Clinical Assessment of Speech Motor Performances of Children with Moderate to Severe Articulation Disorders

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The purposes of the present investigation were to clinically assess children (ages 2 to 12) with normally developing speech and moderate to severe articulation disorders in areas of speech subsystem control and speech movement sequencing. The Verbal Motor Production Assessment for Children (VMPAC; Hayden & Square, 1999) was used to assess three areas: physiological support for speech; oral movement control abilities of articulators; and sequencing abilities. Results indicated that in children with normally developing speech, a hierarchy of competencies emerge. Competency in the area of physiological support of non-oral speech subsystems emerges earliest, whereas competency for movement control of the oral articulators (jaw, lips and tongue) is achieved at later ages. Speech sequencing competencies emerge much later and may continue to be refined even beyond age 12. In children with moderate to severe speech articulation disorders, similar patterns of emergence of competencies were revealed but at much later ages. Delayed development of motor speech control may be the basis of many developmental articulation disorders.

Introduction

For the last three decades the discipline of speech-language pathology has focused largely on phonological explanations for developmental speech disorders. As a result, treatment approaches for developmental speech disorders used phonological therapies that have focused, to a large degree on auditory stimulation to enhance a child's understanding of the correct "sound patterns" of language. The implicit assumption has been that a cognitive awareness of the "sound pattern" will develop and result in emergence of correct speech movements. Prior to the 1970's, explanations of the nature and treatment of developmental speech disorders focused to a much greater extent on speech motor control, per se, and many therapies were "movement" based. In recent decades, however, only developmental apraxia and the dysarthrias are viewed as being motor speech disorders. The dysarthrias are conceived as disorders in which the physiological support for a single or for multiple speech subsystems is deviant due to aberrations in muscle tone and strength or presence of abnormal or absence of normal oro-motor reflexes (Darley, Aronson & Brown, 1975) Developmental apraxia of speech (DAS) has been characterized clinically as a disorder in which volitional oro-motor control deficits for the production of speech (and usually, non-speech oral) movements and speech sequencing deficits exist (Yoss & Darley, 1974; Williams, Ingham & Rosenthal, 1984).

The Verbal Motor Production Assessment for Children (VMPAC; Hayden & Square, 1999) was developed, in part, to clinically assess in a systematic manner the areas of motor speech production that traditionally have been reported to be impaired among children with the developmental motor speech disorders. The three areas tested by the VMPAC that are the focus of this paper include: (1) GLOBAL MOTOR CONTROL (GM) which assesses the physiological support for speech; (2) ORO-MOTOR CONTROL (OM) of the articulators; and (3) ability to SEQUENCE (SE) alternate speech movements. Hayden and Square (1994) hypothesized that each of these areas, GM, OM and SE, emerged in a bottom-up hierarchical fashion in normal development as indicated in their model shown in Figure 1.1. It was hypothesized that levels could be selectively impaired in individuals but generally, levels higher in the hierarchy would be dependent upon a minimum level of competency at lower levels.

Square, Hayden and Ozanne (1995) provided evidence from pilot studies using an experimental edition of the VMPAC that among children between 3 and 6 years of age with normally developing speech, improving performances on these three dimensions of speech motor behaviour emerges hierarchically although there was developmental overlap among areas. When the performances of 59 children, ages 4 to 8, with speech disorders of varying severity were compared to those of children with normally developing speech, 59% of the speech disordered children were found to perform two standard deviations or more below the mean performances of the much younger children with normally developing speech. Group data from the speech impaired children indeed indicated that a general level of competence was required at each of the lower levels of the hierarchy before competency at subsequent levels emerged.

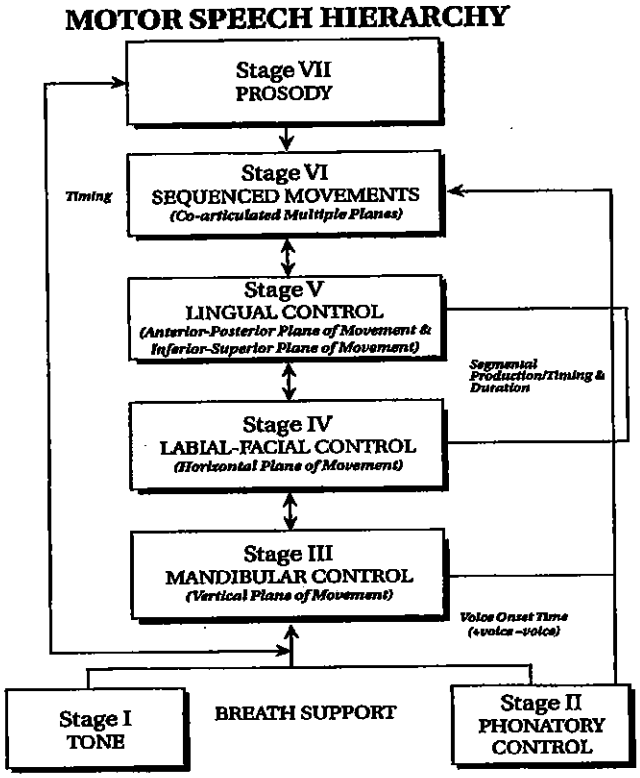

Figure 1. Motor Speech Hierarchy

The purpose of this investigation was to replicate the previous work of Square et al. (1995) using large samples of English speaking children. Two research questions were posed:

1. Is there a hierarchical development in the performances of children with normally developing speech in the areas of GM, OM, and SE?
2. Do children with moderate to severe articulation disorders differ significantly from children with normally developing speech with regard to competency of performances in these three speech motor control dimensions?

Method

The VMPAC was administered to children with normally developing speech (n=1090) and children with moderate to severe speech disorders (n=394) between the ages of 2 and 12. The children with speech disorders were all judged to have moderate to severe articulation impairments. The speech-disordered children were assigned "a prior" to one of four clinical groups based upon performances on a comprehensive clinical battery and success in treatment. This resulted in four groups of speech–disordered children: 1. "Articulation/Phonological" amenable to treatment (n= 148); 2 "Articulation/Phonological" resistant to treatment (n=65); 3. Speech disordered with coexisting oral motor control deficits such as drooling (n=130); and 4. Speech disordered with generalized gross motor impairments (n=51).

The test battery consisted of a total 82 items (GM=20 items; OM=46 items, and SE= 16 items). The GM items assessed the postural tone and stability for respiratory, phonatory and articulatory systems, and oro-motor reflexes for vegetative functions. The OM items assessed the integrity of speech and non-speech movements of the jaw, lips and tongue. The SE items assessed the ability to sequence non-speech, double and triple phoneme sequences. Testing clinicians were all licensed and/or certified, received similar pre-training, and were remunerated $30.00 (USA) for each completed assessment. Intra and inter-judge scoring reliability was undertaken for a sample of 115 clinicians and there was no significant difference between the first and the second administration of VMPAC or between judges.

Results

Developmental Trends in Children with Normally Developing Speech

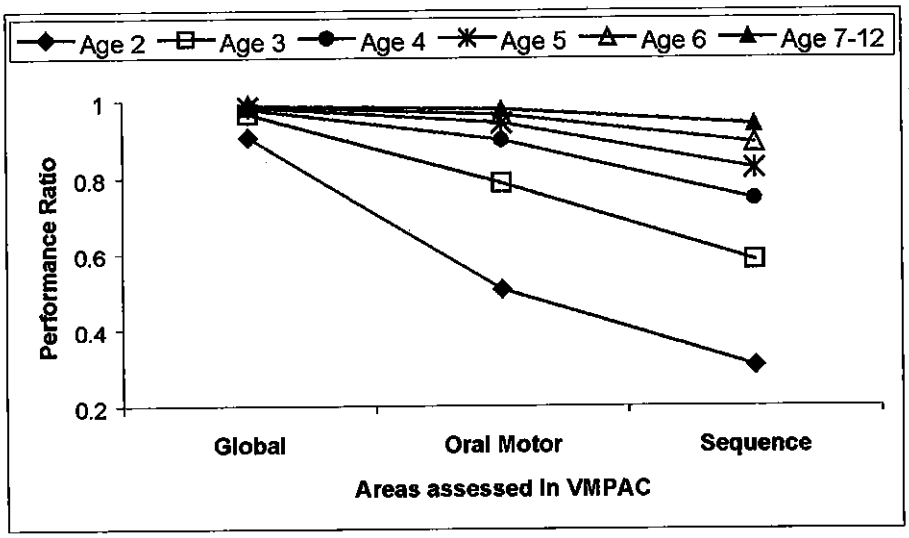

Figure 2. The performance on items on the three areas tested, GM, OM and SE for the children with normally developing speech by age group.

There was a clear age–related hierarchical progression of achievement of precision in performances in GM OM and SE in normal development. As tested by the VMPAC items, precision in GM emerges first and is generally established by age 3. Precision in the ability to control oral movement volitionally (OM) developed substantially by age 4 with further refinement until ages 6 and 7. SE precision is refined last. Development in all of the areas, however overlaps, i.e., one area does not achieve complete refinement before development in the subsequent area begins. All areas appear to develop concurrently but complete mastery within each of the three domains appears at successively older ages.

Performances of Speech Disordered Children Compared to Normal

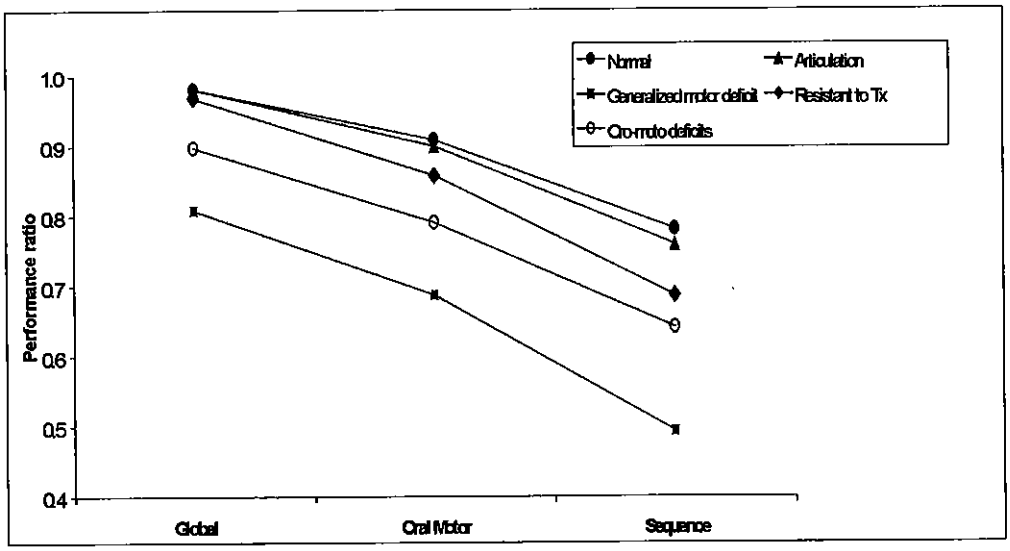

Figure 3. The performances of each speech-disordered groups compared to their age-counterparts with normally developing speech with regard to GM, OM and SE performances.

Results of the performances of the 394 children with moderate to severe articulation-phonological disorders of speech indicate that many children with developmental speech disorders are delayed with regard to the acquisition of motor speech competencies. Children with speech disorders and accompanying generalized motor disorders showed markedly delayed profiles while children with speech disorders accompanied by nonspeech oral motor imairments such as drooling showed a group profile that was less delayed. Children with developmental speech

disorders that are resistant to treatment were impaired to a lesser degree than the two groups of speech-disordered children with frank motor impairments but perform inferiorly to children with speech that is normally developing. Finally, children with articulation and/or phonological disorders that are amenable to treatment were least impaired in their abilities to perform these clinical items. Nonetheless, the later group of speech-disordered children demonstrated performances on both OM and SE items were inferior to those of children with speech that was normally developing.

Discussion

The purposes of this study were to investigate the emergence of skills typically assessed in motor speech batteries in young children with normally developing speech and in children with moderate to severe speech disorders. Results indicated that in children with normally developing speech a group pattern of emergence of competencies was identified. By the age of three, children with normally developing speech have acquired basic control competencies associated with trunk and neck control and respiratory and phonatory support for speech. Basic control competencies for precision of volitional speech and nonspeech movements of the articulatory subsystems-jaw, lips and tongue- are not observed until age 4 and refinements of these movements as indicated by decreased variability in performances continues until age 7. These findings are accordance with those previously reported of Robbins and Klee (1987).

Minimal competencies for sequencing alternate movements of speech are acquired last by children with normally developing speech and appear to continue to be refined through late childhood. Although this study tested ability to sequence speech movements in a manner different from maximal performance rates for /p t k /, similar results have been reported by Fletcher (1992) and others. The results of the systematic testing of 1090 children with normally developing speech in the three areas of GM, OM and SE provide further validation of the hierarchical model of development of motor speech skills put forth by Hayden and Square (1994) (See Figure 1)

Speech-disordered children demonstrated performances on this clinical battery that followed the patterns observed in normal development but that were significantly delayed. Speech-disordered children who had frank accompanying motor impairments, i.e., those with generalized motor and oral motor impairments, demonstrated dramatically delayed profiles. As a group, children with phonological/articulation disorders that were resistant to treatment demonstrated less delayed emergence than the children with frank accompanying motor impairments; nonetheless, 60% of the children in this group demonstrated delayed performances. This latter finding suggests that speech motor control impairments are frequent in this group. As a group, children with phonological/articulation impairments amenable to treatment also demonstrated delayed-acquisition speech-motor control profiles but to a far lesser degree. In the latter group, delays especially in the areas of OM and SE control were evident, but only among 25% of the members of this group. In that many children with articulation/phonological impairments performed dissimilarly to children with normally emerging speech, kinematic analyses, particularly on the OM and SE tasks should be undertaken. Because the results of this clinical investigation revealed the likelihood that many children with articulation/phonological disorders are delayed with regard to speech motor control, kinematic studies are the next logical step required to validate these results. In addition, kinematic studies reveal more about the nature of speech movement control disruptions in children with articulation/phonological disorders and may lead to different rehabilitation approaches for some children with this diagnosis.

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