commercial source. McCauley and Strand (2008) reviewed the tests to see if the tests showed information about the intended population for whom the test was intended to be used, item content, norms and behavioral standards used to guide score interpretation and evidence of reliability and validity.

McCauley and Strand (2008) categorized the test content as assessing nonverbal oral motor function, motor speech function, or oral structure, and subcategories of non-verbal oral function as non-feeding or feeding oral motor function. The authors tested the psychometric characteristics of tests by using operational definitions. They found that the tests provided no relevant information about the characteristics examined, and the task failed to meet the operational definition for adequacy. The authors then examined the quality of norms, behavioral standards used in test interpretation, or both, based on each test's purpose. In addition, then they examined the reliability and validity of tests (test-retest and interexaminer reliability). The reviews of the tests indicated that six out of 22 tests met the criteria. The tests that met the criteria were Apraxia Profile (AP) Preschool Age Versions, the Oral Speech Mechanism Screening Third Edition (OSMSE-3), and Screening Test for Developmental Apraxia of Speech Second Edition (STDAS-2), The Verbal Motor Production Assessment for Children (VMPAC) Verbal Dyspraxia Profile (VDP) and Kaufman Speech Praxis Test for Children (KSPT). The authors omitted the other 16 tests because they did not include focus on nonverbal oral

motor or motor speech performance. The characteristics of the six tests that significantly affected the relevance for assessing children were age ranged and showed that the tests tested their intended purposes. McCauley and Strand (2008) stated that the manual for the Verbal Dyspraxia Profile (VDP) did not specify an appropriate age range and the Kaufman Speech Praxis Test for Children (KSPT) only included children below the age of three years old. In addition, all of the six tests except for the OSMSE-3e were described as appropriate for multiple purposes. All six tests were said to be used as either screening or diagnosis by their authors. Authors of five tests indicated that they were appropriate to use for criterion referencing. The McCauley and Strand (2008) also found that oral structure was assessed in only the VMPAC and the OSMSE-3; nonverbal oral motor function was assessed in five of the six tests, motor speech function was assessed in all six tests, and only five tests included both nonverbal oral motor and speech motor content except for the STDAS-2. The only tests that did not include a sample of nonverbal oral function for feeding and non-feeding were the KSPT and OSMSE-3. During the research the only test that demonstrated some true evidence related to norms and behavioral standards for use in test interpretation was the VMPAC. In addition, the VMPAC came closest of any test to meeting operational definitions of adequacy of its reliability and was the only one that demonstrated validity. None of the tests provided clear behavioral standards to base decisions regarding treatment planning, and to measure changes in performance over time. While McCauley and Strand (2008) demonstrated that most tests for children were not adequate to point

out certain details needed to classify a child as disordered, they argued the VMPAC did meet the criteria. The results of this research shows more research on tests given to children before diagnosing them needs to be considered , because some tests are lacking information needed in order to identify and plan treatment goals for children with developmental disorders.

Treatment

According to Strand & Debertine, (2000) integral stimulation is effective in the treatment of DAS. "Both the intensity and the use of techniques that align closely with the core of a DAS deficit in motor planning and programming make integral stimulation an excellent treatment choice for children with DAS" (Strand & Debertine, 2000, p. 298). Treatment using integral stimulation requires knowledge of motor learning theory. According to the ASHA website, motor learning theory is working from phonologically simple to motorically complex, understanding the type of motor task helps determine optimal practices for treatment.

To plan the sequential rules needed to create the appropriate order of sounds for speech is suspected to be a difficult step for children with DAS. Being able to sequence sounds is enabling the usage of the phonological rules of that language. According to Nijland et al. (2002) DAS is a speech disorder that interferes with the ability to produce intelligible speech due to impairment in sequencing speech sounds, syllables and words. This is commonly seen in children who are assumed to be have DAS and adding sound sequencing is essential to the therapy for that child. Nijland et al. (2002) suggested that children with DAS are impaired in

their ability to generate and utilize frames. This means that children with DAS are aware of the organization that is needed to create intelligible speech but are unable to sequence or organize them into the appropriate language patterns. According to Watson and Leahy (2010), a multimodal therapy approach should be implemented in the treatment of children with DAS. The multimodal therapy approach includes using tactile, visual, and auditory approaches. They also stated that "in reference to DAS that each child's phonological response to his or her oral-motor limitations is idiosyncratic. Thus, the clinical challenge is to find the appropriate framework to use to help children build a phonological system" (2010, p. 271).

The longitudinal study by Watson and Leahy (2010) examined the development of a child with DAS speech using a multimodal therapy approach. They believed that deemphasizing oral motor speech production tasks first and emphasizing knowledge of the sounds as most important. They believed that starting from the inside out would be best to facilitate learning of speech. This child was studied in therapy sessions from age two to age five. The therapy techniques used to facilitate this child's development were reading, sign language, finger spelling, and articulation therapy. The study indicated that the child's speech improved by starting and then reducing the emphasis on manual sign language and then increasing his dependence on oral and literacy activities. The child's speech improved dramatically with the use of literacy activities implemented in therapy. Watson and Leahy (2001) believe that allowing the child to see the word increased his production accuracy. This shows that the use of multiple communication

techniques as effective therapy technique. The authors stated that the child's communication development success was the result of an interaction of many variables. The variables include that the child's desire to communicate and to use alternate communication modes, clinical intervention principles that were sensitive to the client's needs, and a supportive home environment. Treatment practices still need further research. Even though the therapy techniques mentioned were proven successful with their specific client, more treatment strategies can possibly be considered. According to the childhood apraxia of speech (2010) website treatment considerations are having frequent therapy sessions depending on the tolerance and severity, incorporation of parents and family into therapy, repetitious motor therapy, and increasing a vocabulary, all of which are deemed necessary for successful treatment.

Conclusion

DAS is a broad and controversial topic that still needs further investigation. Clinicians turn to use a wide variety of techniques in assisting the diagnosis and treatment of DAS. Techniques used for diagnosis and therapy are informal and formal. "The existence of DAS as a distinct disorder continues to be debated, with some reports suggesting that the disorder is subsumed under the general category of phonological, whereas other classification schemes regard DAS as a separate disorder with a motor-based etiology" (Forest, 2003). There is an inconsistency of production of syllables by omitting, substitution, and coarticulation and are still major factors to consider when diagnosing DAS. It is important to observe

communication characteristics of a child who is suspected to have DAS to rule out other disorders, that resembles DAS like dysarthria and apraxia. There is some discrepancy between the production errors and etiology of DAS researcher found that using a multiple stimulus approach during treatment is recommended. This approach will allow clinicians to tap into the neurological and motor aspects of the disorder. As stated by Maassen et al. (1999)" This clinical perspective calls for a more eclectic system of classifying speech disorders, making use of whatever information is available with respect to symptomatology and possibly available information with respect to etiology, treatment history and educational and psychological variables" (p2).

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