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Original Article

Speech-Language Therapy Interventions in Childhood Apraxia of Speech Aimed at Developing Functional Communication: A Scoping Review

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ABSTRACT

The treatment of Childhood Apraxia of Speech (CAS) has traditionally focused on enhancing expressive skills such as articulation and intelligibility. Although most of the available strategies promote improvements in speech production, those that improve functional communication have yet to be explored in depth. The objective of this scoping review was to compare the speech-language therapy interventions for CAS that have the most substantial literature support in terms of their focus on promoting functional communication. This review adhered to the PRISMA-ScR guidelines for scoping reviews and considered five interventions frequently mentioned in the literature: The Nuffield Dyspraxia Programme (NDP-3); Physically Restructuring Oral Muscular Phonetic Targets (PROMPT); Dynamic Temporal and Tactile Cueing (DTTC); The Kaufman Speech to Language Protocol (K-SLP); and Integrated Phonological Awareness (IPA). Furthermore, articles published between January 2015 and December 2021 were included from PubMed, WoS, LILACS, Cochrane Library, and Scopus databases. The most relevant findings indicate a lack of generalizability due to small sample sizes, hindering the extrapolation of results related to the intervention of functional communication. This represents a problem in the field of research and could be detrimental to Evidence-Based Practice. In conclusion, an eclectic and holistic approach may be more effective in the treatment of CAS; therefore, we propose a checklist aimed at assessing interventions based on their indicators of functionality.

Keywords:
Childhood Apraxia of Speech; Functional Communication; Treatment; Intervention Approaches

Intervenciones fonoaudiológicas en apraxia del habla infantil orientadas al desarrollo de la comunicación funcional: una revisión de alcance

RESUMEN

El tratamiento de la Apraxia del Habla Infantil (AHI) clásicamente se ha enfocado en favorecer las habilidades expresivas como la articulación y la inteligibilidad. Si bien, las diversas estrategias disponibles actualmente promueven mejoras en el habla, no se ha profundizado en aquellas que logran potenciar la comunicación funcional. El objetivo de la presente revisión de alcance es comparar las terapias fonoaudiológicas para la AHI con mayor sustento bibliográfico, en función de su orientación al incremento de la comunicación funcional. Esta revisión siguió los lineamientos PRISMA-ScR para revisiones de alcance, considerando las cinco terapias mayormente mencionadas en la literatura: Nuffield Dyspraxia Programme (NDP-3); Physically Restructuring Oral Muscular Phonetic Targets (PROMPT); Dynamic Temporal and Tactile Cueing (DTTC); The Kaufman Speech to Language Protocol (K-SLP); Integrated Phonological Awareness (IPA). Las bases de datos fueron PubMed, WoS, LILACS, Biblioteca Cochrane y Scopus, en el periodo que incluyó enero del año 2015 a diciembre del año 2021. Los resultados más relevantes muestran la dificultad de extrapolar los resultados por ser muestras pequeñas y por tanto difíciles de generalizar en cuanto a la orientación en la comunicación funcional. Lo anterior podría perjudicar a la Práctica Basada en Evidencia. En conclusión, es relevante seleccionar un enfoque más ecléctico y holístico para intervenir a usuarios con AHI, para lo cual se propone un checklist que permite valorar las intervenciones según indicadores de funcionalidad.

Palabras clave:
Apraxia del Habla Infantil; Comunicación Funcional; Tratamiento y Enfoques de Intervención

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INTRODUCTION

Childhood Apraxia of Speech (CAS) is a motor speech disorder diagnosed in infants who exhibit difficulties in planning, coordinating, producing, and sequencing speech sounds (American Speech-Language-Hearing Association [ASHA], 2021b; Kumin, 2013). This speech disorder has been regarded as "strange," controversial, and of low prevalence within the fields of Speech-Language Therapy, Neurology, and Pediatrics, leading to limited interest in its research. However, its prevalence has been increasing in recent years, prompting the American Speech-Language-Hearing Association (ASHA) and other language and health organizations to recognize CAS as a legitimate speech disorder (Duffy, 2012; Morgan & Webster, 2018; Murray et al., 2014; Shriberg et al., 2019). Nevertheless, both the assessment and intervention for CAS remain underexplored areas, as evidenced by the scarcity of scientific publications that meet reliability and validity criteria to guide evaluation and intervention strategies (Gubiani et al., 2015; Murray et al., 2014). Additionally, the effectiveness of most treatments has not been assessed (Souza & Payão, 2008).

Traditionally, interventions are categorized into three approaches: the motor approach, the linguistic approach, and the multimodal communication approach. The motor approach, which is likely the most evidence-based (Kent, 2004), focuses on improving the movement aspects of speech production (Maas et al., 2008; Murray et al., 2014). Some therapies of this approach include the Nuffield Dyspraxia Programme (Williams & Stephens, 2004) and the PROMPT System (Hayden, 1984). The linguistic approach centers on stimulating linguistic skills such as phonological awareness, both receptive and expressive vocabulary, and syntactic complexity. An example of an intervention based on this approach is the Integrated Phonological Awareness (IPA) program (McNeill et al., 2009a, 2009b). The multimodal approach employs strategies and methods from both the motor and linguistic approaches, such as using sign language or visual cues to support the acquisition of speech.

From a clinical perspective, choosing an approach is crucial in an intervention. Currently, this choice primarily depends on factors such as the characteristics of the individual, the specifics of the disorder, and the therapist's level of training (Souza & Payão, 2008). Regardless of the approach, there are points of consensus such as the beliefs that strategies should be repetitive and intensive (Maas et al., 2008), that the order of tasks should be by increasing complexity, and the vocabulary used in the intervention should be part of the individual's usual repertoire or functional for communication. Additionally, the progression of treatment for CAS is slow and is influenced by various factors such as the type of treatment, age, cognitive abilities, severity of the child's apraxia, and the presence of comorbid conditions. Another important factor is the experience and knowledge of the professional (Souza & Payão, 2008).

The literature analyzing treatment for CAS focuses on the severity of the disorder; consequently, interventions target the accuracy of speech production and articulatory movements (Kearney et al., 2015; Murray & Iuzzini-Seigel, 2017). It is assumed that improvements in movement and sound production result in positive outcomes in intelligibility, which serves as a measure of the level of activity (Aceituno et al., 2019), thereby enhancing the child's communication through participation in various everyday activities. This approach emphasizes a different perspective from that proposed by Evidence-Based Practice (EBP), which considers criteria and measures primarily focused on severity to assess therapy outcomes (Kearney et al., 2015). This emphasis placed by EBP on the evaluation of treatments has been recognized as one of its major limitations.

Furthermore, the analysis of a specific treatment must consider the intensity of therapy, which is contingent on the selected intervention and the type of approach used. Studies show that greater therapy intensity leads to more efficient progress. In fact, it has been proved that a minimum of two sessions per week is clinically effective (Murray et al., 2014; Namasivayam et al., 2015).

One of the functional parameters considered in speech disorders is speech intelligibility, which impacts a listener's ability to successfully comprehend spoken messages without contextual support. Additionally, it involves a child's capacity to interact with family and peers, using expressive language, receptive language, and contextual and socio-emotional factors. Consequently, intelligibility is a parameter that can affect the functional communication of individuals with CAS.

Some methods for assessing intelligibility have been described such as the Intelligibility in Context Scale (ICS) (McLeod et al., 2012) and The Focus on Outcomes of Communication Under Six (FOCUS) (Thomas-Stonell et al., 2010). However, these measures have not been frequently used as parameters for evaluating the effectiveness of treatment in infants with CAS. In fact, to the authors' knowledge, the only published study that has used the intelligibility parameter from FOCUS or the ICS is that of Namasivayam et al. (2015), where FOCUS was one of the measures used to evaluate the treatment.

The concept of functional communication, although not frequently found in the literature on Childhood Apraxia of Speech (CAS), refers to the skills and knowledge an individual employs to meet the communicative demands of their environment (ASHA, 2021a). Various competencies and knowledge areas influence functional communication. These competencies can take different forms and are interrelated with psychosocial factors, facilitators, and barriers that impact the functionality of communication (Barty et al., 2016; Choi et al., 2018; Light, 1989; Light & McNaughton, 2014).

Scientific literature analyzing interventions for CAS has not considered functional communication. However, some authors incorporate functional communication in their interventions, even if merely mentioning the concept (Mahoney, 2015; Morgan et al., 2018; Murray & Iuzzini-Seigel, 2017). Such studies do not clearly elucidate which therapies align with current paradigms in speech-language therapy, where functional communication is regarded as one of the primary goals of intervention.

The purpose of interventions for CAS should focus on improving communication and the participation of children in daily experiences and activities. In fact, this focus has been oriented toward intelligibility, without considering the effects of therapy on a relevant aspect such as functional communication. Thus, the analysis of the usefulness of an intervention transcends the level of "disturbances" and adopts a more holistic perspective on the functionality achieved through treatment (Enderby, 2014; Simeonsson et al., 2012).

Therefore, this research aims to analyze interventions that could be effective and beneficial. Additionally, it examines whether the interventions align with the following aspects: a) the contemporary needs of patients with Childhood Apraxia of Speech (CAS) in Chile, b) current health and rehabilitation parameters, and c) the biopsychosocial model. One of the primary goals of intervention in this regard is functional communication (World Health Organization [WHO], 2001).

Considering the above, the question of this study is: what interventions for CAS described in the scientific literature are oriented toward functional communication?

A scoping review is proposed to compare some of the treatments that are most contemporary and supported by the literature in order to establish their impact on functional communication. The objectives are as follows:

1. To highlight speech-language therapies for CAS that are focused on increasing functional communication.
2. To compare the CAS approaches based on the criterion of functional communication.
3. To evaluate the quality of the selected studies.

METHODOLOGY

A scoping review was conducted according to the criteria established by the PRISMA ScR guidelines for scoping reviews (Tricco et al., 2018). The PRISMA ScR checklist is available in Appendix 1.

Search Strategy

The search in this scoping review was conducted on the databases US National Library of Medicine National Institutes of Health (PUBMED), Web of Science (WOS), *Literatura Latino-Americana e do Caribe, em Ciencias da Saúde* (LILACS), Cochrane Library, and Scopus. The analyzed period spanned from January 2015 to December 2021. The initial search syntax included the components "intervention," "childhood apraxia of speech," and "functional communication." However, this approach, considering their word families and terms from the Medical Subject Headings (MeSH) and the Health Sciences Descriptors (DeCS), yielded excessively broad results (over 500 articles) that were not particularly relevant to the research purpose. Consequently, the search strategy was modified to focus on the most commonly used interventions in clinical practice and those most frequently reported in the scientific literature (initial search). Five interventions were selected: Dynamic Temporal and Tactile Cueing (DTTC), Nuffield Dyspraxia Programme - Third Edition (NDP-3), Physically Restructuring Oral Muscular Phonetic Targets (PROMPT), Integrated Phonological Awareness (IPA), and The Kaufman Speech to Language Protocol (K-SLP). The terms used in each database consisted of the full name of the therapy approach combined with the boolean operator OR, its abbreviation, AND "Childhood Apraxia of Speech," OR "CAS."

Inclusion and Exclusion Criteria

The inclusion criteria defined for the selection of studies were: a) articles published between January 2015 and December 2021; b) studies reporting interventions with a motor, linguistic, or multimodal focus that impact functional communication; c) patients under 18 years old with a diagnosis of Childhood Apraxia of Speech (CAS) undergoing intervention; d) articles in English or Spanish; and e) studies presenting internal and external validity. The exclusion criteria were: a) articles older than 6 years; b) articles that do address a CAS diagnosis; c) articles that do not

address therapy or treatment for CAS; and d) documents corresponding to protocols, theses, and grey literature.

Data Extraction

All articles identified in the previously mentioned databases were imported into Mendeley software (version 1.19.4). Following the location and filtering by limits, titles, and abstracts were read to apply the inclusion and exclusion criteria. Each manuscript was evaluated independently by two of the authors. When discrepancies arose, a third reviewer-author acted as a judge to reach a consensus. This consensus was achieved for only 6 articles. Finally, it is noteworthy that for data extraction, the most relevant information from the papers was organized into tables presented in the results of this study.

Study Validity Assessment Tools

The internal and external validity, as well as the impact of the results, were determined based on the guidelines from Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) and the Critical Appraisal Skills Programme (CASP) in Spanish to assess the level of evidence and the degree of recommendation of the studies (Sackett & Wennberg, 1997).

RESULTS

Literature Search

The search process is illustrated in Figure 1, showing the PRISMA-ScR flow diagram (Tricco et al., 2018). A total of 227 articles were identified, and 213 remained after duplicates were removed. Subsequently, a screening process was performed, resulting in 109 articles selected for eligibility assessment. From this selection, 91 were excluded for not meeting the inclusion criteria, leaving 18 articles for full-text analysis. Finally, after further filtering, 7 articles were included for qualitative analysis.

The most relevant aspects extracted from each study are summarized below. The results are considered in terms of their usefulness for addressing the objectives and research questions of this work (Table 1).

Study Validity Assessment

The relevant CASP and STROBE guidelines for each type of text were used for the critical analysis of the 7 articles included in this scoping review (Table 2). The type of study, internal validity, external validity, impact, degree of recommendation, and level of evidence of the articles were determined. Additionally, the degree of recommendation and level of evidence were evaluated based on only 6 articles, as one study is quasi-experimental (Murray et al., 2015), which does not apply to the parameters for the degree of recommendation and level of evidence (Sackett & Wennberg, 1997).

The overall results, excluding the quasi-experimental study, indicate that of the six articles, three present descriptive observational studies, which were rated with a low degree of recommendation (D). The other three studies were rated with the highest degree of recommendation (A), with one of them achieving a level of evidence of 1b.

Finally, the analysis of various therapies is presented, in relation to their impact on the functional communication of patients with CAS. These results were extracted from the information provided by the seven scientific articles concerning the different interventions and approaches. The details of this analysis are presented in the discussion (Table 3).

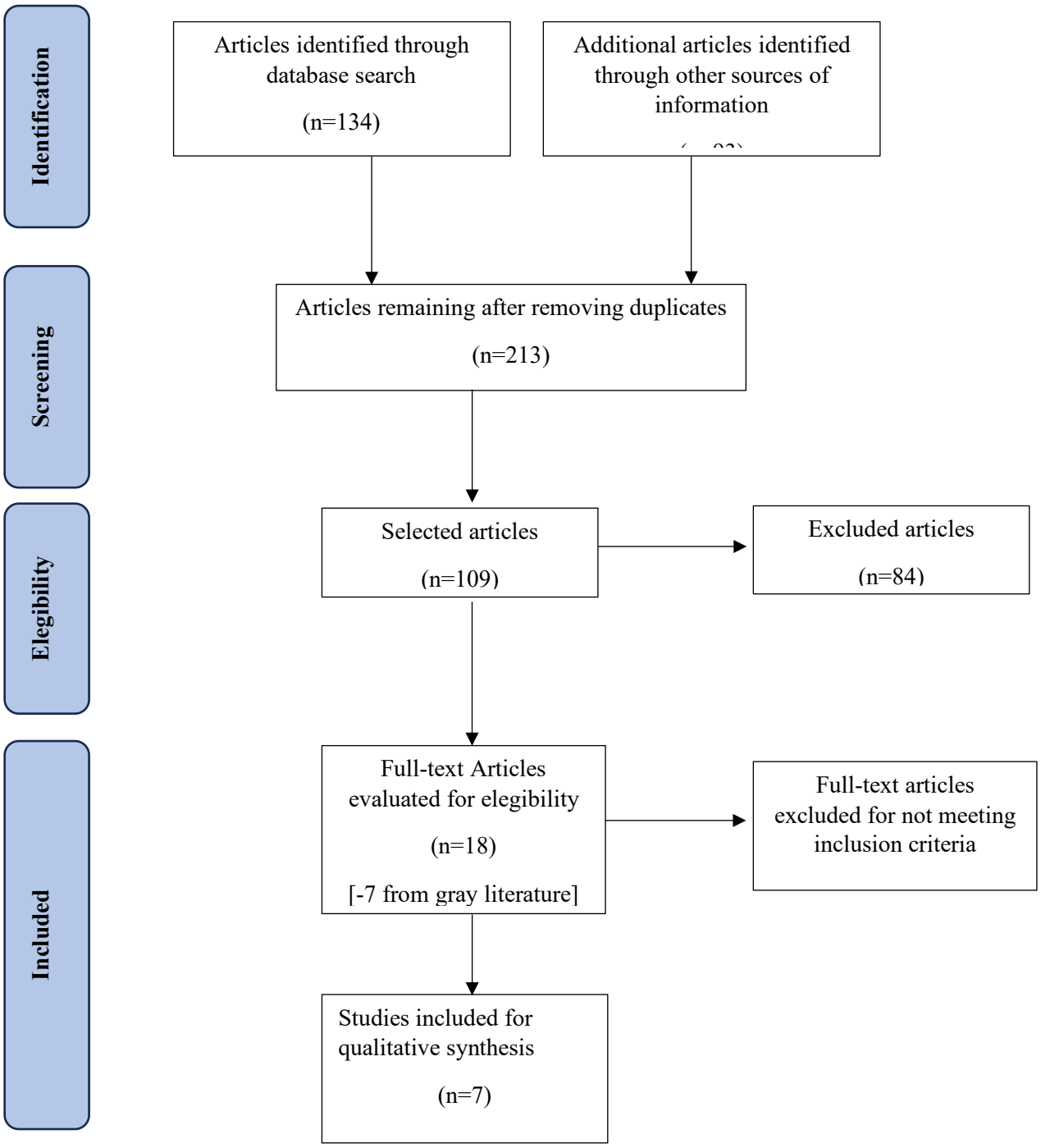

Figure 1. PRISMA Flow Diagram.

Table 1. Summary of the selected articles.

N°	Reference	Objective	Population/Comparison Group/Included Documents	Measurement Instruments	Most Relevant Results
1	(Bahar et al., 2022)	To examine the effectiveness of teletherapy compared to in-person therapy to treat CAS.	Scientific articles published between 1993 and 2020 on the effectiveness of online therapy for CAS in people under 18 years old, with selection criteria published in English.	Does not apply	– One of the selected studies showed that ReST has similar outcomes when delivered online and in person. – The second study provided preliminary evidence on the use of Tablet applications to complement the NDP3 online intervention.
2	(Gomez et al., 2019)	To describe the therapeutic approaches used by speech-language therapists to intervene CAS: Exploring their perspectives of evidence-based practice and identifying the perception of SLT about barriers to empirically implement recommendations.	Speech-language therapists who have worked with children with CAS	– 68-Question Questionnaire.	– 138 surveys started, with only 109 validated and analyzed for the study. – Most of the speech-language therapists indicated they worked in the private sector (51%) or in both (public and private). – The majority (91%) reported they worked with children treating various pathologies. 86% indicated working with between 1 and 5 children with CAS per year. – Speech-language therapists frequently provide traditional, in-person therapy for CAS (97%). – When asked how often they used different interventions with diverse levels of evidence, the results were: 88% do not use NSOME for its lack of scientific evidence. 89% do not use PROMPT due to lack of training. 68% have never used MIT. 50% have never used Biofeedback. – Regarding barriers identified for evidence-based practice, some SLTs indicated that the evidence level was not enough to implement some interventions. On the other hand, around one-fifth of the participants mentioned that they did not feel confident enough to judge the quality of the research on different interventions.
3	(Morgan et al., 2018)	To evaluate the efficacy of interventions focused on speech and language in children and adolescents with CAS, delivered by	Experimental Studies: Randomized clinical trials and non-randomized clinical trials (quasi-experimental) in children between 3 and 16 years diagnosed with CAS by speech therapists or linguists.	Does not apply	– Only one randomized clinical trial was included, belonging to the University of Sydney's International Development Fund: Murray, E., McCabe, P., & Ballard, K. J.(2015). A Randomized Controlled Trial for Children with Childhood Apraxia of Speech Comparing Rapid Syllable Transition Treatment and the Nuffield Dyspraxia Programme–Third Edition. Journal of Speech, Language, and Hearing Research,

N°	Reference	Objective	Population/Comparison Group/Included Documents	Measurement Instruments	Most Relevant Results
		speech-language therapists and therapists.			58(3), 669-686.4. Doi:10.1044/2015_JSLHR-S- 13-0179. PMID:25807891. – The study is described in another row, but the authors of this review found a low risk of bias and assessed its evidence quality as moderate due to certain imprecisions. They also consider that the study does not evaluate results related to functional communication.
4	(Murray et al., 2015)	To compare the Rapid Syllable Transition Treatment (ReST) and the Nuffield Dyspraxia Programme (NDP3)	Children diagnosed with CAS /26 children (4 and 12 years old) with mild or severe, with 1-hour treatment, 4 hours per week for three weeks. Group 1: Children in treatment with ReST. Group 2: Children in treatment with NDP3.	– Diagnostic assessment to confirm the diagnosis of idiopathic CAS (anamnesis, hearing screening test, CELF- 4, CELF-P2, and Oral and Speech Motor Protocol (Robind & Klee, 1987). – Diagnostic Evaluation of Articulation and Phonology (DEAP) and Inconsistency subtest. – Goldman- Fristoe Test of Articulation Second Edition (GFTA-2). – Single-Word Test of Polysyllables. – Speech sample made up of 50 connected statements. – Experimental test of 292 items, designed for the study including 162 items of the NDP3 assessment, 80 pseudowords from ReST, and 50 real words (one, two, and three syllables) excluded from treatment.	– Treatment Gains: There was a significant effect, as both groups improved after the treatment. – Group 2 (NDP3) had greater gains than Group 1. Maintenance of Treatment Gains: Between the first week and one month post-treatment, the effect of time was not significant, meaning that, in general, the gains were maintained. However, during the month, Group 1 (ReST) showed a slight improvement in the precision of treated aspects, while Group 2 (NDP3) demonstrated a slight decrease in precision. – Expected responses to the generalization of untreated real words and pseudowords in the items of the experimental test.
5	(Namasivayam et al., 2018)	To evaluate the reliability and sensitivity of the Parent-Child Interaction Observation Scale (PCIOs) used to monitor the quality	Children diagnosed with CAS / 84 preschoolers (19 girls, 65 boys) between 30 and 62 months old, with moderate to severe CAS.	– Assessments for inclusion criteria (hearing, sight, difficulties in language and motor aspects of speech, etc.). – Therapy plans. – Clinical progress reports. – PCIOs scale at the beginning, middle, and end of treatment. – Video of a mid-therapy session	– The intensity of the treatment does not produce significant clinical changes in children nor in the children's enthusiasm for participating in therapy activities. – The children's response to their parents improves only between the beginning and end of the treatment, and not during the first five weeks (from the start to the midpoint of the therapy).

N°	Reference	Objective	Population/Comparison Group/Included Documents	Measurement Instruments	Most Relevant Results
		of parent-child interaction.			– Adapted PCIOs is reliable and sensitive for monitoring parent-child interaction in speech-motor interventions. – Overall, the Kappa coefficient for all items on the observation scale ranged from K = 0.33 to 0.64, indicating potential for a higher reliability index.
6	(Skoog & Maas, 2020)	To investigate the relationship between precision and intelligibility in children with CAS to determine which sounds contribute more to intelligibility.	Children diagnosed with CAS/Six children (5, 7, and 11 years old) diagnosed with CAS.	Measures of Accuracy: – Percent Consonants Correct (PCC). – Percent Vowels Correct (PVC). – Percent Phonemes Correct (PPC) – Percent Whole Word Accuracy (PWWA).	– The PPC, PCC, and PWWA tests showed a positive association with intelligibility, indicating that as accuracy increases, so does speech intelligibility. This association is not absolute, indicating that there are other factors related to intelligibility that are not captured by the accuracy measures.
7	(Tierney et al., 2016)	To demonstrate the advantages of multimodal intervention in a CAS case.	A three-year-old child with suspected CAS.	– The Kaufman Speech Praxis Test – The Verbal Motor Production Assessment for Children – Comparison of the child's speech levels.	Parents reported understanding between 90% and 100% of what the child said, while the therapist understood approximately 80%. Additionally, there was an observed increase in the length of the child's phrases and the use of words with three or more syllables.

Table 2. Summary of the quality of the analyzed papers.

No.	Article (APA Reference)	Type of Study	Checklist	Internal Validity	External Validity	Impact	LE	GR
1	(Bahar et al., 2022)	Qualitative Systematic Review	CASPe Systematic Review	It has internal validity, as its methodology and design ensure that the results are precise and bias-free. The article presents a clear research question and objectives, and the authors are rigorous throughout the entire search process.	It has external validity because the research considers the use of telerehabilitation in therapies for Childhood Apraxia of Speech (CAS), focusing on treatment efficacy. It is useful for the study due to the similarities in the clinical area and the population addressed.	Considering the type of study, the determination of impact does not apply.	1a	A
2	(Gomez et al., 2019)	Observational-Descriptive Study	STROBE	It has internal validity, as the study focused on a clearly defined topic and a specific population. Regarding the methodological design, it is a study with detailed processes. The research question and objectives of the article are clear.	It has external validity, as the results are useful and applicable to the addressed clinical area.	Considering the type of study, the determination of impact does not apply.	5	D
3	(Morgan et al., 2018)	Qualitative Systematic Review	CASPe Systematic Review	It has internal validity because the methodology and design ensure that the results are precise. The study maintains clear objectives.	It has external validity, as the results are useful and applicable to the field; the therapies analyzed correspond to the clinical area and the targeted population.	Considering the type of study, the determination of impact does not apply.	1a	A
4	(Murray et al., 2015)	Non-Randomized Controlled Experimental Study (Quasi-experimental)	CASPe Clinical Trial*	It has internal validity because the objective is clear and met. Methodologically, the theoretical framework is comprehensive and up-to-date, considering previous studies. The authors demonstrate rigor throughout the research process, and the design yields accurate results.	It has external validity as the study significantly contributes to the clinical area of intervention in Childhood Apraxia of Speech (CAS), providing applicable results.	Not enough information to determine the impact or the magnitude of the real value.	Does not apply due to the type of study	Does not apply due to the type of study
5	(Namasivayam et al., 2015)	Randomized Experimental Study	CASPe Clinical Trial	It has internal validity because the study presents a clearly defined topic. Although the methodology and design exhibit some biases (as the authors adapted tools for the evaluation of the intervention), the article's question and objectives are clear, and the authors demonstrate	It has external validity because the research topic and the findings are closely linked to this study. The studied population and the importance of family support are relevant to the research.	Kappa (K): 0.669 - Moderate Impact	1b	A

No.	Article (APA Reference)	Type of Study	Checklist	Internal Validity	External Validity	Impact	LE	GR
				rigor in the search and research process.				
6	(Skoog & Maas, 2020)	Observational-Descriptive Study	STROBE	It has internal validity because the topic is clearly defined, the population is specific, and the methodological framework specifies the processes. Both the research question and the objectives are well articulated.	It has external validity, as its primary purpose of examining the relationship between intelligibility and speech precision in a functional manner contributes to the research question.	Considering the type of study, the determination of impact does not apply.	5	D
7	(Tierney et al., 2016)	Observational-Descriptive Study	STROBE	It has internal validity as it focuses on a clearly defined topic and a specific population. Regarding its methodology, it is a thorough study, and its research question, objectives, and results are precise.	It has external validity as it addresses the multimodal approach and the use of sign language to support communication (AAC). Although the current research is not specifically focused on the multimodal approach, it is closely related and useful.	Considering the type of study, the determination of impact does not apply.	5	D

Table 3. Functional communication checklist for intervention in Childhood Apraxia of Speech. Source: Elaborated by the authors.

Functional Communication Components	Therapies for Childhood Apraxia of Speech				
	1. NDP-3	2. PROMPT	3. DTTC	4. K-SLP	5. IPA
ICF					
• Structure and Function	✓	✓	✓	✓	✓
• Activity and Participation	✓				
• Personal factors – centered on the patient	✓	✓		✓	
• Environmental factors – social and family context					
Functional Components of Speech					
• Articulatory precision	✓	✓	✓		
• Intelligibility	✓	✓	✓		
• Prosody	✓				
• Speed					
• Comprehensibility					
Other Aspects of Language and Communication					
• All the syntactic levels (from Word to complex sentences)	✓	✓			
• Pragmatic aspects (spontaneous production, with communicative intention)				✓	
• Use of functional words	✓	✓	✓	✓	
Aspects of Therapy					
• Generalization and transference	✓				✓
• Maintenance over time	✓		✓		✓
• Realistic and feasible therapy (exercises, repetition frequency, aids, etc.)					
Total	10	6	5	4	3

The following conclusions can be drawn from the results:

a) According to functional parameters (Table 3), from the evaluation of each therapy approach, the five interventions are ranked from highest to lowest impact on functional communication: 1. NDP-3; 2. PROMPT; 3. DTTC; 4. K-SLP; 5. IPA. The NDP-3 intervention shows the greatest impact on functional communication, as it meets 10 out of the 15 parameters outlined for defining functional communication. This suggests from the outset that the therapies are not designed holistically.

b) Considering that the five analyzed interventions fulfill different functional parameters (Table 3), it can be proposed that they complement each other. Therefore, to achieve functional communication, an approach that combines these interventions and is implemented according to the child's symptoms and the family's expectations would be appropriate—essentially an eclectic approach. This approach is also preferred by speech-language therapists (Gomez et al., 2019). Furthermore, it is essential to consider the intensity of the treatment (Namasivayam et al., 2015). It is important to note that an eclectic approach requires prior training for the speech-language therapist to effectively select the most relevant strategies based on the child's characteristics and progress.

c) For an intervention aimed at functional communication, it is essential to adopt a biopsychosocial model and adhere to the standards of the International Classification of Functioning, Disability, and Health (ICF), prioritizing activity and participation. This means that actions such as speaking on the phone, singing, recounting anecdotes, conversing, and even understanding peers, as well as the various roles the child plays in different contexts (e.g., as a child, sibling, student, friend) should be considered general objectives of the

intervention. Conversely, aspects related to function and structure—such as intelligibility, articulatory precision, and speech parameters—would define the objectives that guide treatment approaches (Skoog & Maas, 2020).

d) Both the diagnosis and intervention of CAS are controversial and complex (Souza & Payão, 2008), requiring intensive and long-term therapy. This translates into considering critical factors for intervention, which include personal factors (motivation, expectations, baseline individual characteristics, among other personality traits); environmental factors (socioeconomic status, family interaction time, proximity to the therapy location, etc.); and practical components of therapy (frequency of sessions and repetitions, assignment of tasks, complexity of the exercises, and aids and cues provided by professionals). These factors significantly impact adherence to therapy and the continuity of treatment, thereby influencing the expected outcomes and the overcoming of CAS.

e) The probability of CAS persisting into adulthood can be high. This represents a significant gap in clinical practice, as the disorder extends beyond the child population. None of the studies reported follow-up cases, and there are no established standards for assessment or intervention that provide guidelines or tools for addressing the disorder throughout the life cycle. Furthermore, there is a lack of information regarding the actual outcomes for these individuals concerning their overcoming or maintenance of difficulties, as well as their limitations in academic, occupational, familial, or social contexts, and their participation in activities or inclusion initiatives. This is concerning, as it is crucial from a social responsibility perspective within the profession to recognize that children with CAS will also become adults with speech apraxia, given that difficulties do not typically resolve by age 18.

DISCUSSION

The search reaffirms findings from other studies on interventions for Childhood Apraxia of Speech (CAS), indicating a scarcity of publications and a lack of experimental studies (Gubiani et al., 2015; Murray et al., 2014). The search covered the period from 2015 to 2021, hence there was an expectation to find a greater number of scientific articles compared to grey literature. Additionally, the tendency toward observational and quasi-experimental studies with small sample sizes results in minimal impact of the findings on clinical practice.

Moreover, the analysis of the 18 articles during the eligibility stage highlights a difficulty in drawing conclusions, assessing quality, and generalizing results, as these are primarily single-case studies or quasi-experimental designs (Lim et al., 2019, 2020), narrative reviews (Koehlinger, 2015; Kung & Ugas, 2021; Murray & Iuzzini-Seigel, 2017), or involve extremely small and specific samples (McKechnie et al., 2020).

The critical analysis conducted on the seven articles using the CASPe and STROBE guidelines reveals a difficulty in extrapolating results, given that the studies involve small sample sizes, indicating that the findings should be interpreted with caution (Skoog & Maas, 2020). The issue of small sample sizes is a significant concern in research, widening the gap between academia and actual practices used in speech-language intervention. Often, the guidelines provided by research based on their results are not adopted by professionals working with individuals with CAS, either due to a lack of awareness, absence of tools, or difficulties in adapting therapeutic conclusions to clinical realities (Gomez et al., 2019). On the other hand, it is noteworthy that treatment intensity impacts functional communication as assessed by instruments such as FOCUS and through applying motor approaches (Namasivayam et al., 2015). In this regard, it is also relevant to review the measures used to analyze speech intelligibility in children with CAS, as this dimension is crucial for establishing the level of communicative participation and functional impact, which can guide treatment approaches and objectives. For instance, determining the level of consonant rather than vowel precision may be prioritized (Skoog & Maas, 2020).

The therapies identified in the analysis are described below, along with selected strategies aimed at enhancing functional communication.

1. DTTC (Strand, 2020)

This approach is based on stimulation and operates through clinician-modeled imitation. It targets speech intelligibility, but only at the level of the syllable and functional word. Consequently, it does not consider other communicative aspects such as prosody (Lim et al., 2020). In this regard, one might question the relevance of a child accurately producing an isolated word if the rest of their speech remains unintelligible or if other factors, such as speech rate or the use of gestural and non-verbal resources, interfere with message comprehension.

When applying the ICF to the DTTC approach (Murray & Iuzzini-Seigel, 2017), it becomes evident that the intervention integrates only the components of structure and function. This limitation

arises because its primary objective is to enhance the motor production of speech through specific movements, without addressing the components of activity and participation, nor the personal and environmental factors.

Time, motivation, and therapeutic adherence are essential to generalize the outcomes of therapy, and positive results have been associated with conducting short sessions twice a day, five times a week. In practice, maintaining this frequency is challenging within everyday family contexts, especially when parents are responsible for guiding the therapy (Koehlinger, 2015; Lim et al., 2020). Additionally, the structured nature of the program complicates its application by caregivers, although teachers, who implement it more informally, report an increase in articulatory precision (Lim et al., 2019). Despite these challenges, it has been demonstrated that the skills learned in therapy are retained over time (Koehlinger, 2015).

2. NDP-3 (Williams & Stephens, 2004)

This approach is grounded in a psycholinguistic framework and principles of motor learning (McKechnie et al., 2020; Murray et al., 2015). It involves high rates of repetition and constant, specific feedback regarding both performance and outcomes. While the frequency of repetition may seem impractical, unrealistic, and potentially monotonous in everyday contexts, specialized feedback aligns with the biopsychosocial model and the person-centered approach. Additionally, it has been demonstrated that feedback enhances therapy outcomes (Murray & Iuzzini-Seigel, 2017; Skoog & Maas, 2020) and facilitates learning in practice (Murray et al., 2015).

This intervention has a hierarchical structure that progresses from sounds to syllables, words, sentences, and connected speech, ultimately directing efforts toward functional communication. This approach considers all syntactic levels and uses real words from incidental speech databases (Bahar et al., 2022).

It considers articulation, sequencing, and prosody at the level of function, while at the level of activity, it focuses on "speaking with precise words and phrases" (Murray & Iuzzini-Seigel, 2017). These considerations, in relation to the ICF and according to qualitative analysis, result in progress within a month of treatment, which can be maintained for at least four months and generalized to other contexts (Bahar et al., 2022; Morgan et al., 2018).

3. PROMPT (Hayden, 1984)

This motor-based approach emphasizes proprioceptive information for all processes underlying speech production. By utilizing visual, auditory, proprioceptive, and tactile sensory cues tailored to the child's needs and responses, the intervention becomes more focused on functionality. This leads to improvements in sound articulation (Tierney et al., 2016) because it considers the motor hierarchy components of the PROMPT method (Namasivayam et al., 2015). It allows children to feel how their structures should functionally move to produce speech sounds in real time (Murray & Iuzzini-Seigel, 2017).

Although PROMPT is commonly used in speech-language intervention, it has more evidence supporting its efficacy in individuals diagnosed with cerebral palsy or other motor disorders (Murray & Iuzzini-Seigel, 2017). To date, no research has systematically examined the effectiveness of PROMPT in CAS (Dale & Hayden, 2013).

The analysis conducted using the ICF model (Murray & Iuzzini-Seigel, 2017) indicates that motor practices are confined to the components of structure and function, while activity and participation include the action of producing precise and intelligible sounds, words, and complete sentences. The latter aspect is crucial to consider in evaluation, employing accurate measurements of consonants and complete words, as demonstrated by one of the studies included in this review. This study, despite its small sample size (three children with CAS), has proven that these measures are essential for establishing the functional impact of each treatment (Skoog & Maas, 2020).

This intervention method addresses both physical and sensory skills, as well as cognitive-linguistic and social-emotional domains (Hayden, 2006). However, there is no evidence that PROMPT affects the ability to perform activities of daily living. This limitation confines its potential to therapeutic settings, preventing the generalization of results beyond therapy sessions (WHO, 2001).

4. IPA (Gillon, 2000)

This is one of the most clinically recommended interventions (Gomez et al., 2018; McKechnie et al., 2020). Its uniqueness lies in the emphasis placed on phonological awareness, a skill that is not directly associated with functional communication. Although it is used in clinical practice with positive effects on outcomes, maintenance, and generalization (McKechnie et al., 2020; Murray et al., 2014), it is unlikely to be one of the first interventions offered to infants with CAS (particularly those who

are young and have moderate to severe symptoms), as it requires the development of linguistic skills that many infants have not yet acquired.

This intervention emerged around the year 2000, and the search, limited to the years 2015-2021, yields virtually no studies updating it or conducting research that evaluates its orientation toward functional communication, which is more closely linked to spontaneous and contextual communication. Consequently, based on what the approach aims to address, it can be asserted that it diverges from functional communication.

5. K-SLP (Kaufman Children´s Center, 2021)

One of the primary studies found regarding this intervention indicates that the research related to this protocol is scarce and limited (Gomez et al., 2018). After applying critical analysis there is only one case report (Tierney et al., 2016) that used multiple simultaneous interventions (oral motor therapy, sign language, and K-SLP). This means that it has a multimodal approach, which makes it difficult to attribute positive outcomes to a single treatment. This is added to the analysis, which reports that the lack of training for speech-language therapists to implement this intervention (which requires certification) has resulted in it being the least used (Gomez et al., 2019).

This program proposes to simplify words into syllables or sound groups to construct approximations to the target word until children can effectively say the lexeme. Decomposing words into something pronounceable could contribute to functional communication, as it prioritizes the message, the use of functional expressive vocabulary, and communicative purpose over articulatory precision and intelligibility. Moreover, it is based on the processes already used by the child, thereby being centered on the person. As analyzed in this scoping review, the studies assessed according to the CASPe and STROBE guidelines do not allow for definitive conclusions regarding this treatment's direct effects on functional communication, which consequently raises doubts about its functional orientation.

Finally, one of the therapy approaches that frequently emerged was the Rapid Syllable Transition Treatment (ReST) program created by Don Robin (McCabe et al., 2017), based on the motor approach. It is a structured program characterized by the repetition of syllables, according to information from the selected articles (Gomez et al., 2018; McKechnie et al., 2020; Morgan et al., 2018; Murray et al., 2015; Murray & Iuzzini-Seigel, 2017; Skoog & Maas, 2020). Its association with functional communication may be related to significant outcomes. Additionally, this approach could be linked to a generalization process that aims at functional words and new stimuli, emphasizing intelligibility through the precise use of words and phrases. However, it is not possible to assert that this approach is more functional than others, as its results do not reference functional communication. The only hypothesis that can be proposed is that an eclectic approach would likely be the most effective in achieving functional communication in children with CAS.

Limitations

The first limitation of this study is that the search focused on five intervention methods, as these were the most frequently mentioned in the initial bibliographic search and the most utilized in clinical practice, according to the same analysis. The second limitation pertains to the period defined in the inclusion criteria, as only studies published from 2015 to 2021 were included. Therefore, future reviews should consider a broader publication time frame. While this may limit the conclusions of the work, it is important to emphasize that the analysis of each article related to one or more interventions is largely focused on the axes of activity and participation. The third limitation is that only five databases were used for the search; therefore, it is suggested that future studies increase the number of databases utilized. The final limitation concerns the fact that the search was conducted in English and Spanish, resulting in the exclusion of papers published in Portuguese. However, literature in this field is generally published in English.

CONCLUSION

This research proposes a way to promote interventions for CAS oriented toward the development of functional communication, in alignment with current tendencies. While guidelines regarding interventions and considerations that direct toward functional outcomes are provided, one limitation of this study is that such orientations are derived solely from the selected scientific articles. This means that they do not include information obtained from other sources such as original manuals for each treatment, clinical practice, or the opinions of experts with extensive experience. In other words, not all the information that speech-language therapy professionals historically consider when conducting their interventions was included. Moreover, considering that some therapies were developed and published several years ago (such as IPA and K-SLP), they do not appear within the studies selected by publication year. Nevertheless, they are included in this study due to their frequent use and mention in older articles.

Finally, this research contributes to the state of knowledge regarding the definition of what constitutes effective therapeutic goals by positioning the development of functional communication as a primary objective. The checklist allowed for the evaluation of the selected interventions based on the functional aspects inferred from the reports of each treatment. This tool could be standardized and used for both therapeutic planning and measuring the effectiveness of an intervention. Thus, one of the projections of the study, in addition to extrapolating to other therapies and periods, could be the validation of such an instrument.

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