Research Paper

Assessment and Treatment of Childhood Apraxia of Speech: An Inquiry into Knowledge and Experience of Speech-Language Pathologists

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ABSTRACT

Objectives: The present research aims to identify the assessment and treatment processes used by Iranian Speech-Language Pathologists (SLPs) for Childhood Apraxia of Speech (CAS) and investigate the impact of their knowledge level and experience on their choice of assessment and treatment.

Methods: This research is a cross-sectional study using a survey design conducted on 260 SLPs with a minimum of a Bachelor's degree and at least one year of experience of working with preschoolers. The CAS assessment and treatment were measured by a validated questionnaire, which was completed in person or online.

Results: The tests of Diadochokinesis (DDK) (66%), single-word speech sampling (58.1%), oral-motor assessment (54.6%), and connected speech sample analysis (53.1%) were the popular tests chosen by the participants. The treatment approaches indicated that Oral Motor Exercises (OMEs) (57.7%) were the only treatment for which over half of the participants voted. The experts chose phonologically-based treatments and Integrated Phonological Awareness (IPA), but the less-experienced participants were more interested in PROMPT (prompts for restructuring oral muscular phonetic targets). The majority of the participants (70.8%) believed that children with CAS make very slow progress and 21.9% declared that speech problems of such children persist through the school years.

Discussion: The participants' choice of assessment tasks is in line with the results of recent studies. However, opting for outdated treatments such as OME indicates a gap between the clinicians' knowledge and experience in using evidence-based treatments.

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Highlights

● Consistent with international studies, the Iranian Speech-Language Pathologists (SLPs) prioritized Diadochokinesis (DDK), single-word speech sampling, oral motor assessment, and connected speech analysis in diagnosing Childhood Apraxia of Speech (CAS).

● In the present inquiry, most participants prioritized Oral Motor Exercises (OMEs) as the main intervention approach for treating CAS; however, there is no convincing evidence to support its use.

Plain Language Summary

Children with CAS are far from being a homogenous population. This study surveyed the SLPs' clinical experience in evaluating and intervening in the speech problems of this group of children. The present study results showed that although there is no clear guideline for identifying actual cases of CAS, Iranian clinicians follow the correct route aligned with the scientific findings. Research findings suggest that insufficient university training or professional development courses may use outdated treatments in managing CAS.

1. Introduction

Childhood Apraxia of Speech (CAS) is a neurological speech sound disorder targeting the accuracy and consistency of speech movements without notifying any neuromuscular defects [1]. Because of the overlap between the speech characteristics of this disorder and other Speech Sound Disorders (SSDs), Speech-Language Pathology (SLP) faces numerous challenges in the differential diagnosis. The absence of a standard evaluation process, which harbors a host of clinical decisions such as diagnosis, determining the intensity, prognosis, and treatment planning, is the major problem in the differential diagnosis of CAS [2].

An overview of different evaluation methods in CAS

Through a systematic review, Gubiani, Pagliarin, and Keske-Soares (2015) [3] explored the available diagnostic tests for CAS. Their results indicated that a few tests had been designed for CAS, and there are very few international studies on the subject. None of the formal evaluation tools have psychometric specifications to evaluate CAS except for Dynamic Evaluation for Motor Speech Skills (DEMSS) [3]. The previous SLP surveys have revealed that in countries with languages other than English, informal or self-made assessment tools are commonly used. Proofs of this finding could be maximal administration of informal assessments by South African SLPs [4], US SLPs [5], and Swedish SLPs [6]. Murray et al. suggested the polysyllabic word test and oral-motor examination containing Diadochokinesis (DDK) to identify CAS with 91% of confidence [7].

Regarding CAS evaluation methods, SLP surveys are restricted to only two studies. Dawson considered the assessment and treatment for CAS in children with autism by 132 American SLPs and noted that at least half of the participants implemented the assessments of connected speech, oral mechanism test, DDK, and imitation of polysyllabic words. They also tended to use informal scales, probably due to the difficulty of performing formal evaluations for children with autism [5]. A Swedish survey, on the other hand, reported a variety of choices on assessment methods indicating an incongruence of opinions among Swedish clinicians. Nearly half of the Swedish SLPs used formal perceptual analysis plus oromotor assessment, and the rest chose their assessment based on their perception of what the origin of CAS might have been, namely, motor-based or language-based. Moreover, only half of them had diagnosed and assessed CAS, among which nearly two-thirds were confident about their approach [6].

An overview of treatment approaches for CAS

Since the American Speech-Language-Hearing Association (ASHA) technical report of 2007 somehow settled a part of disagreements over CAS, instances of CAS studies have risen drastically, and different treatments have been proposed for the disorder. Review articles have categorized treatment approaches into three groups of motor treatments, linguistic approaches, and Augmentative and Alternative Communication (AAC) [8]. The most outstanding evidence-based treatment approaches are summarized in Table 1.

Table 1. Varying treatment approaches to CAS and the research results on each

Therapy Type	Intervention Approach	Cases With Reported Effect	Measures	Judgment of Certainty
Motor-Based	Integral stimulation/DTTC	11/13	Accuracy	Preponderant
	Combined MIT with TCM	1/1	PVC/PCC/PMLU/PWP/PWC	Suggestive
	ReST	3/3	Perceptual stress marches	Preponderant
Linguistic-Based	IPA	11/15	Suppression of process usage PA accuracy	Preponderant
	Combines STP with mCVT	4/4	PCC	Suggestive
			Phones added to inventory	
			Inconsistency decrease	
AAC	Modeling with board	4/4	Morpheme accuracy	Suggestive
	Computer-based AAC	1/1	Multisymbol messages	Suggestive
			Accuracy in:	
			Book reading	
			Discourse	

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DTTC: Dynamic Tactile and Temporal Cueing; MIT: Melodic Intonation Therapy; TCM: Tactile Cueing Method; ReST: Rapid Syllable Transition; IPA: Integrated Phonological Awareness; mCVT: modified Core Vocabulary Treatment; PVC: Percentage of Vowels Correct; PCC: Percentage of Consonant Correct; PMLU: Phonological Mean Length of Utterance; PWP: Proportion of Whole-Word Proximity; PWC: Percentage of Word Correct; PA: Phonological Awareness.

Regarding CAS treatment, SLP surveys are limited to just two choices. AAC and PROMPT (prompts for restructuring oral muscular phonetic targets) were the two treatment approaches used more extensively by US clinicians for children with autism suspecting CAS. The study findings indicated that few participants used integral stimulation, and nearly one-third of them implemented Oral Motor Exercises (OMEs) [5]. In a more recent survey on CAS treatment, Gomez, McCabe, and Purcell reflected the preference of SLPs from Australia and New Zealand for eclectic treatments, while the treatment efficacy in CAS cases has not been proved empirically. It is worth mentioning that the most common treatment in Australia is reported to be a Nuffield Dyspraxia Program [9].

Prognosis of CAS

Because clear results of CAS prognosis are not handy in the literature, the oral reports of therapists on the considerable challenge of treatment have been used as the last resort. In a Swedish survey, the majority of the respondents believed that children with CAS improve rather slowly. The majority of participants voted for the constancy of speech results at school age; more than half of them, as well, reported the children resisted treatment and had a backslide of the symptoms after a remission period [6].

Speech-language pathology faces immense challenges in the valid differential diagnosis between CAS and other Speech Sound Disorders (SSDs). Major reasons could be the absence of a standard evaluation process and distinct inclusion criteria to identify such children.

The body of research in Iran is desperate for studies on the identification, formal assessment, and treatment of CAS. Since using the clinical experience of SLPs in clinical decision-making is of sublime diagnostic and treatment values, investigating the assessment and treatment approaches of children with CAS in the absence of formal assessments in Persian seems mandatory. Thus, investigating Iranian SLPs' performance regarding the evaluation and treatment of CAS was the purpose of this research. It was expected that the viewpoints of the practicing SLPs participated in the present survey, along with international study results, would set the grounds for helping researchers design appropriate assessment packages in Persian.

Consequently, the present study intends to answer the following questions: What are the assessment and treatment approaches used by Iranian SLPs regarding CAS? What is the relationship between their knowledge and years of experience? For what assessment and treatment approach do they opt? How confident are they about the assessment and treatment approaches they choose? And what prognosis do the participants assume for children with apraxia?

2. Materials and Methods

Study participants

This cross-sectional study implemented a researcher-made questionnaire to access the knowledge and experience of Iranian SLPs regarding the assessment and treat-

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ment of CAS. The inclusion criteria for participating in the study were holding a minimum Bachelor's degree in speech-language pathology and at least one year of experience working with preschoolers. The questionnaires were excluded if they were filled out incompletely, not completed by a practicing SLP, and if the participants were not treating preschool children.

Questionnaire development

The initial draft of the questionnaire was developed via a literature review [4, 6, 10]. A group of 10 SLP experts in the field of CAS evaluated the face and content validity of items. The Content Validity Ratio (CVR) was found to be acceptable (>0.62) for most items except 3 questions which were rated as "not necessary" by more than half of the experts and thus were omitted from the instrument. The final version of the questionnaire included 18 items with different questions: yes/no, Likert-type scale, short answer, and multiple-choice questions. Questions 1 to 6 asked about the demographic information, including educational background, years of clinical experience, place of work, the work setting, and passing or not the CAS course. Questions 7 to 9 targeted the amount of CAS referrals and caseloads of the participants. The clinicians' knowledge of the definition and etiology of the CAS was assessed through two multiple-choice questions based on definitions provided by the ASHA (Qs 10-11). The four multiple-choice questions check the participants' knowledge and experience regarding CAS disorder included choosing speech characteristics of CAS (from the 14 speech features from the literature) (Q 12), choosing the co-occurring problems (Q 13), choosing common test(s) appropriate for CAS from 10 common SSD tests (Q 14), choosing a treatment approach or approaches currently in practice (from eight treatment approaches) (Q 15), and choosing prognosis of children with CAS (from the provided four items) (Q 16). The participants were also asked to rate their ability to diagnose and treat the disorder based on a 5-point Likert scale ranging from the least confident to the most confident (Qs 17-18). The questions regarding assessment, treatment, and prognosis of the CAS are considered in this article.

Study procedure

The questionnaires were distributed among SLPs either in print at the workshops and conferences or online (hosted on http://www.cafepardazesh.ir). They were accompanied by a letter explaining the study subject and objectives. SLP participants were invited via email or social media posts by the Iranian Scientific Association of Speech-Language Pathology among practicing mem-

bers, allowing a 3-month response time. A total of 260 questionnaires, according to the inclusion criteria, were rendered valid for analysis.

Statistical analysis

Data analysis, including descriptive and inferential statistics, was conducted using SPSS software v. 20.0. Descriptive statistics (frequency and percentage) were used to illustrate the characteristics of the participants and their knowledge of CAS assessment and treatment. The inferential statistics (bivariate analysis, the Chi-square) were performed to investigate any possible significant relationships between the study variables. The level of statistical significance was set at $P<0.05$.

3. Results

The results of the addressing questions of the study are presented under the three subtitles of assessment methods, treatment approaches, and prognosis.

Study participants

The participants were 179 Bachelor's holders, 61 Master's holders, and 20 PhD holders in speech therapy. They were divided into three groups: less-experienced (one to three years of experience, n=107), experienced (four to ten years of experience, n=95), and expert (more than ten years of experience, n=58) [10]. The participants came from different clinical settings, including hospitals (14.6%), general or daily rehabilitation centers (17.3%), public speech therapy clinics (8.7%), private speech therapy clinics (62.3%), exceptional schools (20.4%), and other places (8.8%). The participants' characteristics are summarized in Table 2.

Results of assessment methods

Of the ten considered tests used to diagnose SSDs, eight demonstrated sufficient reliability and validity in Persian. The frequency of each assessment voted by the participants is presented in Figure 1. DDK test was the main CAS assessment task with 66% of the votes, and the articulation test [11] displayed the least favorability, with 18.8% voting. Selecting the type of assessment task was not significantly related to educational level, but the relationship between work experience and using DDK and inconsistency test [12] proved to be significant. Both DDK (χ^2=8.840, P<0.01) and inconsistency (χ^2=9.062, P<0.01) tests were selected mainly by the less experienced SLPs. However, those confident participants

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Table 2. Characteristics of respondents (N=260)

Characteristics		Frequency of Respondents (%)
Level of education	Bachelor	68.8
	Master	23.5
	PhD	7.7
Work experience	1-3 years (less-experienced)	41.2
	4-10 years (experienced)	36.5
	Above 10 years (expert)	22.3
Work setting	Hospital	5.4
	University hospital	9.2
	Rehabilitation center	17.3
	Public speech therapy clinic	8.8
	Private speech therapy clinic	62.3
	Exceptional school	20.4
	Other working places	8.8
Diagnosed children with CAS	Yes	87.7
	No	12.3

about their diagnosis tended to select the articulation test (χ^2=19.881, P<0.001).

Results of treatment approaches

Among the eight approaches presented as the common SSD and CAS treatments, OMEs (57.7%) were the most selected, and Rapid Syllable Transition (ReST) (18.8%) was the least favored. Table 3 presents SLPs' frequency of use of treatment approaches. Regarding the treatment preference, only traditional articulation therapy [13] was negatively correlated with educational level. Compared to others, participants with a BA degree tended to go for traditional articulation therapy for CAS intervention (χ^2=4.668, P<0.009). Investigations on the relationship between work experience and treatment approaches revealed that only phonologically based approaches, PROMPT, and Integrated Phonological Awareness (IPA) significantly correlated with work experience. The experts placed a high priority on selecting phonologically-based approaches (χ^2=13.827, P<0.001) and IPA (χ^2=28.254, P<0.0001), whereas the

Table 3. Frequency of votes on each CAS treatment approach as decided by the SLPs participating in the research (N=260)

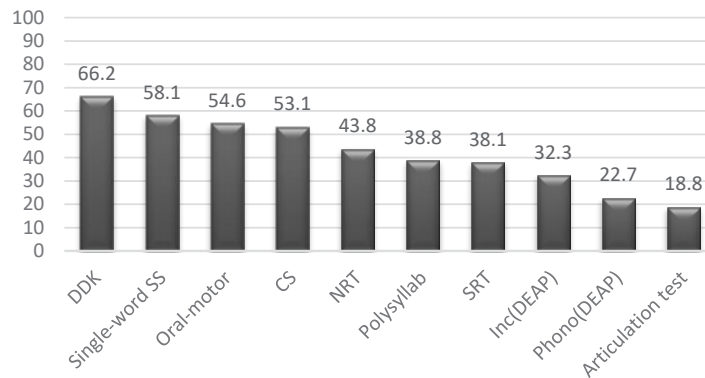| Treatment Approaches	Frequency of Respondents (%)
Non-Speech Oral Motor Exercises (NSOMEs)	57.7
PROMPT	46.5
Core Vocabulary Treatment (CVT)	41.2
Traditional articulation therapy	35
Dynamic Tactile and Temporal Cueing (DTTC)	28.1
Integrated Phonological Awareness (IPA)	28.1
Phonologically based treatments	21.9
Rapid Syllable Transition (ReST)	18.8

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Figure 1. Frequency of votes on each test as decided by the survey's participants (n=260)

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DDK: Diadochokinesis; Single-word SS: Single-word Speech Sampling; CS: Connected Speech; NRT: Nonwords Repetition Test; Poly-syllab: Polysyllabic word test; SRT: Syllable Repetition Test; Inc: Inconsistency test of DEAP; Phono: phonological test of DEAP

less-experienced ones had a significant inclination towards PROMPT (χ^2=21.148, P<0.0001). Interestingly, higher work experience coincided with an increase in selecting OMEs and traditional articulation therapy. The confident participants about their choice of treatment selected PROMPT, Core Vocabulary Treatment (CVT), and IPA in this order.

Results on prognosis

Participants were invited to choose one of the four options that were given to them for assessing their experiences with treatment results. Frequencies of the participants' choices regarding the prognosis of CAS disorder are presented in Figure 2. The experts had no hopes for CAS children to be treated (χ^2=5.271, P<0.0072), and those who felt confident about choosing an appropriate treatment were more certain that such children would never be cured (χ^2=35.674, P<0.0001). Although a significant relationship was not reported between educational level and CAS prognosis-related questionnaire items, the

more educated participants selected the following statement "these children reach a complete improvement".

4. Discussion

This study aimed to consider the clinical decisions of Iranian SLPs regarding CAS assessment and treatment approaches and investigate the relationship between background knowledge and experience of participants and their assessments and treatments, and their stance on the disorder's prognosis.

Assessment methods

The question of assessment methods revealed that Iranian SLPs prioritized DDK, single-word speech sampling [14], oral motor, and connected speech analysis. Selecting the task of DDK as CAS's main evaluation tool by the Iranian clinicians, especially those who had recently graduated, is consistent with the findings of Lewis et al.'s and Murray et al.'s studies and the US survey [5, 7, 15].
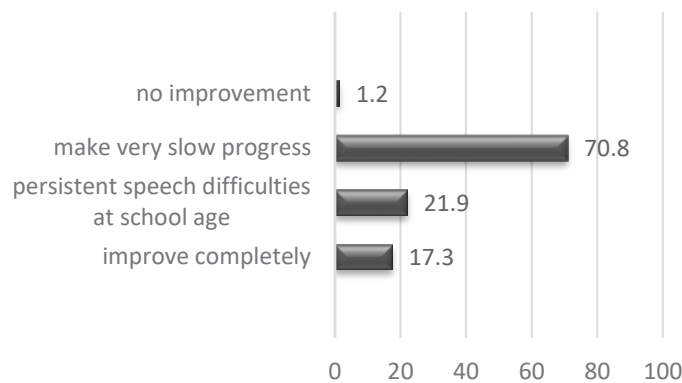

Figure 2. Frequency of votes on each CAS prognosis as decided by the participants (N=260)

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The participants placed second priority on the single-word speech sampling test, indicating that they pay close attention to the necessity of eliciting children's production information. Additionally, due to its good recognition, availability, and easy application, this test is more widely favored in Iran than Goldman-Fristoe or the articulation test.

The favorability of oromotor assessment demonstrates that clinicians have always had in mind that the oral motor problems of CAS root in motor planning deficit. In the current study, those who were quite confident about their knowledge and experience tended to choose oral motor assessment. Such a choice has been confirmed by Lewis et al., Strand and McCauley, Iuzzini and Forrest, and Murray et al. They all emphasized the importance of oromotor assessment as one of the major diagnostic approaches of CAS [7, 15-17].

In this research, favoring the task of deriving the connected speech sample indicates that Iranian SLPs are drawn to a more real sample of children's production. It is still possible that the lack of standardized tests and their availability in Iran are driving clinicians toward broader use of connected speech analysis. The same justification can be applied to Dawson's conclusion regarding the inability of children with autism to take structured tests as the probable reason for choosing connected speech analysis to diagnose CAS [5]. Further, Australian SLPs have reported that they use detailed transcription more often when recording the speech of children with CAS [18].

As it is challenging, if not impossible, to obtain and transcribe an appropriate speech sample due to the unintelligibility of the child, a polysyllabic word test has been suggested to acquire a more realistic sample of speech and induce motor challenges for the production of speech [7, 19]. Such assessment has been referred to as one of the most fundamental evaluations of CAS by Murray et al. and Dawson [5, 7]. However, almost a third of Iranian SLPs voted for the test, possibly because of the absence of formal polysyllabic words test in Iran.

Although Iranian practitioners acknowledged inconsistency as the main characteristic of CAS [20], fewer SLPs prioritized the inconsistency test of DEAP for assessment. This choice is supported by recent studies by Luzzini and Forrest, Murray et al., and Luzzini et al., which have not endorsed the validity of the DEAP inconsistency test in the diagnosis of CAS [7, 17, 21].

Treatment approaches

An abundance of treatment approaches for CAS makes it very difficult to select the appropriate one, but it is known that the top priority of choosing an approach is to eliminate the fundamental deficits. In the present inquiry, most participants prioritized OMEs, although we know that orofacial structural impairments are not associated with the CAS diagnosis, and no convincing evidence shows this treatment improves the verbal skills in such children [22]. The data analysis traced a declining trend in implementing OMEs with an increase in educational level versus an ascending trend as years of experience increased. Dawson (2010) also analyzed practitioners' ideas in their respective studies and concluded similarly, which could demonstrate experts' lack of awareness about evidence-based treatments and their inclination toward traditional approaches. Although PROMPT was Iranian SLPs' second choice and preferred treatment of US SLPs, less than one-sixth of Australian therapists reported using it to treat CAS cases [5, 9]. The treatment has certain limitations that make it usable only to certified people through passing authorized educational courses. Therefore, an increase in selecting PROMPT by respondents is due to their information acquired through reading books and articles. Choosing CVT with a high frequency by the respondents is thought-provoking. This intervention has been introduced for treating an inconsistent phonological disorder in the absence of CAS [23], and there is no evidence of using it for the treatment of CAS in the literature. The two motor-based treatments of Dynamic Tactile Temporal Cueing (DTTC) and ReST, which are highly convincing in terms of evidential resolution and generalization rigor, were chosen the least by Iranian SLPs. Gomez et al. came up with similar results and reported that less than 15% of Australian SLPs voted for the treatments mentioned above [9].

Prognosis of CAS

A high percentage of Iranian SLPs reported children with CAS as slow to improve. The majority of SLPs in the Swedish survey voted for the same concept [6]. Around one-fourth of the participants believed that the disorder persists at school age. This is what the Swedish survey portrayed with higher vote frequencies. Studies that picture such children as prone to reading, educational, social, and occupational problems also affirm and support the attained results [24, 25].

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5. Conclusion

Consistent with other countries' clinicians and recent studies, Iranian SLPs are more inclined to use informal tests, leading researchers to devise efficient and easy-to-implement assessment tools. Although it was expected that the clinicians would share their clinical experience about the efficient treatment of CAS, older treatments with low levels of evidence were reported. The reasons can be attributed to lack of information resources, lack of standardized assessments, and limited national and international CAS-related studies.

Ethical Considerations

Compliance with ethical guidelines

Human Research Ethics Committee of the University of Social Welfare and Rehabilitation Sciences approved this research (Code: IR.USWR.REC.1397.141).

Authors' contributions

Conceptualization and Supervision: Talieh Zarifian; Methodology: Nasibeh Zanjari; Investigation,Writing-original draft: Mersede Imani Shakibayi; Writing-review &editing: all authors; Data collection: Mersede Imani Shakibayi; Data analysis: All authors.

Conflict of interest

The authors of the manuscript declared no conflict of interest. The authors are responsible for the content and writing of the paper.

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