



## DIAGNOSIS OF CHILDHOOD APRAXIA OF SPEECH: A SYSTEMATIC REVIEW

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### ABSTRACT

*This review employed to establish frequency usage of clinical markers and diagnostic tests for childhood apraxia of speech. following databases were searched for published papers between 1980 and 2015 looking for clinical studies used the six introduced tests for motor speech performance; Web of Science, Scopus, CINAHL and Pubmed. . The review considered articles which for children at or below elementary school age with diagnosis of childhood apraxia of speech. Fifty seven articles met the inclusion criteria. Studies included other developmental motor speech disorders as well as childhood apraxia of speech were excluded. Twenty four articles excluded from the study and thirty three studies were reviewed. Twenty articles were in diagnostic tests and thirteen articles were in clinical markers. The Verbal Motor Production Assessment for Children is the most reliable diagnostic test for diagnosis of childhood apraxia of speech, and Inconsistency as well as vowel errors are the most frequent clinical markers.*

**Keywords:** Childhood apraxia of speech, Diagnostic tests, Clinical markers.

### 1. INTRODUCTION

Childhood apraxia of speech (CAS) is a developmental motor speech disorder which is described by variable errors in speech production. The produced words by children with CAS are with inconsistency including correct and incorrect forms. The most accepted theory for the underlying deficit of CAS is deficits in motor planning of speech production [1].

Diagnosis of CAS is controversial and there are two methodologies in clinical studies of CAS [2]. The first group of studies uses behavioral markers like variable errors in repeated words and inappropriate stress [3-7] but the number of introduced diagnostic markers is more than eighty and there are also disagreements on main features of CAS.

The second group of studies uses standardized diagnostic tests for diagnosis of CAS. McCauly and Strand [8] did a review on standardized tests of speech motor performance in children. They introduced six published tests; Screening Test for Developmental Apraxia of Speech (STDAS) [9] the Kaufman Speech Praxis Test for Children (KSPT) [10] the Apraxia Profile (AP) [11] the Verbal Motor Production Assessment for Children (VMPAC) [12] the Oral Speech Mechanism Screening Examination (OSMSE) [13] and the Verbal Dyspraxia Profile (VDP) [14]. Table 1 presents detailed characteristics of these selected diagnostic tests.

Table-1. Purposes and administration factors of the six selected tests

| Test  | Purpose                      | Age range (years; months) | Administration time (minutes) |
|-------|------------------------------|---------------------------|-------------------------------|
| AP    | Diagnosis                    | 3;0-13;11                 | 25-35                         |
| KSPT  | Diagnosis/Treatment planning | 2; 0-6; 0                 | 5-15                          |
| STDAS | Diagnosis                    | 4;0-7;11                  | 15                            |
| VMPAC | Diagnosis/Treatment planning | 3; 0-12; 0                | 30                            |
| OSMSE | Diagnosis                    | 5; 0- 78; 0               | 5- 10                         |
| VDP   | Diagnosis/Treatment planning | 4; 0- 7; 0                | 10-60                         |

Therefore, introduced diagnostic tests as well as behavioral markers are used in clinical studies, but the frequency of employment of each methodology is unclear. In order to clarification of process of CAS diagnosis, it is necessary to determine the employment of each diagnostic methodology in clinical studies. The main purpose of this study was to review on published articles tracking the employment of these two approaches of diagnosis of CAS in clinical field.

## 2. METHODS

### 2.1. Search Strategy

Articles published between January 1980 and January 2015 was located through searches of four sources: Web of Science, Scopus, CINAHL and Pubmed. The primary keyword was "Childhood apraxia of speech". This keyword OR "Developmental dyspraxia", "Developmental apraxia", "Childhood dyspraxia", "Childhood apraxia" used AND the name of six introduced tests and clinical markers. The only filter was "children". Reference lists of articles thus identified were examined.

### 2.2. Inclusionary/Exclusionary Criteria

The articles which addressed children at or below elementary school age were included for review. From these articles, the studies which were not focused on CAS and included diagnosis of other motor speech disorders in children were excluded.

### 2.3. The Review Process

Selected articles were reviewed looking for information about the frequency of employment of introduced tests and clinical markers for diagnosis the subjects.

## 3. RESULTS

Fifty seven articles were found. Twenty one articles were used clinical markers and thirty six articles were used introduced tests. Twenty four articles met the exclusionary criteria (Nineteen articles in introduced tests and five articles in clinical markers) and were excluded from the study. Finally, thirteen articles in clinical markers and twenty articles in diagnostic tests were reviewed.

### 3.1. Clinical Markers

The diagnostic markers used in reviewed articles were summarized in Table 2. The Decreasing order of clinical markers is inconsistency, vowel errors, prosodic abnormalities, difficulty in complex sequences, consonant and syllable omission, inadequate didochokinetic profile, groping, intelligibility, limited phonetic repertoire, and reduced expressive language.

Table-2. Clinical markers in reviewed articles

| Markers                           | Studies                     |
|-----------------------------------|-----------------------------|
| Prosodic abnormalities            | [15-20]                     |
| Vowel errors                      | [17, 18, 20-23]             |
| Consonant and syllable omission   | [17-20, 22]                 |
| Inadequate didochokinetic profile | [22, 24-26]                 |
| Groping                           | [22, 24, 27]                |
| Intelligibility                   | [21, 22]                    |
| Difficulty in complex sequences   | [20, 22-25]                 |
| Inconsistency                     | [15, 17-20, 22, 23, 25, 28] |
| Limited phonetic repertoire       | [20]                        |
| Difficulty in imitating speech    | [19, 20, 27]                |
| Reduced expressive language       | [20]                        |

Twenty articles used standardized tests for diagnosis of CAS. The content of selected articles was summarized in Table 3.

Table-3. Standardized tests in reviewed articles

| Test  | Studies     |
|-------|-------------|
| STDAS | [29-33]     |
| KSPT  | [31, 34-36] |
| AP    | [37-39]     |
| VMPAC | [40-48]     |
| OSMSE | [49]        |

As it is observed in Table 3, VMPAC has been the most frequent test by eight articles, STDAS and KSPT have been used in five articles and AP in three articles. The least frequent test was OSMSE by one article. No article was found which used VDP for diagnosis of CAS.

#### 4. DISCUSSION

Diagnosis of CAS is controversial and there are disagreements on determining the best approach for diagnosis of CAS. In the present study, thirty three articles were reviewed looking for approaches of diagnosis of CAS. The results showed standardized tests have been used more than behavioral markers in clinical studies since 1980. Twenty of reviewed articles have used standardized diagnostic tests for CAS. The most frequent test was VMPAC and after that KSPT, STDAS, AP and OSMSE. No article was found for VDP. [McCauley and Strand \[8\]](#) have suggested that the most influential factor in clinical decision is psychometric data. The VMPAC is the only diagnostic test which has reliable normative data.

Clinical markers for diagnosis of CAS have been used by thirteen articles. [Forrest \[6\]](#) investigated the performance of clinical markers by speech therapists but there was not a specific marker among clinicians. In this study Inconsistency and vowel errors were the most employed behavioral markers, but Inconsistency is a vague marker. It is also observed in other developmental speech disorders including inconsistent speech disorder and subclinical dysarthria [\[39\]](#). Vowel errors marker plays a complementary role in differential diagnosis of CAS. Inconsistency and vowel errors could use as differential diagnostic markers for CAS.

VMPAC contains subtests for inconsistency and vowel errors. In fact, this diagnostic test covers the frequent behavioral markers and could be used as a gold standard for clinical studies of CAS. Therefore, VMPAC is the link of two methodologies.

## 5. CONCLUSION

According to reviewed articles in CAS, standardized tests are used more than clinical markers. VMPAC is the most reliable diagnostic test for diagnosis of childhood apraxia of speech, and Inconsistency as well as vowel errors are the most frequent clinical markers.

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