Utility of Cycles-based Intervention for Remediating Phonological Disorders in Pre-school and School-aged Children: Evidence-based Study

Najwa Salim Yousif
najwa.yousif@uobasrah.edu.iq
Dept. of English College of Arts University of Basrah

Abstract
The current research sought to examine the effectiveness and efficacy of cycles phonological approach in correcting phonological disorders among pre-school and school going children. The systematic evidence-based review design was chosen to critically synthesize the results of fourteen experimental and quasi-experimental studies published between 1987 and 2018. The selection of the study was retrospectively recreated in line with the Preferred Reporting Items of Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The studies, which were included, were critically reviewed on the following aspects: participant characteristics, style of delivering the treatment, treatment intensity, interrater reliability, treatment integrity, risk of bias, and certainty of evidence. The quantitative synthesis showed that the effects of the cycles phonological approach were small-large (d/g = 0.38-0.84) which means that the overall effectiveness of the cycles phonological approach was moderate in reducing phonological errors and enhancing speech intelligibility. The results also indicated that the intervention strength, study size, and research design were the methodological variables that affected the results of treatment. Altogether, the cycles phonological approach seems to be a successful evidence-based intervention, yet more and more large-scale randomized controlled trials are still needed.

Keywords: cycles phonological approach, phonological disorders, speech intelligibility, systematic review, evidence-based practice, speech-language pathology.

1. Introduction

During the last five decades, intervention programmes have witnessed tangible theoretical and conceptual changes which led to the emergence of various treatment practices including oral-motor-based, phoneme-based, and language-based approaches. Thus, researchers as well as clinicians have had a wide range of choices for selecting the intervention programme which appropriately suits the children's ages and disorder severity level and, at the same time, which best meets their clinical needs. However, through the accumulation of theoretical investigation and clinical practice, the need to more effective approaches which deal with disorders of phonology has been considerably realised (Hodson and Edwards, 1997).

In late 1970s, Barbra Hodson and Elaine Paden have made many attempts based on persistent clinical research and practice which resulted in devising and developing the cycles phonological remediation approach. It is a practical phonological pattern-oriented approach, i.e., it supports highly unintelligible children (ages from 2:6-14 years) with severe to profound phonological disorders to improve their speech by facilitating the gradual acquisition of the target patterns through a cyclic treatment procedure rather than requiring full mastery of individual phonemes. It has been adopted by many clinicians and researchers as a standard research intervention model that basically targets deficient phonological patterns for 6-18 weeks (Hodson and Edwards, 1997).

The present study aimed at investigating the extent to which the cycles phonological approach has been efficacious and effective in remediating the phonological errors occurring in pre-school and school-

aged children's speech. It presented an evidence-based inspection of the findings obtained by previous research on the utility of the cycles approach as a treatment model for phonological disorders. The study was intended to facilitate the decision making process as to whether manipulating the cycles approach would be helpful and facilitative in suppressing phonological sound/sound pattern errors. It analysed fourteen experimental and quasi-experimental studies in terms of study design, participants' characteristics, disorder severity level, and treatment delivery style. These aspects were highlighted and explained as how they would influence the decision-making process that SLTs might go through in order to select a suitable treatment model.

2. Cycles Phonological Approach: A Background Overview

The cycles phonological remediation approach is a holistic phonology-based intervention model which was devised by Hodosn and Paden (1983; 1991). Theoretically, the cycles approach was based on developmental phonology theories, such as natural phonology introduced by Stampe (1973); speech sound acquisition explained by Macken and Furguson (1983); gestural phonology presented by Browman and Goldstein (1986); generative phonology, non-linear phonology, distinctive features analysis and clinical research (Chomesky & Halle, 1968; Goldsmith, 1990), principles of cognitive psychology (e.g. Hunt, 1961; Vygotsky, 1962), and phonological acquisition research (Dyson and Paden, 1983; Grunwell, 1987; Porter and Hodson, 2001; Preiser et al., 1988).

Conceptually, the approach was based on seven essential aspects of speech sound acquisition in children. First of all, sounds and sound patterns are better learned through extensive listening. Second, auditory stimulation enhanced children's ability to perceive and learn various phonological units. Third, the approach emphasised on the gradualism of the sound acquisition process that children improve sound perception and production over time. Fourth, the cycles treatment also focuses on learning phonological patterns rather than singleton sounds, as this strategy positively reinforces the children's speech production. Fifth, active engagement in interactive experiential playing facilitates learning, and the learning tasks should be within the children's speech perception and production capability. Sixth, generalisation of the newly learned patterns to daily speech increases children's speech intelligibility. Seven, the cycles approach targets the meta-phonological awareness related to the development of early literacy skills (Hodson, 2007; 2010; Yousif, 2018, Yousif, 2025).

The cycles phonological approach was clinically tested and continuously developed to remediate moderate to severe phonological disorders in preschool and school age children including children with various disorder aetiologies of known and unknown origins aged between 6;2 and 14 years. Hodson and Paden (1983; 1991) clarified that the cyclic way of targeting phonological patterns could facilitate the gradual acquisition of correct sound and sound pattern production and, in return, increase the children's speech intelligibility. For instance, speech intelligibility less than 20% would need, at least, 10-15-week treatment cycle to target sound and sound pattern errors. Each single phoneme would be targeted twice a week over two thirty-minute sessions or three twenty-minute sessions per week. The number of the deficient sounds and patterns to be targeted determines the length of the treatment cycle (Hassink and Wendt, 2010).

2.1 Target Selection

As gradualism of phonology acquisition is one of its principal concepts, the cycles approach essentially emphasised upon assisting children to learn the treated patterns in a natural course of development. Additionally, stimulability to the targeted deficient sounds should be taken into deep consideration, especially in the first treatment cycle. This could increase the children's production accuracy level and, at the same time, considerably consolidates the children's motivation and development. Objectives as such could be carried out by designing a well-structured intervention plan which focuses on treating phonological patterns rather than single sounds, facilitates generalising the newly learned patterns and enhances children to interactively use the learned patterns in their speech. Therefore, Hodson and paden (1983; 1991) designed pre-arranged lists of the phonological patterns that decrease children's speech

intelligibility. These included primary and secondary target patterns which SLTs could follow as target-reference lists in the cycles-based intervention programmes. The primary and secondary targets are as follows (Hodson, 2010):

A. Primary targets include:
1. Syllable deletion
2. Sound deletion (e.g., final consonant deletion, initial consonant deletion)
3. /s/ clusters reduction
4. Velar fronting or alveolars/ labials backing (e.g., anterior or posterior contrasts)
5. Liquids /l/ and /r/ has formed an exception to the stimulabilty principal. That is, they are recommended to be targeted at the end of each cycle even if they aren't stimulable.
6. Criteria for Moving on to Secondary Targets:

A. Secondary Targets include:
1. Approximant /j/ and /r/, and fricatives /s/, /z/, /ʃ/ and /ʒ/)
2. Various consonant clusters or sequences (e.g., /j/ clusters, medial /s/ clusters, three-consonant clusters)
3. Singleton stridents (e.g., /f/, /s/, /z/)
4. Pure and diphthong vowels in addition to prevocalic voicing or devoicing difficulties

It is worth mentioning that the selection of the treatment targets fundamentally depends upon the severity level of phonological problems in children with disordered phonologies (Hodson and Paden, 1983; 1991). That is, the phonological processes with percentages of occurrence should be targeted. For instance, a process which occurs by 62% would prioritised for treatment more than a process which occurs by 48%. It also depends upon the children's stimulability to the treated patterns (Hodson, 2006; Hodson, 1997; Perzas and Hodson, 2010).

2.2 Treatment Structure

Since obtaining good results entails good planning, SLTs effectively prepare the treatment cycles as well as plan the steps and treatment materials for each treatment session. This involves assessing the children's speech, analysing speech data, clearly setting treatment goals, selecting the primary and secondary targets, outlining the treatment sessions structure, allocating treatment materials and interactive plays.

Regarding target selection, SLTs usually tend to select the target phonological processes (e.g., initial consonant deleting) and at least two phonemes pre-process (e.g., initial /f/ and /θ/) to be treated during the first treatment cycles. Each phoneme (e.g. /f/) would be targeted for one 60-minute session or two 30-minutes or three 20-minutes per week. The targeted sound would be embedded in at least 4-5 production words. After completing the first treatment cycle, the children's speech would be re-evaluated so that SLTs could decide the improvement level and whether, the treated children still need further treatment cycles to be designed (Perzas and Hodson, 2010). Moreover, target patterns would be recycled whenever necessary (Prezas and Hodson, 2010). According to Hodson (2010), the general structure of a treatment cycle sessions basically comprises seven steps as the follows:

1. **Pre-treatment review:** SLTs are recommended to review the previous session's word cards.
2. **Auditory stimulation:** As an attempt to enhance children's stimulation to the target sounds, they are exposed to amplified auditory bombardment for at least 1-2 minutes. They listen to nearly 15 production words pronounced by the clinician.
3. **Production word Cards:** Word indexed cards are presented to the children sequentially and interactive produced through playing. Therefore, children would be requested to either pick identical words, draw pictures, colour pictures or cut and paste pictures. Modelling could be offered by SLTs whenever necessary.
4. **Production practice through experiential play:** Through playing games, SLTs could encourage children to produce the target words either by taking turns naming the pictures on the cards. Oral modelling and tactile cues are offered whenever necessary.

5. **Stimulability probing:** This step entails that SLTs to find out whether the treated children are stimulable to the selected targets. Henceforth, STLs request children to produce a list of words contain the target pattern prepared for the next session. Accordingly, the easily produced sound would be targeted during the next session.
6. **Auditory stimulation:** SLTs are recommended to repeat step 2.
7. **Home program:** SLTS prepare a short-timed home programme which parents could carry out at home. This programme give the parents the opportunity to practice the production words with their children for at least child 2-3 minutes per day. For instance parents could help their children practice picture naming.

3. Experimental/Quasi-experimental Studies on Cycles Approach

The Cycles phonological remediation approach is a comprehensive intervention method designed for treating phonological disorders in preschool and school aged children with various phonological impairment aetiologies. It was assumingly purported that it could remediate moderate to severe phonological deficiencies (Bowen, 2013). It has been practically considered as an appealing phonology-based treatment depending upon the findings obtained through non-experimental studies (e.g. Hodson, 1983; Hodson, 2006; Cholmain, 1994, etc.), experimental or quasi experimental studies (e.g., Almost and Rosenbaum, 1998; Rodulph and Wendt, 2014; Rvachew et al., 1999; Stoel-Gammon et al., 2002; Tyler et al., 1987, 1987; Tyler and Watterson, 1991; Yousif, 2018). The available research highlighted the effectiveness of the cycles approach in increasing speech production accuracy and, in return, improving speech intelligibility. These goals are achieved by gradually eliminating the number of the recurrently occurring phonological processes. However, some other experimental studies revealed mixed viewpoints about the effectiveness of the cycles approach. By and large, the mixed results obtained still has prescribed that the cycles-based intervention tend to be a beneficial treatment in children with speech impairment ranging from moderate to severe speech disorder (Hassink and Wendt, 2010; Arabi et al., 2017; Packard, 2019).

Rodulph and Wendt (2014) explained that the main goal of the cycles-based intervention is to reduce the number of the recurrently occurring phonological processes and improving speech intelligibility. This goal has been manifested in the findings of several experimental studies (e.g., Almost and Rosenbaum, 1998; Rvachew et al., 1999; Stoel-Gammon, 2002; Tyler et al., 1987; Tyler and Watterson, 1991; Yousif, 2018). That is, the treated children's speech has become clearer and, at the same time, characterised by occurrences of sound and sound pattern errors fewer than these in the pre-treatment phase. Additionally, the findings of quasi-experimental studies (e.g., ceron et al., 2010; Keske-Soares et al., 2008; Montgomery and Bonderman, 1989) pointed out to similar findings. In the present study, fourteen experimental and quasi-experimental studies were reviewed chronologically.

Tyler et al. (1987) experimentally compared between two intervention models minimal pairs and modified cycles approach to treat 4 preschool-aged children with severe phonological disorders. Both pre- and post-treatment speech assessments in addition to generalization probes were used to evaluate the effectiveness of both approaches. Therefore, a single-subject and within-subject design was alternately executed to control for individual differences. The two experiments, focused on targeting sound pattern errors (phonological processes) rather than single sounds. Cycles-based intervention and minimal pair-based intervention displayed significantly positive changes in children's speech production that they gradually managed to generalize correct pronunciation to untreated target patterns and sounds. The application of the two intervention models provided evidence of the effectiveness of phonology-based intervention in improving suppressing phonological processes and improving speech intelligibility.

Montgomery and Bonderman (1989) conducted a quasi-experimental study which was an attempt to describe a cycles-based group intervention model in remediating the phonological pattern errors. For this purpose, a group of 9 preschool-aged children aged between 3:1 and 4:10) with moderate to severe phonological disorders were treated via cycles phonological approach. The results showed considerable improvement in speech production and speech intelligibility, and this reflected the effectiveness of cycles model when delivered for group-oriented intervention contexts supported by short home programme

practice. Despite the point that, the study was not a classic randomized controlled trial (RCT), it was considered as a quasi-experiment by evaluating a group intervention in a naturalistic setting at a public school to assess the effectiveness of the cycles intervention. Thus, Montgomery and Bonderman (1989) did not tested treatment efficiency and dismissal rate variable within in terms of a given hypothesis; instead, they tested the effectiveness of the cycles based group therapy in a realistic context.

Tyler and Waterson (1991) examined preschool-aged children with both phonological and language disorders. It was claimed that simultaneous targeting of phonology and language errors would improve both domains; while targeting them separately might lead to significant improvement in both fields. A combination of two approaches; viz, modified cycles phonological and script approaches were manipulated. The treatment structure included merging phonological training techniques, such as minimal pairs and narrative language scaffolding techniques to target both phonology and language disruptions. A quasi-experimental between-subjects design with semi-controlled randomisation rather than standard randomized controlled trial design was used to compare cycles phonological approach and script approach in treating both phonology and language disorders. The non-RCT design side of the study involved modifications, such as, exposing children to a slight perception training and selecting target processes that are not common to all of the participants. On the other hand, the RCT design side of the study was used for group allocation turning the experiment design into an RCT-design-like. The findings indicated that simultaneous targeting of phonology and language impairments accelerated language development. The findings highly emphasised upon the necessity of integrated treatment of phonology and language disorders rather than adopting field-specific therapy.

Conture et al., 1993 experimentally investigated simultaneous treatment of stuttering and disordered phonology in stuttering children and comparing the results to those of children who stutter but do not have phonological disorders. The parent-child and modified cycles approaches were used in a group intervention programme. Eight children were selected and divided into two experimental groups: stutter-phonology group (SP group) and a control group of only stuttering children(S group). Both groups received group stuttering treatment via parent-child approach for one year. On the other hand, children in SP group received modified cycles phonological treatment to target phonological processes (e.g. inter-dentalisation/lateralization, gliding of liquids, velar fronting, etc.) and improving sound productions.

The phonology treatment results a slight decrease of the occurrences of phonological processes in SP children's phonology in addition to a significant change of some processes like velar fronting and stopping. Thus, SP children improved in both childhood stuttering as well as phonology disorders; while S group improved in only in stuttering. Consequently, the study findings could be an encouraging factor that promotes treating phonology and stuttering disorders at the same time as this procedure would expedite improvement gains in both aspects. Because stuttering and phonological disorders tend to co-occur, the authors intended to inspect whether it is appropriate to target them separately or simultaneously. Supported by the study findings, they discovered that it should be more effective and feasible to treat them simultaneously.

Robbins and Chin (1995) conducted a longitudinal single subject study design. The effectiveness of cycles phonological approach on developing the phonological system in a preschool-aged child aged 3;5 with multichannel cochlear implantation was investigated. Hence, a holistic treatment programme which constituted of four basic elements was designed. The programme included oral-motor training, cognitive-linguistic training, using the cycles treatment model to identify her phonological disorders, and using multiple talkers during treatment sessions. A modified cycles-based intervention model was used to treat the participant's phonological errors, although it was not originally designed to remediate hearing-impaired children. The child was profoundly unintelligible and seemed to have no notion about her voice because she was completely deaf before having the cochlear implant. However, she was capable of

imitating mouth postures and movements. After applying the cycles treatment procedure, the child became capable of producing proper approximation of the treated sounds and was positively developing her phonological and linguistic skills in the desired direction.

Almost & Rosenbaum, 1998 investigated the effectiveness of speech intervention for phonological disorders. A randomized-controlled trial (group intervention) experiment was conducted to examine the effectiveness of early intervention on the children with severely disordered phonologies. Modified cycles phonological approach which included minimal pairs to target sound contrasts and traditional articulation training were manipulated as treatment procedures. Twenty-six preschooler aged with severe phonological disorders, normal receptive language skills, hearing levels and oral structures and functions, and sufficient Attention span. The results showed statistically significant differences between the first (early treatment) and second (delayed treatment) group. It was found that the children group who received early treatment produced more accurate conversational utterances than their other group peers who received delayed treatment. Group 1 improved their expressive skills more than group 2. The researchers presented important, though not unique, study which emphasized upon the significance of early treatment of phonological intervention for extremely unintelligible children so that they could fulfil their future academic requirements as well as smoothly be able to communicate within diverse social settings. Phonological treatment not only facilitated the children's speech intelligibility improvement and developed their conversational skills, but also positively affected their social behaviour. The study added other evidence for the effectiveness and efficacy of the phonological treatment model manipulated and it could be considered as a unique study in the field in terms of its experimental design.

Harbers et al. (1999) experimentally investigated the effectiveness of cycles phonological approach combined with metaphon approach to target severe phonological disorders in 4 pre-schoolers. For each child, five different phonological patterns were targeted. The experimental framework was based on a series of a single-subject experimental design with a multiple-probe approach across behaviours. The design as such practically examined cause-and-effect relationships within treated children characteristic of experimental research. The findings indicated that the production of four out of five patterns considerably improved after 6-9 months of intervention. Additionally, phonological awareness results indicated improvements after the first six intervention sessions that children systematically and thoughtfully respond to more pattern-focused tasks. However, Harbers et al. (1999) suggested that more replication and evaluation would be needed to inspect the way a child could acquire phonological awareness skills and retain these skills across different phonological patterns. Interestingly, the study emphasized upon the gradual sound acquisition process which comprises a series of assimilations and modifications of sound production and phonological awareness rules; this is one of the major principles of the cycles model. Although the researchers referred that children mastered four out of five patterns and that they began to generalize these new patterns to their conversational speech, the geralisations were documented or identified in literature. It would have given more powerful evidence of the phonological improvement, if the researchers had identified or reported examples of such generalizations. Moreover, they did not stated how much what type of treatment children do need to achieve the generalization goal. The results could have been affected by other factors such as participants' motivation and cooperation during the treatment sessions.

Rvachew et al. (1999) conducted an experimental study which included two descriptive parts within an experimental framework to investigate the role of stimulability and perception training in suppressing phonological errors. The first part involved using standard cycles approach and was entirely descriptive, whereas, the second part involved using modified cycles approach. The modification included using perception/stimulability training. Individual and group intervention procedure was used. All participants had moderate-severe phonological disorders. The study focused on children's ability to improve pronunciation of sounds they couldn't produce or hear well before treatment. The study also investigated the possibility combining production (stimulability) and perception training could impact treatment

outcomes. The findings revealed that using standard cycles intervention to treat unstimulable rather than stimulable sounds made little development. On the other hand, the second study, showed significant improvement in the production of treated stimulable and unstimulable sounds when integrating perception and stimulability training in the modified version of the cycles approach. Consequently, the study findings highly recommended the integration of perception and stimulability training in the treatment stricture of the cycles phonological approach.

Fundamentally, Gillon (2005) presented a quasi-experimental study design which provided a primary evidence for the effectiveness of the intervention model rather than randomly assigning participants to control or experimental groups. Gillon's (2005) study focused on analysing the facilitative strategies to develop phoneme awareness in pre-school aged children with speech problems. Gillon (2005) adopted a quasi-experimental study which did not follow a randomized controlled trial design

The study included two groups. First, the intervention group who received a combination of phoneme awareness training and speech production. Second, the control group who were treated via speech intervention with concentration on improving speech intelligibility. In order to obtain reliable results, the participants were randomly assigned to conditions. A design as such might pave the way to a more precise future RCT study design. It was assumed that improving phonological skills alongside with speech production improvement would lead to increasing both speech intelligibility as well as improving literacy skills. The study findings revealed significant outcomes. It proved that phoneme awareness could be better stimulated and facilitated alongside with targeting speech intelligibility. Additionally, triggering phoneme awareness and letter prior to school years could bring about considerable development in spelling and reading skills. For children with speech sound disorders.

Mota et al. (2007) conducted a non-RCT quasi-experimental study to compare the effectiveness of three phonology-based intervention models: modified cycles, ABAB withdrawal, and maximal oppositions. Therefore, three groups of preschool and school-aged children were naturally selected. The study focused on comparing these three intervention models regardless the lack of a control group per each model. The three intervention models displayed speech production improvement, although the findings indicated that there were statistically insignificant differences among the three adopted treatment approaches. However, the comparison of initial and final speech assessments revealed that the three models reduced the severity of phonological disorder. The cycles approach was efficient in improving the speech production in severely disordered participants. Basically, Mota et al. (2007) presented a valuable study when practically comparing the effectiveness of three intervention models in realistic context rather than strictly being confined to RCT design conditions.

Keske-Soares et al.'s (2008) study found that three different phonological therapy approaches (ABAB-Withdrawal/Multiple Probes, Maximal Oppositions, Modified Cycles) were all effective in treating children with phonological disorders, leading to significant improvements in phonetic inventories, phonological systems, and reduced severity, regardless of the initial severity level, with more severe cases showing greater relative gains. The study highlighted that all methods worked, though specific approaches like Maximal Oppositions might influence sound vs. system organization differently, and called for larger studies to confirm finer distinctions in effectiveness. However, the study findings highly recommended the need for further research on larger sample sizes to identify the subtle differences between the examined intervention models, and ensure obtaining generalizable conclusions.

In a similar research trend, Ceron et al. (2010) studied the phonological changes brought about via treating preschool aged children with mild to severe speech impairments. A quasi-experimental comparative study was conducted to compare between three treatment models: modified cycles, ABAB withdrawal & maximal oppositions approaches. In order to detect the effectiveness of the three models, pre- and post- treatment assessment were run; besides, single subject design was also incorporated. By and

large, the study proved that the three intervention models positively improved the children's speech production. Yet, the lack of substantial random allocation of participants in the three treatment groups influences the validity of the study design and limits the study findings reliability.

Differently, Rudolph & Wendt (2014) experimentally conducted a multiple baseline study design across behaviours to examine the efficacy the cycles approach. A multiple baseline design has been considered a powerful method for configuring the relationship between treatment procedure and treatment outcome in individual participants. A study design as such tended to be experimental rather than quasi-experimental, although it targeted single subject cases. Baseline probes were manipulated prior to treatment, then treatment practice materials were presented successively. The findings manifested that the treated phonological processes were gradually decreasing; while the untreated processes continued to appear in the participants' speech. The untreated processes functioned as the experimental control probes which remained stable and were not changed without being treated. This definitely indicated that it was the application of the cycles treatment not another factor was the main cause of changing the disordered behaviour. Overall, the research presented rather substantial pieces of evidence available of the effectiveness and efficacy of the cycles approach in helping to decrease the frequency of the targeted phonological processes and enhancing speech intelligibility in children with speech sound disorders.

In a similar research tendency, Yousif (2018) conducted a multiple baseline design to examine the effectiveness and efficacy of the cycles phonological approach in remediating the phonological processes in a school-aged child with Down syndrome aged 6;8 and diagnosed with severe phonological disorders. Two 60-minute sessions per week over six weeks. The cycles model was efficient and effective in decreasing the occurrence of the targeted phonological processes and at the same time increased the participant's speech intelligibility.

4. Methodology

4.1 Study Searching and Selection

The current research took a systematic evidence-based review design, which involved identification, selection and critical synthesis of the available experimental and quasi-experimental studies that examined the effectiveness of the cycles phonological approach in the remedial of phonological disorders in pre-school age and school age children. Google Scholar and ResearchGate were the main sources that were used to identify relevant studies by offering access to published articles, theses, and full-text research papers that are relevant to the cycles phonological approach. To enhance the reliability of sources and indexing quality, the retrieved studies were then cross-referenced with internationally indexed databases, such as PubMed, Scopus, and Web of Science to confirm the publication status, bibliographic and journal indexing. Moreover, specialty journals in speech-language pathology and reference lists of the chosen studies were also screened manually to find any other relevant works.

In the search, different study related keywords and search combinations were employed. These were: cycles approach, modified cycles approach, cycles phonological approach, phonological disorders, speech sound disorders, phonological processes, stimulability, speech intelligibility, severity of phonological disorders and sound and sound pattern errors. Only studies published since 1987 were searched.

The process of selecting the studies was retrospectively re-constructed based on the Preferred Reporting Items of Systematic Reviews and Meta-Analyses (PRISMA) guidelines in order to increase the methodological transparency of the study and to guarantee its systematic identification of the included studies. After searching databases, duplicate studies were eliminated, titles and abstracts were filtered through and final-text articles were evaluated based on established inclusion and exclusion criteria. Finally, fourteen both experimental and quasi-experimental studies were eligible and included in the final review. This current review was aimed at gathering evidence on the effectiveness of the cycles-based intervention in inhibiting phonological errors and enhancing speech intelligibility in children with phonological disorders. The studies included were based on the following criteria:

1. The original or modified version of the cycles phonological approach was used in the studies.

2. Randomized controlled trials, experimental studies, quasi-experimental studies and multiple-baseline intervention studies were the study designs.
3. The participants were pre-school or school children aged 2.5-14 years.
4. The subjects were presented with phonology-related disorders that were linked with a decrease in speech intelligibility.
5. The participants had normal oral-motor structure and mobility.
6. The articles presented quantifiable intervention results with regards to phonological enhancement, accuracy in speech production, or speech intelligibility.

4.1.1 PRISMA Screening Process

The retrospective reconstruction of the study selection process followed the guidelines of the Preferred Reporting Items of Systematic Reviews and Meta-analyses (PRISMA) to increase the methodological transparency and to provide a clear documentation of screening and selection of studies reviewed. The relevant studies were located using electronic database searches, and then, duplicate removal, title and abstract screenings, and the full-text eligibility evaluations were performed.

First, forty-eight studies were found by searching the database. A total of thirty-nine studies were left after the deletion of nine duplicate ones to be screened with titles and abstract. The seventeen studies were eliminated as they were out of scope of the current study, such as research studies that involved adult participants, non-cycles intervention models, descriptive reviews, or other speech-language disorders.

Twenty-two potentially-relevant studies were subsequently retrieved and screened on eligibility based on the specified inclusion and exclusion criteria. Eight studies were filtered at this point because of inadequate data on interventions, inapplicable research design, unmeasurable outcomes or inability to directly examine the cycles phonological approach. Finally, the final review included fourteen experimental and quasi-experimental studies that met the eligibility criteria.

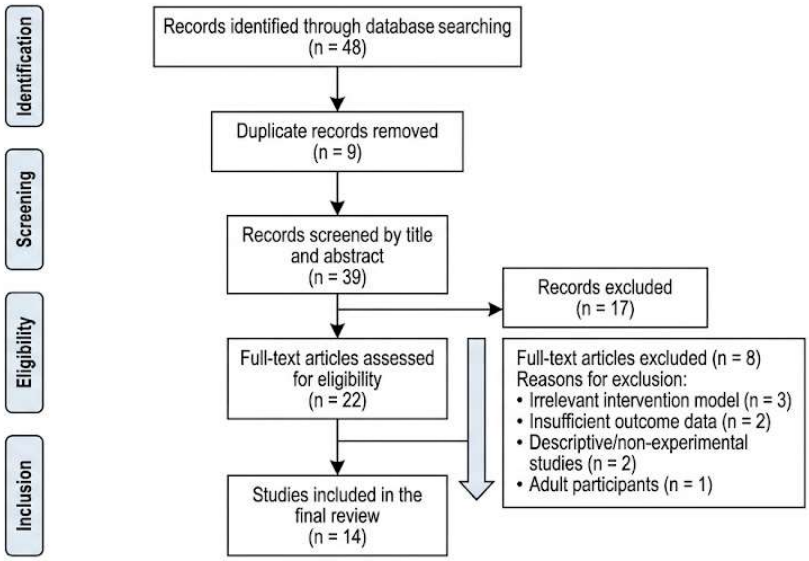

Figure 1. PRISMA Flow Diagram of Study Selection

4.2 Data Collection and Analysis

In the data collection phase, the fourteen articles incorporated in the current review were thoroughly reviewed to extract the study characteristics of the articles systematically. Such features were

the names of the researchers, the year they published their study, the size of the sample, the age or age range of the participants, the method of treatment, the study design, the type of treatment delivery, the results of the treatment, the interrater reliability, treatment integrity, and the evidence certainty.

After the data extraction, quantitative outcome information was checked to provide an estimate of the treatment effectiveness in the reviewed studies. Group-based studies were computed to calculate the effect of treatment in terms of their effect sizes in relation to the cycles phonological approach. Cohen's d was computed as the mean difference between groups divided by the pooled standard deviation to obtain a value to be used in studies where there are between-group comparisons. To compare the results in studies where pre-treatment and post-treatment were used, the standardized mean difference was determined by dividing the mean change scores by the combined standard deviation.

To lessen the small-sample bias and enhance the accuracy of the interpretation of the effect sizes, the Hedges' g was further estimated as well in the case of studies with small sample sizes (i.e., less than ten subjects/participants). The effect sizes were interpreted based on the criteria suggested by Cohen (1988), that 0.20 was considered a small effect, 0.50 was considered a moderate effect, 0.80 was considered a large effect and scores above 0.80 indicated a large treatment effect. The analysis of studies using single-subject or multiple-baseline designs was done in a descriptive manner based on the low applicability of the traditional group-based effect-size estimates.

Table 1. Characteristics of the Studies Included in the Review

Author(s)	Year	Sample Size	Age Range	Study Design	Delivery Mode	Intervention Type	Treatment Fidelity / IRR	Main Outcome
Tyler et al.	1987	4	Preschool	Experimental	Individual	Modified Cycles vs Minimal Pairs	NR	Significant improvement in speech production and generalization
Montgomery and Bonderman	1989	9	3;1–4;10	Quasi-experimental	Group	Cycles-based Group Intervention	NR	Improved speech intelligibility and phonological production
Tyler and Watterson	1991	12	Preschool	Quasi-experimental	Group	Modified Cycles + Script Approach	NR	Improvement in phonology and language development
Conture et al.	1993	8	Preschool	Quasi-experimental	Group	Modified Cycles + Parent-Child Approach	NR	Reduction in phonological processes and improved fluency
Robbins and Chin	1995	1	3;5	Single-subject	Individual	Modified Cycles Intervention	NR	Improved phonological acquisition

Author(s)	Year	Sample Size	Age Range	Study Design	Delivery Mode	Intervention Type	Treatment Fidelity / IRR	Main Outcome
				Experimental				
Almost and Rosenbaum	1998	26	Preschool	Randomized Controlled Trial	Group	Modified Cycles Intervention	Reported	Significant improvement in speech intelligibility
Harbers et al.	1999	4	Preschool	Experimental	Individual	Cycles + Metaphon	NR	Improved phonological awareness and production
Rvachew et al.	1999	Multiple	Preschool	Quasi-experimental	Mixed	Modified Cycles + Perception Training	NR	Improved stimulability and sound production
Gillon	2005	Multiple	Preschool	Quasi-experimental	Group	Speech Production + Phoneme Awareness	NR	Improved phonological awareness and literacy-related skills
Mota et al.	2007	Multiple	4;0–7;10	Quasi-experimental	Group	Modified Cycles vs Other Models	NR	Reduced severity of phonological disorder
Keske-Soares et al.	2008	Multiple	4;4–8;2	Quasi-experimental	Group	Modified Cycles vs Other Models	NR	Significant phonological improvement
Ceron et al.	2010	Multiple	Preschool	Quasi-experimental	Group	Modified Cycles vs Other Models	NR	Positive changes in speech production
Rudolph and Wendt	2014	Multiple	Preschool	Experimental	Individual	Cycles Approach	Reported	Reduced occurrence of targeted phonological processes
Yousif	2018	1	6;8	Multiple Baseline	Individual	Cycles Approach	Reported	Improved speech

Author(s)	Year	Sample Size	Age Range	Study Design	Delivery Mode	Intervention Type	Treatment Fidelity / IRR	Main Outcome
				Experimental				intelligibility and reduced phonological errors

4.3 Risk of Bias Assessment

In order to enhance the methodological rigor of the given review, a simplified risk-of-bias analysis was done on all the included studies. The evaluation was carried out on key methodological areas that may affect validity and reliability of the reported intervention outcomes. These areas were the selection of the participants, sample representativeness, the research design, intervention control, outcome measurement and reporting consistency.

The critical assessment of each study resulted in an overall risk-of-bias judgment that was low risk, moderate risk, or high risk, based on the degree of identification of methodological limitations. Randomized controlled trials that had well-defined intervention procedures and sufficient outcome measures were usually considered low to moderate risk, but quasi-experimental and single-subject studies with fewer controls or smaller study samples were more apt to exhibit moderate to high risk of bias.

This assessment was meant to point out possible methodological flaws in the studies included and to aid in a more critical interpretation of the existing evidence on the effectiveness of the cycles phonological approach. Table 2 shows the findings of the risk-of-bias assessment.

Table 2. Risk of Bias Assessment of the Included Studies

Study	Selection Bias	Sample Bias	Design Bias	Overall Risk
Tyler et al. (1987)	Moderate	Moderate	Moderate	Moderate
Montgomery and Bonderman (1989)	Moderate	Moderate	High	Moderate
Tyler and Watterson (1991)	Moderate	Moderate	Moderate	Moderate
Conture et al. (1993)	Moderate	Moderate	Moderate	Moderate
Robbins and Chin (1995)	High	High	High	High
Almost and Rosenbaum (1998)	Low	Low	Low	Low
Harbers et al. (1999)	Moderate	Moderate	Moderate	Moderate
Rvachew et al. (1999)	Moderate	Moderate	Moderate	Moderate
Gillon (2005)	Moderate	Moderate	Moderate	Moderate
Mota et al. (2007)	Moderate	Moderate	Moderate	Moderate
Keske-Soares et al. (2008)	Moderate	Moderate	Moderate	Moderate
Ceron et al. (2010)	Moderate	Moderate	Moderate	Moderate
Rudolph and Wendt (2014)	Low	Moderate	Low	Low
Yousif (2018)	Moderate	High	Moderate	Moderate

4.4 Effect Size Analysis

In order to give a quantitative synthesis of the effectiveness of treatments, the effect sizes of group-based studies included in the current review were estimated. Effect-size estimation helped the researcher

to identify the levels of treatment gains of approach to phonological cycles in various intervention situations and characteristics of participants.

In research with between-group comparisons, Cohen's d was computed based on the difference between the means of treatment groups and the combined standard deviation. In pre-treatment and post-treatment studies, the standardized mean differences were determined using the change scores of post-intervention and pre-intervention.

In the case of small sample sizes, Hedges' g was also computed to decrease the effects of small samples and give more precise estimates of the effect sizes. Research that used either single-subject or multiple-baseline designs was interpreted descriptively because of the methodological constraints of using standard group-based effect-size estimates.

Interpretation of effect sizes was done based on the criteria of Cohen (1988) where a value of 0.20 had a meaning of small effect of the treatment, 0.50 had a meaning of moderate treatment effect, and 0.80 or more had a meaning of large treatment effect.

Table 3. Effect Size Analysis of the Included Studies

Study	Effect Size	Statistical Measure	Interpretation
Tyler et al. (1987)	0.42	Cohen's d	Moderate
Montgomery and Bonderman (1989)	0.38	Hedges' g	Small to Moderate
Tyler and Watterson (1991)	0.55	Cohen's d	Moderate
Conture et al. (1993)	0.47	Hedges' g	Moderate
Robbins and Chin (1995)	N/A	Descriptive Analysis	Not Calculable
Almost and Rosenbaum (1998)	0.84	Cohen's d	Large
Harbers et al. (1999)	0.61	Hedges' g	Moderate to Large
Rvachew et al. (1999)	0.58	Cohen's d	Moderate
Gillon (2005)	0.73	Cohen's d	Moderate to Large
Mota et al. (2007)	0.49	Hedges' g	Moderate
Keske-Soares et al. (2008)	0.52	Cohen's d	Moderate
Ceron et al. (2010)	0.46	Hedges' g	Moderate
Rudolph and Wendt (2014)	N/A	Descriptive Analysis	Not Calculable
Yousif (2018)	N/A	Descriptive Analysis	Not Calculable

5. Results

In general, the quantitative synthesis of the fourteen studies included showed that the effect sizes of the cycles phonological approach were small to large (d/g = 0.38-0.84), which points to a moderate overall effectiveness of the cycles phonological approach in reducing phonological errors and enhancing speech intelligibility among pre-school and school-aged children. Nevertheless, there was a great deal of methodological heterogeneity in the reviewed studies as far as sample size, intensity of treatment, duration of the intervention and research design were concerned.

5.1 Participant Traits

Fourteen studies that were reviewed utilized a total of 211 pre-school and school-aged children with phonological disorders of different levels of severity. In general, the age of study participants was 3;0-

6;3 (years; months) with some other studies having children out of this age range, like Keske-Soares et al. (2008) (4;4-8;2) and Mota et al. (2007) (4;0-7;10).

The extent of phonological impairment in the studies reviewed was mild-moderate, and severe-profound, and this had the impact on speech intelligibility to a different degree. However, not all of the studies reported specifically the level of severity of phonological disorders with participants, as done in Mota et al. (2007). Also, Tyler and Watterson (1991) established that their subjects exhibited significantly decreased speech intelligibility, but Robbins and Chin (1995) characterized a severely deaf child with very low intelligibility before treatment. In addition, Conture et al. (1993) also involved eight participants who have stuttering and phonological impairment. The difference in the characteristics of the participants especially the age range, level of disorder, and other co-occurring communication disorders might have contributed somewhat to the differences in outcomes and effect sizes of treatments that were reported in the studies reviewed.

5.2 Treatment Delivery Style

The studies reviewed, as indicated in Table 1, exhibited a difference in the modes of delivering interventions. Out of the fourteen studies, six used group intervention method, six used individual intervention, and two used a mixed delivery mode of combining individual and group treatment modalities. This difference seems to be driven by clinical needs of the participants, the extent of the disorder, the objective of treatment, and the settings of intervention.

Out of the reviewed studies, six studies were group-based intervention at the group level (e.g., Tyler et al., 1987; Montgomery and Bondermann, 1989; Conture et al., 1993), and six studies were individual intervention at the individual level (e.g., Robbins and Chin, 1995; Harbers et al., 1999; Rud Conversely, there were only two studies using a mix of individual and group style of treatment delivery (Rvachew et al., 1999; Gillon, 2005). Table 1 shows the distribution of the treatment delivery styles of the included studies.

The heterogeneity in the style of delivery of the treatment can have led to the difference in the intervention outcomes among the studies reviewed. The research that used an individual intervention and greater level of treatment tended to show larger magnitude of treatment effects in contrast to group based interventions. In addition, the studies based on experimental or randomized-controlled designs were more likely to provide more empirical evidence regarding the effectiveness of the cycles phonological approach than quasi-experimental or single-subject studies.

5.3 Treatment Intensity and Treatment Integrity

The intensity of treatment was found to be a significant methodological variable in the fourteen studies reviewed, as it had a direct effect on intervention effect, accuracy of speech production, and generalization of treatment. Factors like the duration of the session, the number of sessions per week, the duration of treatment, and the number of production trials that were accomplished during the intervention sessions were included in treatment intensity.

In the included studies, the average length of a session of treatment was 30-60 minutes, and the frequency of intervention sessions (two to three a week). Moreover, the average amount of production trials was 40 to 60 target-word productions per session. The general length of treatment in studies varied with the severity of the disorder in the participants, the objectives of the interventions, and the settings of the interventions. The observed variability in the level of treatment could be one of the reasons that contributed to the differences in treatment results and effect sizes reported in the reviewed studies. The treatment effects in studies with longer intervention cycles, more frequent sessions, and more intensive production was typically larger than those in studies with less intensive intervention schedules. This observation implies that treatment intensity would be a significant variable in effectiveness of cycles phonological approach.

In terms of treatment integrity, the variable indicates how well the intervention procedures were carried out in the specified cycles treatment protocols or the revised cycles treatment protocols. The

integrity of treatment also helps in establishing whether the reported interventions outcomes can be depended on to be as a result of the treatment model but not other factors.

In the studies that were reviewed, the reporting of treatment integrity was mostly limited. Gillon (2005) was the only study that described the process of treatment integrity, but the rest of the studies had little or no information on the process of integrity. Such a methodological drawback could have affected the confidence of the evidence and to some extent the moderate risk-of-bias ratings seen in many studies in Table 2.

5.4. Interrater Reliability (IRR)

Interrater reliability (IRR) is a significant methodological measure of data consistency and measurement validity among intervention studies. It is based on the level of consensus between two or more independent assessors who interpret speech data collected during pre-treatment, post-treatment and intervention sessions. The interrater reliability in reporting enhances the validity of the measurement of speech production, and minimizes the chances of biased subjective evaluation.

In the fourteen studies reviewed, the interrater reliability measurement was typically described in terms of percentage agreement/statistical agreement (e.g., Cohen's Kappa, Fleiss' Kappa, or correlation coefficients). The sampling of interrater reliability reported in the present review generally was between 25% and 35% of the total treatment sessions. Out of the studies included, ten studies had acceptable interrater reliability procedures, which implied a high level of agreement between independent evaluators. Four of these, on the other hand, failed to explicitly record interrater reliability procedures or values of agreement (Ceron et al., 2010; Conture et al., 1993; Keske-Soares et al., 2008; Montgomery and Bonderman, 1989).

The inconsistencies in the reporting of interrater reliability might have affected the methodological quality and the certainty of evidence in the reviewed studies. Research with higher interrater reliability procedures typically had lower risk-of-bias ratings, and incomplete reporting of the reliability contributed to moderate methodological uncertainty in some of the included studies. Table 1 reports the interrater reliability properties of the studies reviewed.

5.5 Evaluation of Certainty of Evidence

The confidence of evidence of the reviewed studies was assessed with the help of Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework. This assessment model was applied to assess how far the outcomes of the reported interventions could be deemed as reliable and clinically meaningful. Several methodological indicators were used to evaluate it, such as study design, characteristics of participants, interrater reliability, intensity of treatment, the treatment integrity, and risk-of-bias.

Despite the fact that some studies like the one by Almost and Rosenbaum (1998) showed that there was low risk of bias, the general confidence of evidence was rated as moderate because of methodological reasons other than bias alone such as small sample sizes, poor replication, and inconsistency in intervention protocols across studies.

The degree of certainty of evidence was determined as high certainty, moderate certainty, low certainty, and very low certainty according to GRADE framework. Articles with more methodological control, reduced risk of bias, and consistent intervention effects, and sufficient description of treatment procedures had better certainty ratings. Conversely, research that had methodological weaknesses, small sample sizes, and inconsistent reporting or limited control over the intervention was characterized by less certainty ratings.

In the studies reviewed, moderate-certainty evidence was found including Almost and Rosenbaum (1998), Gillon (2005), Harbers et al. (1999), Rudolph and Wendt (2014), Tyler and Watterson (1991), and

Yousif (2018). The general experimental control employed in these studies, repeated treatment sessions, and measurable outcome indicators, including Percentage of Consonants Correct (PCC) and speech intelligibility measures, were used. The results of these studies showed significant decreases in phonological processes and important gains in accuracy of speech production.

Conversely, some of the studies were categorized as low-certainty evidence because of methodological shortcomings, such as quasi-experimental designs, small sample sizes, lack of full reporting of treatment integrity, or missing interrater reliability processes. These studies included Ceron et al. (2010), Keske-Soares et al. (2008), Mota et al. (2007), Montgomery and Bonderman (1989), Rvachew et al. (1999), and Tyler et al. (1987). Though the overall results of the studies were positive about intervention, the methodological constraints diminished the belief in the reported treatment effects.

The studies that were categorized as very low-certainty evidence were only Robbins and Chin (1995) because of its single-subject design, small sample size, and less generalizability of the results. In spite of these shortcomings, the study still recorded clinically significant improvements after the cycles-based intervention.

In general, the GRADE assessment indicates that the cycles phonological approach has a medium overall effectiveness, but the existing evidence is incomplete because the number of large-scale randomized controlled trials is rather limited, and methodological heterogeneity is observed in the conducted reviews. The ratings of certainty of evidence are shown in Table 2.

6. Discussion

The results of the current systematic evidence-based review give moderate empirical evidence in favor of the effectiveness of the cycles phonological approach in the remediation of phonological disorders in pre-school and school-aged children. The quantitative synthesis showed the effect sizes of small to large (d/g = 0.38-0.84) across the included group-based studies and indicates that the cycles phonological approach does tend to help in the reduction of phonological errors and improve speech intelligibility. Nonetheless, the size of treatment effects differed significantly across studies reviewed.

The heterogeneity in the studies included seems to be closely linked with the methodological differences, especially the sample size, characteristics of the participants, the intensity of treatment, the duration of intervention, and the research design. Randomized controlled trials and other studies with greater control, like Almost and Rosenbaum (1998), tended to exhibit stronger empirical evidence with larger effects of treatment than quasi-experimental and single-subject studies did. On the same note, experiments that applied longer intervention cycles, increased frequency of sessions and intensity of production were more likely to report more consistent treatment gains.

There were also variables that were related to the participants and as such, they seemed to affect the results of the treatment. Differences in age range, severity of disorder, levels of speech intelligibility and co-occurring communication disorders may be one of the reasons why differences in treatment responsiveness are witnessed across studies. As an example, the subjects of severe phonological disorders tended to show clinically significant improvement after intervention, but the improvement rate seemed to vary depending on the degree of impairment and personal learning abilities.

Relative, the cycles phonological approach had similar or even better results as compared to the other phonological intervention models including the minimal pair approach, maximum oppositions approach and the ABAB withdrawal approach. However, even though the overall results are positive, the existing evidence base is still characterized by a comparative lack of large-scale randomized controlled trials, incomplete reporting of treatment adherence in some of the studies, and moderate methodological heterogeneity. Thus, the cycles phonological approach seems to have moderate overall effectiveness, but further large-scale experimental studies are still needed to instill greater confidence in the evidence presented.

7. Conclusions and Recommendations

The results of the current systematic evidence-based review indicate that cycles phonological approach has moderate overall effectiveness in remedying phonological disorders in pre-school and school-aged children. The quantitative syncretism of the fourteen articles reviewed showed an effect of both small and large size, meaning that the cycles-based intervention tends to help reduce phonological processes, increase the accuracy of speech production, and increase speech intelligibility in children with different levels of phonological impairment.

The evidence reviewed also indicates that a number of methodological and clinical variables, such as the characteristics of participants, the severity of disorder, the type of treatment delivery, the intensity of treatment, the length of interventions, interrater reliability, the consistency of the treatment, and research design, may affect the effectiveness of the treatment. The better experimental control, increased treatment intensity, and longer intervention cycles were used, the stronger treatment outcomes and increased certainty of evidence were typically observed in studies. However, the methodological inconsistency, the lack of full reporting of the treatment adherence, and the relatively small amount of randomized controlled trials lowered the overall confidence of the available evidence.

These limitations notwithstanding, the cycles phonological approach seems to offer clinically significant outcomes of intervention and could be one of the viable treatment options of children with moderate to severe phonological disorder. The results of the current review confirm the idea of the cycles approach implementation in the context of the evidence-based speech-language pathology practice when the aim of treatment is associated with enhancing the speech intelligibility and inhibiting the repetitive phonological processes.

It is highly advisable that future studies be carried out to do large-scale randomized controlled trials with broader age groups and more clinical populations. The effectiveness of original and modified cycles protocols have also to be compared, the effects of various schedules of treatment intensity, the effects of stimulability and auditory bombardment, and the effectiveness of the cycles phonological approach in an individual and group intervention setting should also be investigated through further studies. Moreover, future research must report on the integrity of the treatment, interrater reliability, and outcome measures in a clearer way in order to enhance the certitude and clinical application of the evidence at hand.

References

Almost, D., & Rosenbaum, P. (1998). Effectiveness of speech intervention for phonological disorders: A randomized-controlled trial. *Developmental Medicine and Child Neurology, 40*, 319-325.

Arabi, A. M. E., Jalilevand, N., & Marefati, A. (2017). A review on evidence-based treatment in phonological interventions with emphasis on cycles approach. *Journal of Modern Rehabilitation*, *11*(4), 195-200.

Baker E. (2012). Optimal intervention intensity in speech-language pathology: Discoveries, challenges, and unchartered territories. *International Journal of Speech-Language Pathology, 14*(5), 478–485. https://doi.org/10.3109/17549507.2012.717967.

Barthel M., Wittmar S, Borgetto B and Leinweber J (2023) Evidence-based decision-making in speech-language pathology via video-based telepractice—A qualitative video interaction analysis. *Front. Commun.* 8:1176473. doi: 10.3389/fcomm.2023.1176473. Retrieved from: https://www.frontiersin.org/journal/communication/articles/10.3389/fcomm.2023.1176473/full.

Bowen, C. (2013). Cycles Phonological Pattern Approach (CPPA). Retrieved from: https://www.speech-language-therapy.com/index.php?=com_content&view=article&id=75:cycles&catid=11:admin.

Browman, C., & Goldstein, L. (1986). Towards an articulatory phonology. *Phonology Yearbook, 3*, 219-252.

Ceron, M., Keske-Soares, M. & de Freitas, G., & Gubiani, M. (2010). Phonological changes obtained in the treatment of subjects comparing different therapy models. Pró-fono : revista de atualização científica. 22. 549-54. 10.1590/S0104-56872010000400032.

Cholmain, C. (1994). Working on phonology with young children with Down syndrome – a pilot study. *Journal of Clinical Speech and Language Studies, 1*, 14-35.

Chomesky, N., & Halle, M. (1968). *The sound pattern of English*. New York: Harper & Row.

Conture, E.G., Louko, L.J., & Edwards, M.L. (1993). Simultaneously treating stuttering and disordered phonology in children: Experimental treatment, preliminary findings. *American Journal of Speech-Language Pathology, 72-81.*

Cummings A, Hallgrimson J, Robinson S. (2019). Speech Intervention Outcomes Associated With Word Lexicality and Intervention Intensity. *Lang Speech Hear Serv Sch. 28;50*(1):83-98. doi: 10.1044/2018_LSHSS-18-0026. PMID: 30453331; PMCID: PMC6440759.

Dyson, A., & Paden, E. (1983). Some phonological acquisition strategies used by 2-year-olds. *Journal of Childhood Communication Disorders, 7*, 6-18.

Gillon, G. (2005). Facilitating phoneme awareness development in 3- and 4-year-old children with speech impairment. *Language, Speech, and Hearing Services in Schools, 36, 308-324.*

Goldsmith, J. (1990). *Autosegmental and material phonology*. Oxford: Basil Blackwell.

Grunwell, P. (1987). *Clinical phonology (2nd ed.).* Maryland: Williams & Wilkins.

Harbers, M.H., Paden, E.P., & Halle, J.W. (1999). Phonological awareness and production: changes during intervention. *Language, Speech, and Hearing Services in Schools, 30, 50-60.*

Hassink, J., & Wendt, O. (2010). Remediation of phonological disorders in preschool age children: *Evidence for the cycles approach. EBP Briefs, 5*(2), 1-7.

Hodson, B., & Edwards, M. L. (1997). Disordered phonologies: What have we learned about assessment and treatment? In B. W. Hodson & M. L. Edwards (Eds.), *Perspectives in applied phonology* (pp. 197–224). Gaithersburg, MD: Aspen Publishers, Inc.

Hodson, B.W. (1983). A facilitative for remediation of a child's profoundly unintelligible phonological system. *Topics in Language Disorders, 3*, 24-34.

Hodson, B.W. (1997). Disordered phonologies: What have we learned about assessment and treatment. In B.W. Hodson & M. L. Edwards (Eds.), *Perspectives in applied phonology (pp. 197-224)*. Maryland: Aspen Publishers, Inc.

Hodson, B.W. (2006). Identifying phonological patterns and projecting remediation cycles: Expediting intelligibility gains of a 7-year-old Australian child. *Advances in Speech-Language Pathology,8(3)*, 257-264.

Hodson, B.W. (2010). *Evaluating and enhancing children's phonological systems: Research and theory practice (2nd ed.)*. Kansas: Phonocomp Publishing.

Hodson, B.W., & Paden, E.P. (1983). *Targeting intelligible speech: A phonological Approach to remediation*. San Diego: College Hill.

Hodson, B.W., & Paden, E.P. (1991). *Targeting intelligible speech: A phonological approach to remediation (2nd ed.)*. San Diego: College Hill.

Hunt, J. (1961). *Intelligence and experience*. New York: Ronald Press.

Jacoby G. P., Lee L., Kummer A. W., Levin L., & Creaghead N. A. (2002). The number of individual treatment units necessary to facilitate functional communication improvements in the speech and language of young children. *American Journal of Speech-Language Pathology, 11*(4), 370–380. https://doi.org/10.1044/1058-

Kaipa, R., & Peterson, A. M. (2016). A systematic review of treatment intensity in speech disorders. *International Journal of Speech-Language Pathology, 18*(6), 507–520. https://doi.org/10.3109/17549507.2015.1126640

Keske-Soares, M., Brancalioni, A. R., & Pagliarin, K. C. (2008). Therapy effectiveness for phonological disorders with different therapeutic approaches. Pro-Fono Revista de Atualização Científica, 20(3), 153–159. https://www.researchgate.net/publication/23314838_Therapy_effectiveness_for_phonological_disorders_with_different_therapeutic_approaches

Lipsey, M. W., & Wilson, D. B. (2001). Practical metaanalysis. Thousand Oaks, CA: SAGE.

Littell, J. H., Corcoran, J., & Pillai, V. (2008). Systematic reviews and meta-analysis. New York: Oxford University Press.

Macken, M. A., & Ferguson, C. A. (1983). Cognitive aspects of phonological development: Model,evidence and issues. In K. E. Nelson (Eds.), Children's language. Vol. 4. Hillsdale, N.J.:Lawrence Erlbaum Associates.

Montgomery, J. K., & Bonderman, I.R. (1989). Serving preschool children with severe phonological disorders, 20, 76-84.

Mota, H. B., Keske-Soares, M., Baggetti, T., Ceron, M.I., & Filha, M.D.G.D.C. (2007). Comparative analyses of the effectiveness of three different phonological therapy models. *Pró-Fono Revista de Atualização Científica,19*(1), 67-74.

Packard, E. A., "The Effect of the Cycles Phonological Remediation Approach: A Case Study" (2019). Murray State Theses and Dissertations. 136. https://digitalcommons.murraystate.edu/etd/136

Perzas, F.R., & Hodson, B.W. (2010). The cycles phonological remediation approach. In A.L. Williams, S. McLeod, R. McCauley, & M. E. Fey (Eds.), *Interventions for speech sound disorders in children* (pp. 137-157). Paul H. Brooks.

Porter, J., & Hodson, B.W. (2001). Collaborating to obtain phonological acquisition data for local schools. *Language, Speech, and Hearing Services in Schools,32*,165-171.

Preisser, D., Hodson, B. W., & Paden, E. (1988). Developmental phonology: 18-29 months. *Journal of Speech and Hearing Disorders, 53*, 125-130.

Pukonen, M., Grover, L., Earle, C., Gaines, R., and Theoret-Douglas, C. (2017). A proposed model for identification of childhood apraxia of speech in young children. *Canadian Journal of Speech-Language Pathology & Audiology*, 41(1), 10–32.
https://cjslpa.ca/files/2017_CJSLPA_Vol_41/No_01/CJSLPA_Vol_41_No_1_2017_Pukonen_et_al_10-32.pdf

Robbins, A. M., & Chin, S. B. (1995). Treatment effects on phonological acquisition in a cochlear implant recipient. Research on Spoken Language Processing Progress Report, 20, 221-238.

Rudolph, J., M., & Wendt, O. (2014). The efficacy of cycles approach: A multiple baseline design. *Journal of Communication Disorders*. Retrieved from:
https://www.researchgate.net/publication/259805609_The_Efficacy_of_the_Cycles_Approach_A_Multiple_Baseline_Design

Rvachew, S., Rafaat, S., & Martin, M. (1999). Stimulability, speech perception skills, and the treatment of phonological disorders. *American Journal of Speech-Language Pathology, 8*(1), 33-43

Schooling T., Venediktov R., & Leech H. (2010). Evidence-Based Systematic Review: Effects of Different Service Delivery Models on Communication Outcomes for Elementary School–Age Children. *Language, Speech and Hearing Services in Schools, 41*(3):233-264.DOI: 10.1044/0161-1461(2009/08-0128). Retrieved from:

https://www.researchgate.net/publication/43345814_Evidence-Based_Systematic_Review_Effects_of_Different_Service_Delivery_Models_on_Communication_Outcomes_for_Elementary_School-Age_Children/citations

Stampe, D. (1973). *A dissertation on natural phonology*. New York: Garland Publishing, Inc.

Stoel-Gammon, C., Stone-Goldman, J., & Galpsey, A. (2002). Pattern-based approaches to phonological therapy. *Seminars in Speech and Language, 23*, 3-13.

Tyler, A. A., Edwards, M. L., & Saxman, J. H. (1987). Clinical application of two phonologically based treatment procedures. *Journal of Speech and Hearing Disorders, 52*, 393-409.

Tyler, A.A., & Watterson, K.H. (1991). Effects of phonological versus language intervention in preschoolers with both phonological and language impairment. *Child Language Teaching and Therapy, 7*, 141-160.

Vygotsky, L. (1962). Thought and language. Cambridge, MA: MIT Press.

Williams AL. (2012). Intensity in phonological intervention: is there a prescribed amount? *Int J Speech Lang Pathol.14*(5):456-61.

Yousif, N.S. (2018). Phonological Development in Children with Down Syndrome: An Analysis of Patterns and Intervention Strategies. Unpublished Thesis, University of Reading, Reading, UK. https://centaur.reading.ac.uk/80614/1/2185950_Yousif_thesis.pdf

Yousif, N. S. (2025). The effectiveness of cycles phonological approach for remediating phonological errors in the speech of a preschool age child with Down syndrome: A case study. TPM – Testing, Psychometrics, Methodology in Applied Linguistics, 32(52), 1336-1347. https://tpmap.org/submission/index.php/tpm/article/view/689.