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THE EFFECTIVENESS OF CYCLES PHONOLOGICAL INTERVENTION FOR REMEDIATING PHONOLOGICAL ERRORS IN THE SPEECH OF A PRE-SCHOOL AGE CHILD WITH DOWN SYNDROME: A CASE STUDY

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Abstract
The phonological errors occurring in the speech of pre-school and school age children with Down syndrome affect their speech production and reduces their speech intelligibility. Therefore, early phonology-based intervention is needed to overcome the phonological problems and increase speech clarity. Speech language therapists have a wide range of intervention models that could be tailored to the needs of children with Down syndrome. Yet the effectiveness of these models in treating phonological errors have been continuously tested. The present case study aims at evaluating the effectiveness of the cycles phonological remediation approach to treat the phonological processes prevailing the speech of a pre-school age child with a Down syndrome. The study presented a thorough pre- and post-speech assessment analysis of the child's speech sample. Accordingly, two primary patterns were selected to be targeted within the treatment cycle. Post-treatment improvement in child's speech intelligibility was indicated after treatment completion.

1. INTRODUCTION

There have been persistent attempts to develop effective intervention programmes that could help DS children improve in all communication areas. Thus, most of the intervention programmes for DS children focused either on developing daily living communication skills or articulation at the expense of phonology (Hodson, 2011; Stoel-Gammon, 2001). In an attempt to support clinicians choose the most suitable intervention programme, there was an urgent need to differentiate between speech production impairment and phonology impairment. It was stressed that speech impairment need to be treated within traditional articulation-based framework; while phonology impairments need to be targeted within a phonological-based intervention. For children with both kinds of impairment, it is recommended that a mixture of both models techniques to be used. Therefore, clinicians and SLPs insisted on targeting phonological problems separately from other types of speech or communication impairments (Grundy, 2001). Phonology has been considered as a fundamental part of developing other language aspects. That is, extremely unintelligible children need to focus on one aspect at a time (either phonology or language but not on both of them simultaneously). Therefore, current study attempts to deal with the most deficient phonological patterns of the DS participants and help them improve their phonology to increase intelligibility (Hodson et al., 1989; Hodson, 2011; Tyler and Watterson, 1991).

A holistic phonology-based approach has been designed to treat the sounds and sound pattern errors in highly unintelligible children with various impairment aetiologies as well as speech impairments in special population children, such as Down syndrome population. The cycles phonological remediation approach is a phonological pattern-oriented approach to treat the SSDs of highly unintelligible children aged 2:6-14 years (Hodson & Paden, 1991; Hodson, 2011). Its core phonological theory is gestural phonology (Browman and Goldstein, 1986; Kent, 1997) which centres around classes of articulatory movements (gestures) and hypothesises that phonological representation hinges on speech perception as well as speech production. The approach is also based on a number of theoretical considerations including the theories of natural phonology, generative phonology, non-linear phonology, distinctive features analysis and clinical research (e.g. Stampe, 1972; Chomesky & Halle, 1968; Goldsmith, 1990), principles of cognitive psychology (e.g. Hunt, 1961; Vygotsky, 1962), phonological acquisition research (e.g. Dyson and Paden, 1983; Grunwell, 1987; Porter and Hodson, 2001; Preiser et al., 1988), and clinical phonology research (e.g. Almost and Rosenbaum, 1998; Gordon-Branann, Hodson and Wynne, 1992; Hodson, 1978; 1982;1983; 1989; 1994; 1997; 2001; 2006; Hodson et al., 1983; Hodson etal., 1989; Hodson and Paden, 1983; 1991).

Additionally, the cycles approach comprises seven basic concepts underlying its general framework. These include gradual phonology acquisition, learning sounds primarily through listening to adults' sounds, associating kinaesthetic and auditory sensations to enable self-monitoring at later sound development stages, using facilitative phonetic environment, active engagement during the acquisition process, continuously generalising the learned patterns to newly acquired sounds, and providing the child with optimal learning opportunities that are challenging but enjoyably doable (Hunt, 1961; Vygotysky, 1962; Ingram, 1972 ; Dyson and Paden, 1983; Browman and Goldstien, 1986; Dyson and Paden, 1983; Hodson and Paden, 1991).

Consequently, the present case study was designed to investigate the effectiveness of cycles intervention in treating the phonological processes occurring in the speech of a pre-school-age child with DS. It also explained the way the cycles phonological pattern-based approach could be used to increase intelligibility. Clinically, it could be implemented by SLTs (speech-language therapists) as a feasibly flexible intervention model which emphasises that a misarticulating child's phonology can be gradually developed and generalise the learned patterns to other untreated sounds to emerge unconsciously in their conversational speech.

2. Previous Studies on the Cycles Approach

The cycles phonological remediation approach has been one among multiply various approaches which have been adopted by SLTs to treat the phonological errors in highly unintelligible pre-school and school age children. A series of case and group studies were practical attempts to provide evidence of the efficiency of the cycles approach. The cycles approach was feasibly modified and adapted for group intervention in different clinical settings. The original and/or the modified version of the approach was used to treat the phonological impairment in children with complicated aetiologies. It was also manipulated alongside other approaches, such as, minimal pairs or maximal oppositions, to test its effectiveness in overcoming the phonological problems in children with disordered phonological systems. These studies included experimental designs such as, single case, between-participants, randomaised controlled trial or multiple probe AB designs. The numbers of participants treated were ranging between 1 and 30 children with disordered phonologies. The cycles-based intervention was also practically adapted to meet the needs of children treated, in the sense that SLTs were intentionally changing and controlling the intervention structure in terms of the length of the treatment programme, perception training tools and activities, or the use of digital listening devices. The effectiveness of the original or the modified version of the cycles model was found to be evident that it facilitated the elimination of most the sound and sound pattern errors targeted and also increased speech intelligibility (Almost and Rosenbaum, 1998; Gierut, 1998; Harbers et al., 1999; Hodson, 2009; 2011; Mota et al., 2007; Royer, 1995; Packard, 2019; Rvachew et al., 1999; Tyler and Watterson, 1991). Additionally, the cycles approach proved to be an economically useful intervention programme which saves time and money with appropriately adjustable schedule, especially, in treating groups of preschool and school age children with phonological impairments (Montgomery and Bonderman, 1989; Tyler et al., 1987).

In a unique study based on a randomised controlled trial design, the effectiveness and efficacy of the cycles approach was examined (Almost and Rosenbaum, 1998). The study added important evidence supporting the utility of the cycles intervention in assisting treated children learn the target sounds, generalise what they learned to their daily speech and, in return, increasing their speech intelligibility. Importantly, the cycles approach emphasised upon the aspect of the gradual acquisition of the treated targets and, at the same time, it promoted the aspect of stimulabilty to the treated sounds. Gierut (1998) highlighted the cyclic nature of the cycles approach which facilitates acquiring the newly learned patterns. It implies that the child keeps vacillating between the correct and incorrect productions until being able to produce the target patterns properly. Similarly, Rvachew et al (1999) found that stimulibility and perception training extensively facilitates learning and internalising the target patterns. However, Rvachew et al. (1999) could not decisively prove the efficiency of the cycles approach due to the small number of participants in their study and the insufficient literature on the efficacy of the cycles approach. Therefore, it was contended that same results might have been obtained if another treatment model had been used. Despite the speech production improvement the participants achieved in the studies mentioned above, it was highly recommended that the efficacy of the original or the modified cycles model need to be further investigated.

Royer (1995) conducted a single –subject case study to evaluate the effectiveness of the cycles and minimal pair treatment models in remediating the phonological errors in the speech of highly unintelligible a male child. As the pre-treatment and post-treatment results were compared, it was observed that there was a slight decrease in the occurrence of the phonological errors. Additionally, the results showed insignificant difference between the child's scores when treated via cycles and minimal pairs approaches. Yet, the cycles procedure significantly proved to supress the occurrence of consonant cluster reduction more than the minimal pairs procedure did. According, such a finding could

reflect the effectiveness of the cycles approach rather than the minimal pairs that the phonological cycling approach was more effective for this subject than the minimal pairs approach.

Many single-subject case studies (Galpsey and Stoel-Gammon 2005; Hodson,2007; 1983; Hodson, et al., 1989; Hodson, 2006; lambert, 1992; Stoel-Gammon et al., 2002; Packard, 2019; Royer, 1995; and Rudolph & Wendt, 2014) were conducted to examine the efficacy of cycle intervention model in remediating children whose ages were between 3:11 and 7 years, and were diagnosed with moderate to profound SSDs of unknown origin. The findings of these studies revealed that the cycles model was both effective and efficient in improving the children's speech production and increasing their speech clarity gains. The improvement as such could be attributed the cycles approach practicality in facilitating learning the treated patterns via targeting the sounds to which the children were stimulable. This would feasibly facilitate improving the other more difficult sounds and, in return, gradually increase speech intelligibility (Galpsey and Stoel-Gammon, 2005; 2007; Hodson, 1983; Rudolph and Wendt, 2014).

Phonology is a crucially fundamental constituent of a language; therefore, deficient phonology decreases speech intelligibility and, at the same time, negatively impacts children's literacy skills and academic achievement. As a result, phonology-based treatment approaches tends to be more convenient to start with, particularly for highly unintelligible children. Hodson et al. (1989) insisted that phonology had an important role in developing other language aspects, such as syntax. This is importantly reflected by the overriding finding which revealed that the child under investigation did not make any achievement when language and phonology were simultaneously targeted. On the contrary, the child highly scored when focusing on gradual acquisition of correct phonological patterns and then followed by language intervention. Furthermore, Hodson (2006) and Rudolph and Wendt (2014) highlighted another practical characteristic of the cycles intervention model which is its flexibility in introducing the targets to the client. Thus, a new target sound or pattern could be introduced to the child and used in the treatment session even before completely supressing the former one. This could be considered as an indication of the treatment effectiveness and efficacy and efficiency as the child would begin to gradually transfer from the emergent pattern to sound mastery even without direct intervention.

In a single subject case study, Hodson (2009) designed a cycles-based intervention programme for a school-age child with severely unclear speech. The child's phonology was profoundly impaired. The cycles was found effective in supressing most of the pattern errs in the child's speech, especially /s/ clusters, and in return, his speech intelligibility improved. In a recent case study, Packard (2019) investigated the efficacy of the cycles phonological approach in remediating the speech sound errors in a six-year child diagnosed with a moderate to severe phonological disorder and unclear speech. The results revealed a substantial improvement from moderate to mild severity level. I addition, the occurrences of sound and sound patterns errors were noticeably decreased to the extent that the child managed to generalise the learned patterns to the untreated sounds without being maintained or modelled generalisation to the untreated sounds was not maintained or modelled.

Examining the effectiveness of the cycles approach has continued to be the main focus of a mixture of studies who claimed that it could be adopted to treat phonological disorders brought about by different causes. For example, the cycles model used to treat preschool or school age children with developmental verbal dysapraxia (Lambert, 1992; Hodson and Paden, 1983), hearing problems and cochlear implantation (Gordon-Brannan et al., 1992; Robbins and Chin, 1995); repaired cleft palate (Hodson et al., 1983), stuttering and cognitive delay disorders (Conture et al., 1993; Culatta et al., 2005); and Childhood Apraxia of Speech (CAS) (Perzas and Paden, 2010).

Hodson et al. (1983) presented a challenging piece of research and was the first study in the field. A school age child who had a repaired cleft palate and severely impaired expressive skills and learning disabilities which negatively impacted his educational as well as social life. A cycles –based intervention programme was designed to target the phonological deviations extensively prevailing the child's speech. The findings revealed that the child's speech considerably improved Robbins and Chin (1995) selected cycles model to treat the participant with hearing problems and highly unintelligible issues. The selection of the cycles-based intervention was due to its practical components including auditory bombardment of the target patterns, kinaesthetic images related to speech sensation, and the cyclic structure of the treatment sessions. Interestingly, the cycles procedure enabled the child to produce proper approximation of the treated sounds rather than 100% mastery which would require stressful drilling and take longer time to achieve the treatment goals.

Hodson and Paden (1983), Culatta et al. (2005) and Perzas and Hodson (2010) have inspected the extent to which the cycles model in remediating was effective in treating the phonological patterns of children with different intellectual impairments. Conture et al., (1993) presented a description of the intervention programme designed to simultaneously treat phonological errors and stuttering problems in stuttering children. The results were to those of stuttering children without phonological errors. The study findings could be an encouraging factor that promotes treating phonology and stuttering disorders at the same time as this procedure would maximise 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. Despite the progress the clients achieved, further research was still needed to evaluate the efficiency of the cycles model for treating the SSDs in children with variable aetiologies (e.g Down syndrome) and severity levels.

Cole (1995) conducted a cycles-based intervention programme to treat a male pre-school age child diagnosed with highly unintelligible speech. After completing two treatment cycles, the results of post-treatment assessment revealed a change in the severity level for profound to severe. The results also manifested a considerable improvement in the child's speech intelligibility. The finding indicated that the cycles approach effectively contributed to decreasing the phonological errors occurring the child's speech. Lambert (1992) treated the phonological disorders in the speech of two male pre-schoolers diagnosed with developmental verbal dyspraxia. The selected patterns were targeted within the cycles-based intervention; yet the intervention procedure was individually designed to meet the needs of each participant separately. The post treatment assessment revealed that the percentage of occurrence of processes increased rather decreased; although his speech intelligibility witnessed a slight improvement. On the other hand the second participant showed a considerable improvement as the percentage of occurrence of the processes decreased and speech intelligibility considerably improved. Consequently, it was recommended that the cycles approach still need more investigation to evaluate its effectiveness in treating the phonological disorders in children with more complicated aetiologies.

3. METHODOLOGY

3.1 The participant

A female pre-schooler with Down syndrome aged 5:4 (year: month) participated in the present study to (1) assess her speech and identify the most frequently occurring sound and sound pattern errors; and (2) to target these errors with the cycles procedure and evaluate the effectiveness of the cycles-based treatment. The child attended the assessment and intervention sessions carried out in the speech and language clinic at the University of Reading. The participant was a monolingual British English-speaker. She did not have serious medical complications, such as hearing and vision problems. She was diagnosed with dysarthria or childhood apraxia of speech (CAS). Her parents reported that her speech could hardly be understood. Although the child received a private speech-language therapy when she was 4 years old, her family member and close acquaintances kept facing difficulty to understand the child's words. Therefore, her parents strongly supported her to receive speech intervention in order to increase her speech intelligibility.

3.2 Speech Assessment

The participant's speech was initially assessed by using Hodson Assessment of Phonological Patterns-Third Edition (HAPP-3) (Hodson, 2004). Based on the results of pre-treatment speech assessment, the most frequent phonological processes occurring in the child's speech were identified. HAPP-3 assessment results showed that her PCC was 58% in that she correctly produced 86 consonants out of 147. The child substituted a far more back uvular fricative /*x*/ for velar plosive /k/. Her speech was characterised by extensive substitutions and omissions. See more examples in Table 1. Based on the assessment results, cluster reduction was the most pervasive phonological process that dominates the child's speech. In addition, she deleted unstressed short syllables and was found to be experiencing difficulty in producing words with two or more syllables or producing cross boundary consonant sequences. She tended to replace some of initial consonants in CVC words with either front bilabials, nasals or glides. Yet, she was not able to pronounce some of the back consonants. See Table 1 for more illustration.

The cluster reduction process was the most dominant sound pattern error which prevailed the child's speech. See Table 1. The child continued to reduce consonant clusters process which was a characteristic of the speech of children younger than the current participant. Nonetheless, she was found stimulable to pronouncing singleton /s/ in word initial position. She also responded to sound modelling and tried to imitate most of the targeted singleton consonants.

Table 1 The Percentage of Occurrence of the Phonological Deviations

Dominant phonological processes	Occurrences	Percentage	Sound Pattern Error

Cluster Reduction	26	39%	/s/ clusters e.g spoon [pu:]; liquid clusters/kl/ e.g. clouds [laʊdz]; /gl/ e.g. glove [lʌv]; consonant sequences /-θbr-/ e.g. toothbrush [brʌʃ]; /-skj-/ e.g. ice cubes [aɪs u:t].
Backing	13	19%	/f/→/s/ e.g. fork [sɔ:, /t/→/s/ e.g. television [seseʒən],
Fronting	13	19%	/k/→/z/ e.g. cowboy [zæbɔɪ], /g/→/d/ e.g. gum [dʌm]
Reduplication	4	6%	/sə/e.g. television [seseʒən], /fə/ e.g. feather [fefə]
Gliding	3	4.5%	/r/→/w/ e.g. rock [wɔ:k]
Other Assimilations	3	4.5%	/θ/→/f/ e.g. three [fri:]
Labial Assimilation	2	3%	/dr/→/f/ e.g. screwdriver [sefefə]
Stopping	1	1.5%	/bz/→/t/ e.g. ice cubes [aɪs u:t]
Palatalisation	1	1.5%	/l/→/j/ e.g. yellow [jejəʊ]
Prevocalic Voicing	1	1.5%	/t/→/d/ e.g. truck [dæ]
Prevocalic Devoicing	1	1.5%	/v/→/f/ e.g. screwdriver [sefefə]
Total	68		

The results of the pre-treatment speech assessment manifested that the total occurrences of major phonological deviations (TOMPD) was 68, and this score was within the range 51 and 100 processes. See Table 2. Accordingly, the child's speech was considered as moderately impaired. The child also experienced difficulty in producing multisyllabic words, such as toothbrush [brʌʃ]; /-skj-/; ice cubes [aɪs u:t]. She was able to utter single words and produce the test words with modelling. Her phonetic repertoire included the following sounds /f, v, p, b, m, n, ŋ, t, d, l, w, r, ʃ, j/; yet, she was unintelligible for she has recurrently made inconsistent sound errors. 30% of her consonant productions were incorrect. In addition, she was not able to produce two- or more syllable words, for example, toothbrush, music box, cowboy hat, television. The child's speech was described as highly unintelligible that scored 62.5% for structural phonological deviations. She deleted most of the initial consonant and final consonants. She also was not able to produce consonant clusters between words. She managed to pronounce singleton /s/ and /k/ sounds with modelling; yet, she found it difficult to produce these sound when occurring in clusters, for example, school is pronounced as [tu:l] and spark as [pɑ:k].

Table 2 Summary of the Child's Speech Assessment by Using HAPP-3

Severity Level (TOMPD) sum	68 (51-100 moderate)
Consonant Category Deficiencies sum	33
Word/Syllable Structure Deficiencies sum	45
Percent Consonant Correct (PCC)	58%

Ability Score	55
Percentile Rank	< 1

3.3 Intervention Design

A six-week treatment cycle was designed. The intervention programme comprised three phases: baseline, treatment and follow-up. Since the /s/ cluster reduction was the most frequently occurring phonological process which impacted the child's speech intelligibility, it was selected as the primary target with three stimulable sounds the bilabial stop /p/, the alveolar stop /t/, and the velar stop /k/. The three clusters were embedded in five monosyllabic and disyllabic words per each cluster. The three phases of the intervention programme are as follows:

3.3.1 Baseline

Three baseline measures were administered over two weeks prior to intervention commencement in order to ensure the recurrent occurrence of /s/ cluster reduction prior to starting the cycles treatment. Thus, a stable baseline over at least three-time points was established for each target behaviour prior to the intervention initiation. For example, for the /s/ cluster reduction, three sounds were selected /sp-/, /st-/ and /sk-/ with five words per sound. The 3 five-word sets (15 words in total) were elicited over three baseline measurement sessions over two weeks in the clinic. See Table 3 for more illustration.

Table 3 The Target Words with /sp-/, /st-/ and /sk-/ Clusters

No.	**Week 1**	**Week 2**	**Week 3**
	/sp-/ Targets	**/st-/ Targets**	**/sk-/ Targets**
1	Spot	Star	Scooter
2	Spoon	Stick	School
3	Spider	Stone	Skirt
4	Spade	Sticker	Scarf
5	Speaking	Stop	skipping

3.3.2 Intervention

The results of the pre-treatment assessment indicated that /s/ cluster reduction occurred extensively in the child's speech. It formed 39% of all the processes in the participant's speech. Although she produced initial singleton /s/correctly, she deleted it when it was part of a cluster. The process of /s/ cluster reduction has been supposed to be typically suppressed by the age of 5 (Hodson, 2010), however, the participant continued to produce it even at older age. As a result, this phonological error considerably impacted the child's speech clarity. Consequently, a six-week cycles-based treatment was designed. The clusters which were targeted included /sp/, /st/ and /sk/ in the sense that each cluster was treated within two 60-minute sessions a week. The participant had a limited number of vocabulary items (nearly 50 words)and her speech was highly unintelligible. Therefore, the practice words selected were the most familiar ones to the participant. Additionally, various learnable production practice activities were designed to be appropriate to the child's cognitive abilities.

The structure of a single treatment session was administered as explained in Hodson (2010):

1. The first step included reviewing the practice words treated in the previous session.
2. In the second step, the child was encouraged to attentively listen to the new practice words for three sequential times without being required to do verbal repetition. This technique was intended to enhance the child's auditory awareness of the target sounds.
3. In the third step, speech production activities were presented to the child. Thus, the child was requested to produce the target practice words on the picture cards. Accordingly, the child tried to name the pictures representing words containing /sp-/ cluster, such as, spider, spade, spoon, speaking and spot; for words beginning with /st-/ cluster

the child named pictures of stick, sticker, stone, stop and star; and for words beginning with /sk-/ cluster the child named pictures of school, skirt, scooter, skipping and scarf. The words were elicited by asking the child "what's this?" If the child could not name the picture, she was given an indicative cue (e.g. saying something that the picture was not representing). The child was also provided with assistive modelling and tactile cues of the target sound. For example, to make the child aware of the continuity of /s/, the sound was modelled and facilitated by pointing to the mouth and then slide the finger over and along the arm. Moreover, by completing the second session of a target sound, the same treatment procedure was followed and the other two target word sets were elicited as intervention control items. For example, in the end of the second intervention session of /sp-/ words, the three word sets were elicited, i.e. the/st-/ and /sk-/ control word sets as well as /st-/ target word set. To get the child engaged in the word elicitation activity, the production cards of the three sets were stuck at the back of laminated ladybirds which were hidden in a box full of colourful balls. Thus, the child tried to find and pick a ladybird and names the picture stuck at the back. A mixture of experiential play activities were provided to support the child progress and learn the target sounds.

4. The child was provided with assistance (modelling the sound, giving tactile cues) whenever needed, particularly during the first two treatment sessions.

5. The final step implied encouraging the child to attentively re-listen to the target practice words.

6. A short home programme (for 5 minutes a day) was prepared for the parents/caregivers. The parents By the end of each treatment session, the child's parents were given two sheets: the first is the activity sheet in which the listening and production tasks are explained in detail; the second is the activity table in which she indicates the tasks completed or any other note. The home programme is short and manageable that it requires the mother to practice the same vs. different task for listening and, then, ask her child to name the picture cards) (Hodson, 2010).

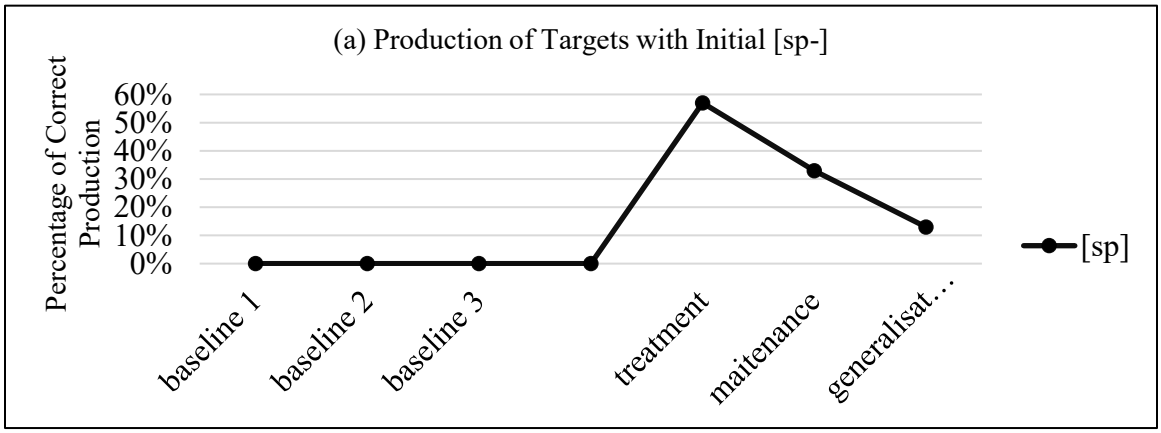
4. RESULTS AND DISCUSSION

The baseline, treatment and generalisation obtained were summarised. The results of baseline measures assured the child's inability to produce /s/ clusters correctly, and emphasised the child's need to receive immediate intervention to supress this phonological process. Later on, these results could be manipulated as effectiveness indicator of the utility of the cycles approach remediate the child's phonological errors. For more illustration of the baseline results, see Table 4 and Figure 1.

Table 4 Percentage of Correct Production of Targets with Initial [sp-], [st-] and [sk-] During the Pre- treatment Baseline Sessions

Targets	Week1	Week2	Week3
[sp-]	0%	0%	0%
[st-]	0%	0%	0%
[sk-]	0%	0%	0%

Figure 1 Percentage of Correct Production of Targets with Initial [sp-], [st-] and [sk-] During the Pre- treatment Baseline Sessions



Production Words with [sp-]

Five words with initial [sp-] cluster were selected and treated over two sessions (2 hours) a week by using various listening and production activities. Modelling of the target sounds and assistance was also provided whenever necessary. The child's scores showed that the spontaneous production has remarkably improved in the second session. See Table 4. The /s/ cluster was facilitated by making an initial long /s/ sound that the examiner slides the finger along the arm to stimulate the child to produce a continuant /s/ sound followed by /p/. This technique was very helpful in getting the child aware of producing /s/ at the beginning of a given target word. After several facilitations the participant was able pronounce the /sp-/ correctly.

The scores of baseline and treatment sessions were statistically compared via Chi-square test. The results indicated that there was a statistically significant difference between the child's performance in the baseline and treatment sessions of targeting [sp-] cluster. The test results manifested that, for the practice production words with initial [sp-] cluster, the X^2 value of 19.00, DF=1 was found to have an associated p-value of 0.002. This led to conclude that the application of the cycles treatment significantly improved the production of initial [sp-] cluster. See Figure 2a.

After completing the listening and the production tasks for the target words with /sp-/, a final elicitation task was run to elicit /st-/ and /sk-/ words as control items which were not treated beforehand. The participant's scores revealed production improvement for the /sp-/ targets, while there was not a considerable change for /st-/ and /sk-/ words. See Table 8. The X^2 was 10.125 when the production of treated [sp-] was compared to the production of the control (untreated) items with [sk-] and [st-] clusters which were not treated until later sessions. The child performance in the production of the treated [sp-] target was found significantly different from that of the untreated items with p-value <0.05. This indicates that the difference is unlikely to occur by chance and it took place due to the application of the treatment procedure. See figure 2a.

A generalisation session was administered by the completion of the first treatment a week later. The child was required to produce a five-word set with initial [sp-]. The results revealed that there was regression in the treatment gains in the sense that the child was able to generalise what she learned only to two of the generalisation items. See Figure 2a. The statistical analysis of the child's performance in the treatment and generalisation phases showed that X^2 value of 0.50 with an associated p-value >0.05. This indicated that the child needed more training and time to retain the newly learned targets.

4.1 Production Words with [st-]

The words with initial [st-] cluster were treated over two sessions (2 hours) a week. The results showed that 12 correct spontaneous production were successfully elicited when /st-/ words were treated for the first time. The number of correct productions increased when the same words were treated for the second time that 19 correct spontaneous productions were made. With repetitive facilitation of the target pattern, particularly during the second session, the total correct production was increased and the child seemed to be able to produce the target pattern own her own. By the end of the second session the child's production of [st-] cluster improved by 66%. The results statistically showed a considerable change in the child production of [st-] words during the baseline and treatment sessions. The X^2 value of 7.189 was obtained with a p-value<0.05 (p-value=0.02). Assuming the null hypothesis was true, such p-value would be rarely obtained. Thus, the production improvement occurred after the child began training within the cycles-based model. See Table 5 and Figure 2b.

The control items [sp-] and [sk-] were elicited during the second session. The results revealed that the cycles-based intervention was effective in facilitating learning the treated [st-] items by 66% in comparison with 33% and 0% for the untreated [sp-] and [sk-], respectively. See Table 8. It can be easily noticed the improvement achieved by the child in pronouncing the treated targets with initial [sp-], which was targeted in the earlier sessions, as well as [st-] cluster. On the contrary, the production of the untreated words with [sk-], which were not treated until later sessions, did not show any change. The production of treated items with initial [st-] cluster was compared to the productions of the other selected untreated items with initial [sk-] and [sp-] clusters. See Figure 2b. The X^2 value of 19.703 with an associated p-value<0.05. The results of the treated set with initial [st-] indicated the positive effect of applying the cycles-based intervention procedure. However, there was a regression in the treatment gains during the generalisation phase. The X^2 value of 0.027 with and associated p-value>0.05. The results showed a statistically non-significant change in the child's performance during the treatment and the generalisations phases. See Figure 2b.

4.2 Production Words with [sk-]

[sk-] was the third targeted cluster over two sessions in the first treatment cycle. The child was required to produce a five-word set with initial [sk-]. This was the most challenging sound combination for the participant to produce partly because it was a sound cluster and partly because it contained /k/. /k/ sound was one of the difficult sounds for the child to produce, particularly when it occurred in word initial position, although she was able to produce it in word final position, such as stick [stık]. Therefore, the child was provided with /k/sound stimulation training. For example, she

was asked to lean her head back and make several false coughs in order to get her lower the tip of her tongue and raise its back. With the parent approval, a tea spoon was also used to fix her tongue tip when she was asked to make several /k/ productions. She was capable of approaching the correct /k/ production; yet, she still needed more training.

In the baseline phase, the participant could not produce the target cluster correctly, i.e. she experienced a substantial difficulty to produce /s/ and /k/ when occurring in combination. Although she was able to pronounce single initial /s/ as scooter [su:tə], and single final /k/ stick [stık]. However, she managed to make six prompted productions of only one target item out of five items which was school [sku:l]. The results showed no difference between the productions of the target items with initial [sk-] during the baseline, treatment and generalisation phases. See Figure 2c. Compared to the production of the untreated (control), the child scored no change in the production of treated items with initial [sk-] cluster. See Figure 2c. The results indicated the progress the child achieved in terms of improving /sp-/ and /st-/ target words. In addition, the child revealed very slight improvement in the production of /sk-/ target words. The treated items indicated noticeable improvement due to applying intervention, whereas the untreated items did not improve unless treatment was applied. See Table 6. Therefore the current design promotes attributing production improvement to the treatment procedure applied rather than to any other unrelated variables. See Table 5. The child did not improve the [sk-] production during the first treatment cycle; therefore, this target needed to be retreated in the second treatment cycle. \

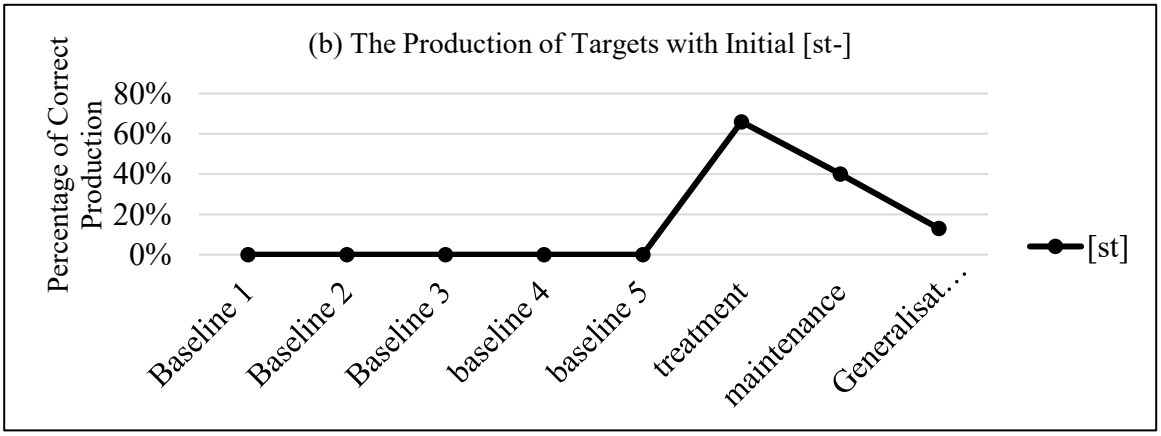
Table 5 Percentage of Correct Productions of Targets with Initial [sp-], [st-] & [sk-]

Targets	Baseline	Treatment	Generalisation
[sp-]	**0%**	**57%**	**13%**
[st-]	**0%**	**66%**	**13%**
[sk-]	**0%**	**8%**	**6%**

Table 6 Percentage of Correct Productions of Treated and Untreated Targets

Targets	[sp-]	[st-]	[sk-]
Treated	57%	66%	8%
Untreated	33%	40%	0%

Figure 2 Baseline, Treatment and Maintenance for Targets with Initial [sp-], [st-] and [sk-]



5. CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The present study reviewed the characteristics of the phonological profile of children with DS. It indicated that DS children develop their phonological systems in a way similar to that of the normal children; especially, during infancy.

As children with DS grow older, they move through the same sound acquisition phases and continue to acquire the essential constituents of their sound systems as in the typical children community; yet, at slower pace. Children with DS produce sound pattern errors similar to the ones pronounced by their typical peers, and these processes last longer to appear in the speech of DS children. This substantially indicated a crucial delay in speech development for children with DS. Additionally, the speech of DS children evidenced the inconsistent occurrences of various phonological processes. In the present case study, the sound system of a DS child was examined and her speech was assessed via a standardised and non-standardised phonological tests. The assessment results unveiled the basic elements of the child's sound system. It configured the consonants, consonant clusters and vowels acquired. In addition, the study examined the single and connected speech samples produced by the participant to identify the speech production and perception errors. The results revealed the most occurring phonological errors that appeared in the child's speech. The child's phonetic repertoire included the sounds /f, v, p, b, m, n, ŋ, t, d, l, w, r, ʃ, j/; yet, she produced unintelligible utterances for she has recurrently made inconsistent sound errors. The assessment of both single word and connected speech samples showed that cluster reduction was the most pervasive phonological process that dominates the child's speech. A phonological cyclic intervention model was manipulated to target the sounds and sound error patterns. The intervention facilitated speech production and intrinsically helped the child reduce the occurrence of sound errors and cluster reduction.

Still further research is needed to extensively analyse the phonological profiles of DS population with a variably wider age range and large number of participants in order to obtain more accurate analyses of the course of development of their phonological sound systems. In as far as, Iraqi society is concerned, there an urgent need to commence data collection of DS community and develop a comprehensive database of DS population so that researcher could be able to analyse their phonological characteristics, diagnose their speech problems and design appropriate early intervention programmes that assist DS children improve their speech and, in return, feasibly communicate with their follow individuals.

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