Differential Diagnosis of Motor Speech Dysfunction in Children

Deborah A. Hayden

Toronto Children's Centre, Speech Foundation of Ontario, Toronto, Ontario, Canada

An experimental version of the Verbal Motor Production Assessment for Children (VMPAC) is presented. This test provides data for the differential diagnosis of children with four types of speech disorders: global motor, oromotor execution, oral and speech motor sequencing, and by exclusion of the preceding three types, phonological disorders. Rationale on which the test is based are given. The test itself, is discussed in detail as are the diagnostic indicators. Profiles for four children illustrate the integration of the VMPAC data with sensory, cognitive, language and social development data. These profiles are discussed in terms of the diagnoses and implications for intervention.

Keywords: Apraxia of speech in children; differential diagnosis; assessment

The speech disorder *apraxia* has been referred to by a myriad of terms, for example, "motor aphasia" (Morley, Court, and Miller, 1954), "developmental verbal apraxia" (Eisenson, 1972; Aram and Nation, 1982), and "developmental apraxia of speech" (Edwards, 1973; Rosenbek and Wertz, 1972). In recent years not only have these terms become problematic, but the diagnosis of the disorder in children has become confused, in part because of confused connotations such as "apraxia" meaning lack of action. (Nicolosi, Harryman, and Kresheck, 1989). Guyette and Diedrich (1981), in a critical review of developmental apraxia of speech (DAS), came to the conclusion that DAS was "a label in search of a population."

Our premise is that whereas there is a small population of children for whom the term *apraxia of speech* is relevant, DAS is indeed a label in search of a set of clearly defined characteristics that specify the nature of the disorder. Guyette and Diedrich (1981) also presented a set of criteria that should be considered before one can accurately define the disorder. They suggested that the most important feature was the inability of the child to perform volitional/imitative productions of sounds and sequences. Second, they suggested that associated deficits be considered when trying to sort out the presenting characteristics that are significant or falsely attributed to the disorder (i.e., cognitive disorders, hearing deficits, sensory deficits). Other areas for investigation were cited as the "individual's ability to voluntarily imitate speech . . . and the predominance of error type and word length." Last, they suggested that family history, treatment history, and severity of the production disorder be considered.

We recognize that Guyette and Diedrich's arguments are old ones, but they still have not been resolved (Hall, 1992; Robin, 1992). We agree with the main thrust of their objections and find that the state-of-the-art has not changed much. We hope this discussion will pave the way for a new set of thoughts about the nature of this disorder. In this article we present a "set of clearly defined characteristics" that, in our experience and clinical research, identify a disorder of motor sequencing and explain our working definition of developmental apraxia (Dewey, Roy, Square-Storer, and Hayden (Chumpelik), 1988).

We argue that: (1) at the root of DAS is the inability to sequence speech movements, especially over several planes; and (2) DAS should only be diagnosed after the exclusion of other disorders that could result in speech movement

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sequencing disruption. As such, all sensory, cognitive, and language disruptions that could result in the disruption of speech movement sequencing must be found *not* to exist.

In addition, it is our belief that DAS is not a "cluster of symptoms" that are inconsistent or that change over time. There is not a large group of children who evidence DAS. In fact, only a very small number exhibit speech motor sequencing disruption in the absence of other identifiable motor, cognitive, and sensory disturbances that could also account for the disruption. Finally, we believe that most children who evidence an "oral nonverbal apraxia" may be primarily dysarthric and not apraxic.

Consistent with the above beliefs, a new diagnostic instrument, the *Verbal-Motor Production Assessment for Children (VMPAC)*, was developed (see Appendix A). The VMPAC results in differential profiles for children with four types of speech disruptions: global motor, oro-motor execution, oral and speech sequencing, and, by exclusion of the three preceding, phonological. Following further refinement, norms will be collected which establish age ranges at which oral-motor behaviors are normally established. This information will provide objective milestones regarding the development of various aspects of speech motor control in children. With that information, we may finally be able to answer Guyette and Diedrich's challenge and state with certainty that there are children with developmental apraxia of speech, and that this is a population deserving of the label.

Toward a Better Definition

In its purest form, DAS is an exclusionary disorder (Hayden, 1987). To clearly identify DAS one must exclude sensory disorders, cognitive disorders, receptive language disorders, emotional and/or pragmatic language disorders, deviations of muscle tone and imbalance, and global neurological involvement. In DAS, oral volitional movements of the articulators are intact within broad normal limits, and the quality of the observed movement trajectories/transitions is also within the broad normal range. Single, repetitive speech movements (/ p ʌ p ʌ p ʌ /) may be performed similarly to same-age peers. *In its purest form DAS is a disorder of the ability to translate phonemic and linguistic codes to differing planes of movement over time.* In verbal production disorders when there are two or more coexisting levels of involvement, that is, cognitive, motor, receptive, etc., it is not possible to identify whether a "pure" disorder of speech motor sequencing exists. The "apraxic-like" symptoms may be a result of one or more additional sensory or processing disruptions or the interaction among them.

Diagnostic Reasoning

To diagnose a disorder one must observe all presenting behaviors, formulate testable hypotheses using clearly stated and answerable questions, test the hypotheses to determine their validity, and formulate conclusions based on these hypotheses (Emerick and Hatten, 1974). Diagnosis by *exclusion* implies that a conclusion about the disorder is reached by excluding other known conditions. It is our opinion that the following conditions must first be evaluated and met before differentially diagnosing a "pure" disorder of speech motor sequencing. First, hearing acuity should be within broad normal limits, bilaterally. The child must be able to hear the sounds of the language and to organize them into auditory patterns with linguistic significance. Second, structural (cranio-facial) features should be intact, in proper alignment, and balanced. Cranial or structural abnormalities should not interfere with muscular placement, balance, or contraction. Third, the results of nonverbal, cognitive testing should be within broad normal limits. The child must understand the nature of the tasks presented and the symbolic nature of language coding. If a child has a cognitive disability, the areas of attention, memory, and organization are often problematic. These difficulties often produce "symptoms" that complicate expressive speech production and, in testing, make it difficult to know whether the results are because of processing difficulties or "pure" motor sequencing breakdowns. Fourth, auditory-verbal comprehension (receptive language) should be within broad normal limits for chronological age. As DAS is a disorder of praxis, and in our opinion *not* language, it is essential that receptive language be close to age-appropriate. Fifth, disorders primarily of an emotional and pragmatic nature should be ruled out. We realize this brings up an area currently in debate, but it is our opinion that DAS does *not* have the same root cause as autism, nor that facilitated communication techniques produce any of the same effects on DAS [see Donnellan, Sabin, and Majure (1992) for a discussion of facilitated communication]. Finally, emotional and pragmatic disorders are not viewed as disorders of praxis or of the ability to sequence the temporal/spatial aspects of speech.

Phonological or articulation tests should be given to determine a severity rating. In our experience, however, a test of speech, whether based on features, phonological rules, or error type, will not determine the *underlying* cause for the errors. This information, however, will be useful for noting the severity of the production difficulty, and for identifying both features that are present or omitted and the types of processes that are used most often. A mild dysarthria may look much like a severe phonological or apraxic disorder on speech error examination alone.

All of the conditions discussed above can result in a speech disorder in which volitional speech production is affected. Children are likely to show various problems with phoneme and language acquisition. Remediation may be difficult and lengthy. Some children may have involvement of the peripheral muscle system (dysarthria) which results in muscle strength and tone abnormalities. Such deficits may be misdiagnosed as oral apraxia. Thus, before one can attempt a differential diagnosis of speech production, all areas listed above must be thoroughly assessed. With this information, the clinician will begin to understand the difficulties confronting the child and will develop a greater appreciation for the complicating factors that may make volitional speech production difficult. Only when all areas are assessed may the clinician formulate a comprehensive view of the child's expressive difficulties. Thorough assessment will result in the ability to pinpoint the accurate cause of a child's disability for the production of volitional speech, and will avoid the misapplication and overuse of the diagnosis of DAS.

Differentiating Motor-Speech Disorders

In our opinion a speech-language pathologist who is highly skilled in motor-speech disorders should be the professional to diagnose DAS. Assessments of other areas should be undertaken prior to the speech assessment and all data should be integrated for final diagnosis. The purpose of the speech evaluation is to determine the nature and degree of involvement of the neuromotor system subserving speech. This assessment should include a systematic evaluation of the neuromuscular function of the speech system. A definitive assessment for the purpose of differential diagnosis cannot be achieved before the child is 3.5 to 4 years of age. Before this time the child's system will not be developed sufficiently to perform the necessary motor sequencing tasks required for the purposes of differential diagnosis (Kent, 1988).

The VMPAC has been designed specifically to assess oral motor and sequencing functions. The four categories of disorders, differentially diagnosed, are speech disorders owing to (1) global motor involvement, (2) specific oro-motor involvement, (3) oral and speech sequencing disability, and (4) phonological disorder. A major working hypothesis underlying the development of the VMPAC is that many developmental speech disorders have their basis in an underlying mild dysarthria. Second, developmental disorders are likely to have a rule-based or auditory/linguistic cause if oro-motor functions are intact. Finally, few developmental speech disorders have as their basis an inability to achieve temporal/spatial targets in sequenced speech over time. The latter disability describes the underlying cause of developmental apraxia of speech. It occurs only rarely.

VERBAL MOTOR PRODUCTION ASSESSMENT FOR CHILDREN

Global Motor Control

The purpose of this area of the evaluation is to assess the integrity of the neuromotor system of the child and conclude if abnormal or aberrant conditions exist that would severely complicate the production of speech. The main areas checked are muscle tone, breath support functions, and airstream management for the support of speech, that is, phonation.

General body tone movement transition is critically important. The ability of the body to support itself against gravity and perform movements with other muscle groups smoothly and in a coordinated fashion is dependent on each muscle group. Either too much tone or too little tone will result in difficulties supporting speech (Love, 1992). On the VMPAC, the clinician is asked to judge general postural tone, head, and trunk symmetry and the presence or absence of abnormal brain stem reflexes (asymmetrical tonic neck), as well as additional movement reflexes (moro, startle) and oral reflexes (hand-mouth, mouth-opening, lip or mouth phenomena, biting, sucking, chewing reflexes).

Supportive speech functions, breath support, and phonation are also evaluated. In order to sustain speech, a child must be able to maintain breath support and voluntarily control the breath stream. Tone difficulties will greatly influence the muscular support required for breath control. The child must be able to maintain subglottal air pressure and control valving at the level of the glottis, tongue, velopharyngeal port, and lips. Tone aberrations interfere with these functions. Without the ability to control these valving functions, air stream management for speech will be disturbed. The child will lose air pressure, may have too much or too little glottal resistance, and consequently will have difficulty producing voiced phonemes, fricatives, sibilants, and affricatives, as well as sustaining breath support over single or extended utterances. On the VMPAC, the clinician is asked to evaluate a coordinated respiratory pattern for phonation and to check for minimally sustained phonation and loudness as indicators of adequate respiratory and phonatory support for speech.

If any of these areas are found to be impaired it is certain that the child will have difficulty sustaining speech over extended utterances, that phonemes will be in error, likely both in place and in manner, and that a broader neurological condition underlies the deviant speech (global motor control). Under these conditions the child's speech will likely show oral and speech movement difficulties but is *not* considered to be apraxic. Rather, this disorder is a developmental dysarthria.

Specific Oro-Motor Execution Disorder

Developmental dysarthria (Hayden, 1992) is defined as a disorder of muscle tone, strength, or imbalance, which is caused by neurological impairment and which directly affects oral movement and speech production skills. *Involvement may be of specific oro-motor speech muscle groups or pervasive throughout the oro-motor musculature.* Dysfunction of the oro-motor musculature may be accompanied by dysfunction of the support systems, vocalization, and phonation, but it can also occur without dysfunction of those support systems. That is, difficulty may exist within individual muscles or muscle coordinates of the oro-facial system. When one of these affected muscle groups is required to interact for speech production, the cumulative result may produce disorders of articulation, rate, and rhythm. Developmental dysarthria may coexist with other developmental delays or disorders, such as cognitive or phonological disorders. *If severe, speech potential will be limited.*

Using the terminology of the VMPAC, both global motor control disruption and specific impairment of the speech musculature would result in developmental dysarthrias. Whereas global motor disruption reflects a disruption of postural control, specific impairment of the speech musculature also results in a neuromotor speech disorder, but is less dehabilitating. It has been our experience that specific impairment of the oromotor speech musculature is often not recognized by clinicians. Indeed, this more specific neuromotor impairment of the speech musculature is often confused with both DAS and phonological disorders.

Planes of Movement Control

Assessment of specific motor control focuses on the evaluations of the *jaw*, or the vertical plane of movement control, the *labial and facial musculature*, or the horizontal plane of movement (rounding/retraction), and the *tongue*, or the mainly anterior/posterior plane of movement. (It is recognized that the tongue body moves in both superior/inferior and anterior/posterior planes. When viewed simplistically, however, the movement trajectory is toward a "target" that lies along an anterior to posterior continuum).

The VMPAC assesses movement execution in these specific and isolated planes of movement; that is, it is at the level of the single plane of movement that muscle function is assessed. Without first making the determination of function in single planes of movement, assessment of function in multiple planes (sequencing) is meaningless. Function in isolated planes includes assessment of nonverbal motor activities, such as the actions associated with "kiss" (vertical plane/labial facial protrusion), "bite" (horizontal plane/jaw), and "show teeth" (vertical plane/labial facial retraction). Assessment of control of tongue movement in one trajectory as well as for strength is also included. Special features of execution which should be noted are asymmetry, smoothness, and range and variability of movements.

It is our belief that if a child is found to have difficulty with motor control in a single plane of movement or for nonspeech movements, the root of the speech disorder is a specific impairment of speech muscle control. This will result in a developmental dysarthria. It has been reported that children with DAS are able to perform repetitive nonspeech or speech movements. These movements are always in the same plane of movement, that is, / p ʌ p ʌ p ʌ /. Such speech and nonspeech alternative movement rates will not be impaired unless the child has a developmental dysarthria. Indeed, we concur that in DAS single plane movements are within normal limits.

Oral and Speech Sequencing

Evaluation of transitions across differing planes of movement is, in our opinion, the true test for DAS. Our hypothesis is that transitions from one plane to another in sequenced speech is the level of disruption in DAS.

The following questions regarding control of sequenced movements are addressed: (1) How is the child's performance affected by increasing planes of movement? (2) Does the child produce sequences that are normally restricted in amplitude and that are tightly controlled? (3) Is the child able to perform oppositional movements in the same plane of movement (i.e., facial retraction and rounding)? (4) Is the child able to maintain valving and air constriction during movement transitions (e.g., voiced/voiceless contrasts and manner distinctions)? The above questions are addressed using the following techniques.

In this part of the evaluation the child is first asked to produce several replications of isolated vowels (a, i, u, o) and one nasal (m). This task is done to assess consistency of production. If the child usually produces /u/ as /o/, the clinician will accept the child's production of /o/ as representative of /u/ and not count it as an error when it occurs in a sequence. In addition, the child's ability to do four single repetitions of the same phoneme in a single plane of movement is evaluated. For this task, the child is allowed to use four colored blocks as a representational aid for the number of reduplications. Using blocks eliminates the confounding effects of memory limitations in the sequencing task and allows the child to focus on the elements of production. The purpose of this task is to assess whether or not the child can initiate and stop a voiced production over a series of four repetitions. If the child cannot, it will be impossible to continue the assessment of sequencing.

Sets of both nonverbal oral movements over differing planes as well as sequenced phonemes that traverse various planes of movement are included. For example, the child is asked to imitate a set of four combinations: "say /a-u/, /a-u/, /a-u/, /a-u/ ." Again, one block represents the production of each pair, and the production of four pairs is desirable. This sequence requires controlled valving at the level of the larynx and velopharyngeal port integrated with movements in the vertical plane (jaw) and horizontal plane (labial-facial rounding). Only one consonant, a nasal, /m/, is included at this level of testing. It is used in order to assess the sequencing of open-closed valving at the velopharyngeal port and ability to maintain continuency. The test sequence is: "say /m-i/, /m-i/, /m-i/, /m-i/ ." In this sequence, control of transition is maintained in the horizontal (labial- facial retraction) plane while velopharyngeal valving control is challenged.

As testing in this section of the evaluation progresses, syllables and short words can be used and represented by real objects or colored pictures in order to assess ability and produce more complex sequences. For example, "say *pea, tea, key*," (sequenced antero-posterior place adjustments), or "say *beat, bat, boat, boot*" (sequenced jaw height adjustments).

The composite results give the clinician a much clearer idea of the effect of different planes of movement or adjustments within one plane of movement in sequences.

There are several differentiating indicators observed frequently among these children; that is, children with different underlying deficits will perform the vowel sequences differently. Children with *cognitive/processing disorders* may forget the number of repetitions requested, not pay attention or not understand the task, not maintain eye contact with the clinician, and may attempt any combination to complete the task. Children with *phonological/functional articulation disorders* may collapse movements or try to make a meaningful representation of the phonemes (i.e., /m-u/ = *moo* or /m-i/ = *me*), or produce movements too quickly, produce an error and then self-correct or slow down the pace of the sequence. These children may not need blocks to help with the pacing or sequencing of the task. Children with *developmental dysarthria* may reduce the range of movements over time, collapse movements over time (i.e., /mi/ to /m/ with reduced horizontal range), or exaggerate movements or produce asymmetrical movements (facial and jaw). Children with *developmental apraxia of speech* may slow their movement, lose focus, and stop the task, or they may change movement or valving thereby introducing new or additional phonemes into the sequence. Children with DAS often break down between the second and third repetition and may be unable to maintain the number of repetitions required, or the one-to-one correspondence of transitional movements to visual representation (blocks) over the sequence. *These sequencing tasks are paramount for the differential diagnosis of DAS.*

Connected Speech

The VMPAC includes a connected speech sample using a sequenced picture story [such as the "boy and the bike" sequence from Developmental Learning Materials (DLM) (1974)]. This task is necessary to check the consistency of the child's productions in connected speech and to briefly assess the level of his/her linguistic development. Although we have already stated that we do not believe DAS to be a linguistically based disorder, we do believe that the development of expressive syntax may be disordered owing to the child's motor speech output difficulties, that is, difficulties controlling multiple planes of movement. That is, a motor control disorder precludes the development of expressive syntax and may make certain word forms preferable over others. Connected speech samples give the clinician a chance to observe how well the child is able to use his/her speech system at various levels of complexity—to form words and use linguistic structures. It has been our experience that children with pure DAS often show consistency at the level of the single phoneme (single plane of movement), may break down at the syllable level (two planes of movement or more), show more consistency at the CVC or short word level (rehearsed, automatic productions), and, again, become inconsistent at the phrase or sentence level (multiple planes of movement with increasing linguistic demands).

With this information the clinician now may integrate the initial diagnostic information from various other sources, the oral motor and sequencing information, and information regarding the child's ability to use the motor and linguistic systems to purposefully communicate.

VMPAC PROFILES

Oro-motor execution and oral sequencing portions of the VMPAC will now be discussed to illustrate the various profiles that have been obtained. The importance of integrating the child's profile with previously obtained information regarding sensory, cognitive, language, and emotional and social developmental levels will be stressed and treatment implications will be considered.

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Case 1

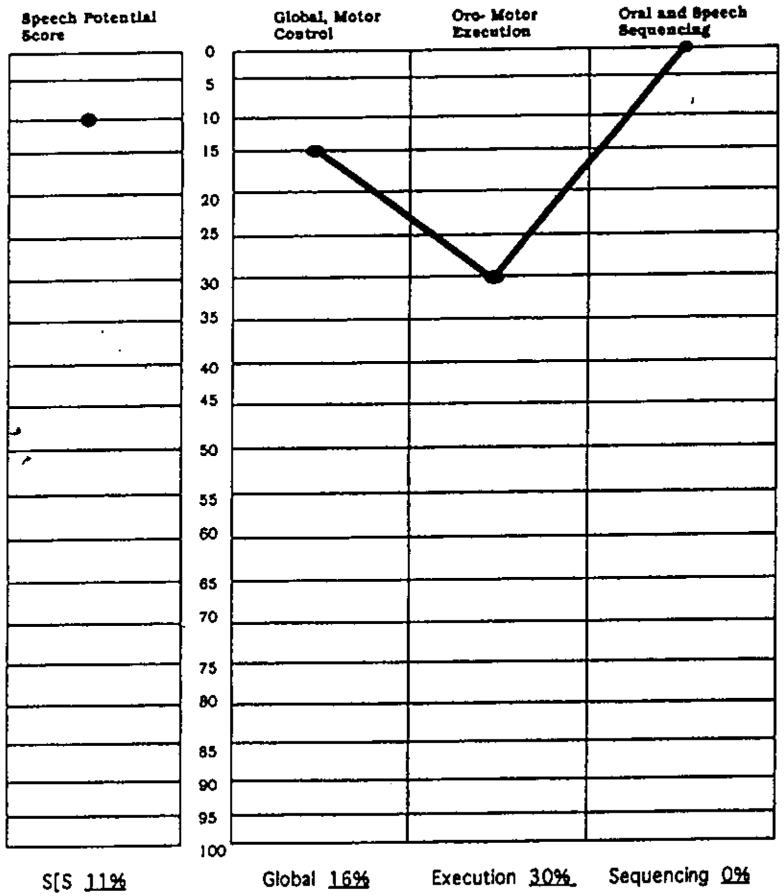
Sam's developmental history and testing results were as follows. His birth history indicated a vacuum extraction and "a low tone" baby of 42 weeks gestation weighing 8.12 pounds. In early pregnancy there was vaginal bleeding and a threatened miscarriage. Later diagnosis indicated generalized "developmental delay and suspected oral and limb apraxia." Recent assessment results at C. A. 4.9 revealed normal hearing bilaterally, nonverbal cognitive abilities [*The Arthur Adaptation of the Leiter International Performance Scale* (Arthur, 1952)] in the moderate range, overall receptive language scores as determined by the *Reynell Developmental Language Scales—Receptive and Expressive* (Reynell, 1989) and the *Sequenced Inventory of Communication Development (SICD)* (Hedrick, Prather, and Tobin, 1984) in the early two year range, and phonological abilities [*Computer Analysis of Phonological Deviations (CAPD)* (Hodson, 1992)] in the profoundly disordered range. Joint attention and turn taking were emerging.

From the VMPAC profile (see Fig. 1) it is immediately clear that Sam evidenced significant difficulty on all sections. In the Global Motor Control section, Sam showed evidence of poor postural tone, presence of uninhibited oral reflexes, inadequate breath support, and poor valving control with a score of 16/100. In the Oro-Motor Execution section, difficulties were noted in control of the jaw and facial musculature and lingual and articulatory structures for a score of 30/100. For example, there was evidence of weakness and the occurrence of involuntary contractions, and there was not a full range of movement of the facial muscles or equal contraction on both sides of the facial midline. On Oral and Speech Sequencing tasks, an inability to perform any of the tasks resulted (0/100). Although Sam was able to produce single, consistent productions of vowels and consonants, four repetitions of the same production could not be completed. He was able to repeat a sequenced speech task with the examiner but was not able to complete it alone. Memory, cognitive age, and motor constraints made all sequencing tasks difficult and inappropriate. Scores indicated that one could *not* attribute Sam's slow speech acquisition to apraxia. With a system as involved as his, other motor and cognitive disabilities precluded such a diagnosis. What is certain is that Sam was involved at all levels and needed intervention that addressed motor, language, and the integration of these into a functional and social language intervention plan. Although visual and tactile feedback would be necessary for helping Sam, a language context for his productions was critical. Augmentative systems would most likely be needed in his overall communication plan.

Case 2

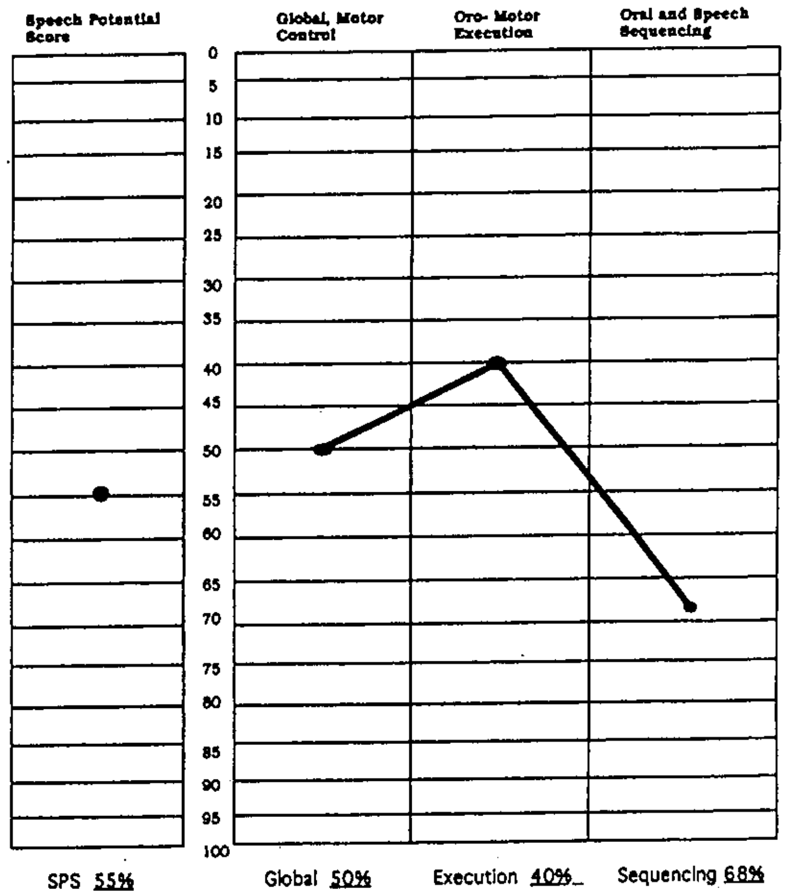
Cathy's history indicated a birth weight of 7.6 pounds. A short umbilical cord and a rapid heart beat between contractions were reported at delivery. A diagnosis of hypotonia was given at birth. Developmental history showed delayed motor milestones and the development of focal seizures by 2 years of age. Seizures were completely controlled by Epinol by age 4. By 5 years, three different surgical procedures were performed, one for an infection in the lymph nodes, a second for myringotomies, and a third for correction of crossed eyes. Current hearing tests were normal, although fluctuating losses had been reported in the past. Normal integrity of the oral structures existed. Recent test results at a C.A. of 6.4 indicated nonverbal cognitive scores (Leiter) in the mild/moderate range, receptive language scores [*Peabody Picture Vocabulary Test—Revised* (PPVT-R) (Dunn and Dunn, 1984)], *Reynell*, *SICD*, and the *Test for Auditory Comprehension of Language—Revised* (TACL-R) (Carrow-Wollfolk, 1985) in the early 4-year range, phonological abilities (CAPD) in the profound range, and good pragmatic functions (joint attention, turn taking, etc.).

From the profile (see Fig. 2) it is clear that Cathy had significant difficulty, especially in the Oro-Motor Execution and Global Motor tasks. In the Global Motor Control section Cathy was found to exhibit low postural tone and inadequate valving control precluding adequate loudness. Her score in this area was 50/100. In the Oro-Motor Execution section poor jaw control, that is, poor



Name: Sam C.A. 5.4

Figure 1. VMPAC profile of Sam.



Name: Cathy C.A. 6.6

Figure 2. VMPAC profile of Cathy.

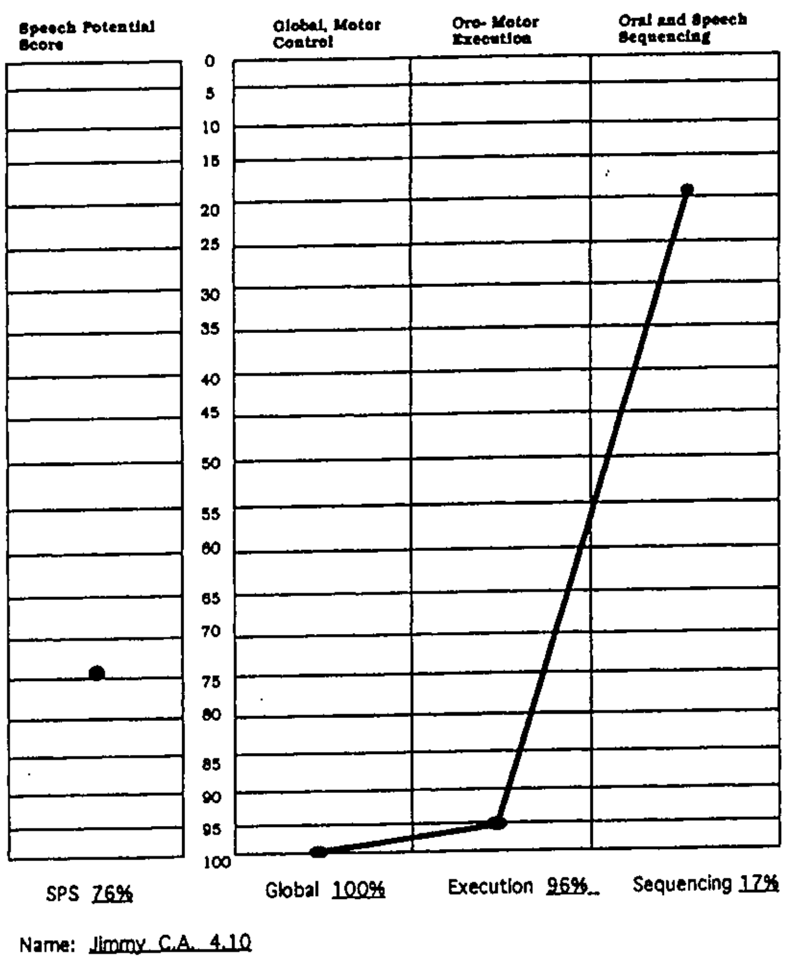


Figure 3. VMPAC profile of Jimmy.

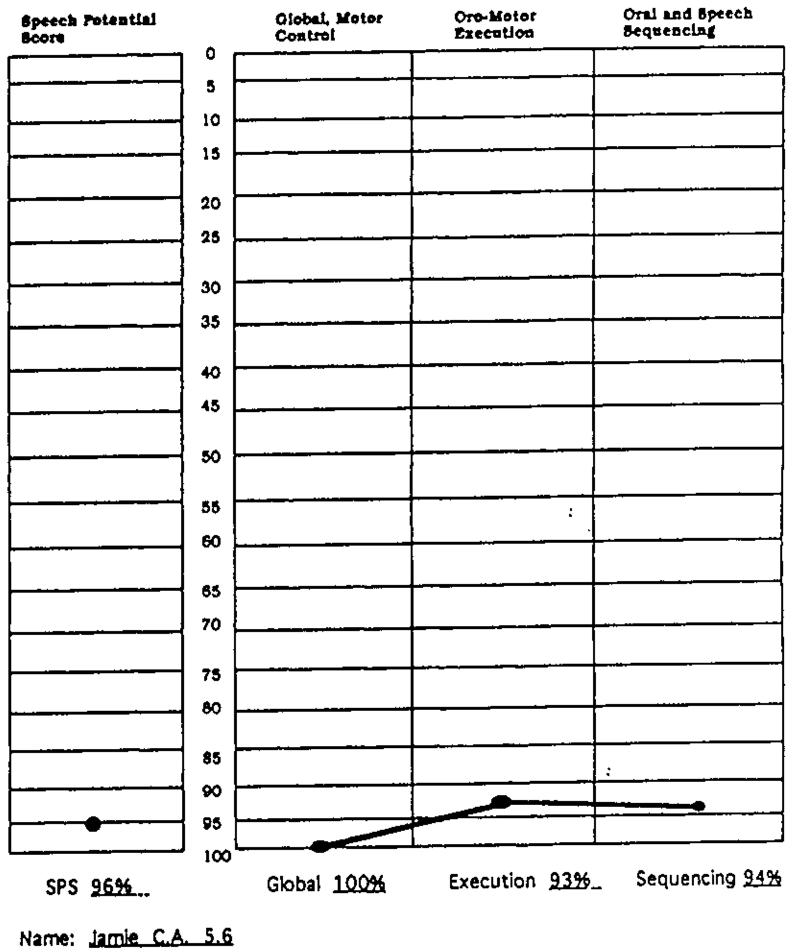


Figure 4. VMPAC profile of Jamie.

range, vertical movement control, and lateral sliding, and some labial weakness were the main factors that contributed to her low score of 40/100. An area of relative strength, Oral and Speech Sequencing, resulted in a score of 68/100. She was able to sequence nonspeech oral movements and movements that required tongue control. Sequences that required more involvement from the jaw and facial musculature were found to be more difficult, for example, /a-i/. These sequences revealed the difficulty of motor control seen in the Oro-Motor Execution section and were exacerbated by the quick transitions needed in sequencing tasks. From the above combined information Cathy would be treated as dysarthric. Interventions that targeted speech production tasks at all levels of valving and muscular control would be used within contextual framework that stressed functional communication.

Case 3

Jimmy's birth history was reported as essentially normal. He was born two weeks premature, weighing 7.11 pounds. A slight jaundice was reported and he was placed in incubation for a day. Mild ear infections were reported at 3 to 4 years. Current test results indicated normal hearing bilaterally. All motor milestones were reached well within normal limits. A suspected "apraxia of speech" was queried in earlier reports. Recent assessment results at a C.A. of 4.10 revealed nonverbal cognitive scores (Leiter) in the normal range, overall receptive language scores (Peabody-R TACL-R, Reynell) in the normal/mildly delayed range, and phonological (CAPD) scores in the severe range.

VMPAC profile results (see Fig. 3) indicated that Jimmy's difficulty was almost entirely at the level of Oral and Speech Sequencing (17/100). In the Global Motor Control section all of Jimmy's functions were normal (100/100). On the Oro-Motor Execution section all functions were judged to be within normal limits with the exception of tongue elevation (96/100). As no extensive normative data on this function has yet been collected it is difficult to know what standard deviations may apply. It is expected that this particular function (tongue-tip elevation without the use of the jaw) is later developing and may have a wider range of normal deviation. However, for lack of normative data to clearly support this position, it was marked as incorrect in this section. Thus, with the exception of tongue elevation, all other tongue functions were intact.

Relatively, all difficulties appeared in the Oral and Speech Sequencing tasks. Consistently, Jimmy would begin the sequence with the correct paired unit, that is, /a-u/, and after approximately two repetitions it would change into other forms, that is, /a-o/, /a-a/. Jimmy appeared to have considerable difficulty maintaining the accurate transition between differing planes of movement over time, resulting in a diagnosis of apraxia of speech.

No problems were found in other motor speech areas and Jimmy's language and cognitive skills were good, so an intervention program aimed at facilitating motor transitions was developed. Programming started at a CVC level and included some phrases (e.g., "I want a ____"). A functional core vocabulary, programmed phrases, and activities that encouraged functional use of speech formed a realistic beginning approach.

Case 4

Jamie's birth history indicated he was 3 weeks premature and that a delivery with forceps occurred. Birth weight was 6.9 pounds. All motor milestones were achieved well within normal limits. Frequent colds and ear infections were reported between 1 and 3 years of age. However, hearing was currently within normal limits bilaterally. Testing at C.A. 5.5 indicated normal nonverbal cognitive scores (Leiter), normal receptive language scores (Reynell, Peabody-R, TACL-R), and phonological scores (CAPD) in the severe range. All nonverbal and verbal communicative functions were well established. The referring agency queried the diagnosis of developmental apraxia of speech.

The VMPAC profile (see Fig. 4) indicated that Jamie's motor speech abilities were normal. With the exception of one error on the sequencing section and one error in tongue-tip elevation, all aspects of his motor speech skills were age-adequate, that is, Global Motor, 100/100; Oro-Motor Execution, 93/100; Oral and Speech Sequencing, 94/100. It is important to note that when testing has been done with normal children 4 to 6 years, profiles with scores within the 90–100% range have been obtained. Thus, Jamie's performances were considered normal.

During testing Jamie was able to use self-monitoring and self-correction to revise his incorrect productions. However, in spite of normal motor control and sequencing skills, his speech was unintelligible. From this information it was concluded that Jamie had a phonological disorder. Intervention aimed at developing several phonological processes. It incorporated metacognitive strategies for learning to use the new behaviors.

A NEW FOCUS ON DAS

Perhaps it is time to refocus our attention, as Guyette and Diedrich remind us, on "... the volitional/imitative production aspects and the predominance of error type and word length." Our feeling about this statement is that they were indeed on the right track. However, we would substitute plane of movement (speech action) for "error type," and transition among multiple planes (multiple speech actions) for "word length." This framework for evaluating DAS and differentiating it from other motor speech disorders may provide the clearest definition of this movement disorder which has resulted in years of controversy.

We need to refocus our attention on aspects of motor control. For example, does the problem involve the entire motor system, the speech musculature that produces the speech action, or the transitions and interactions between different speech actions? The VMPAC is designed to help the clinician begin to answer these questions by profiling the child's ability in each area and integrating the profile with other assessment data. Once a pattern emerges it is much easier to see how the parts contribute to the whole, and to realize that what may once have appeared as an apraxia was really a dysarthria in disguise.

It is certain that most motor speech disorders are combinations of many different dysfunctions, for example, motor disorder, cognitive disability, phonological delays or disorders, and, perhaps, even apraxia. Until the primary characteristics of DAS can be objectively defined, however, there will be little change in the way we assign diagnoses or treatment intervention. The realities of separate disorders with separate characteristics and treatments will remain an enigma.

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APPENDIX A

Note: The experimental edition of the VMPAC is currently undergoing scoring revisions. Subsequently, the following reflects *only* current sections and items now assessed without scoring details. The revised VMPAC which will include a more sensitive scoring system and expanded Section 1, Global Motor Control, will be field tested in the summer of 1994.

VERBAL-MOTOR PRODUCTION ASSESSMENT FOR CHILDREN
TEST FORM
D.A. Hayden (86)

EXAMINER: ____________________ DATE: ____________________
NAME: ____________________ D.O.B.: __________ C.A.: ______

SECTION 1 (*Please refer to VMPAC ADMINISTRATION & SCORING MANUAL for complete instructions/explanations.*)

A. GENERAL BODY POSTURE AND MUSCLE TONE

Score: 1 — agree
0 — disagree

Item 1. General postural tone is within the normal range?

Item 2. Head and trunk control show symmetry?

**For administering instructions refer to Manual.*