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Investigating the Effectiveness of Morphosyntactic Treatment on Production in Two Children with Hearing Impairment Older Than 3 Years

Sayeh Tahbaz[1*], **Azar Mehri**[2]

1. Speech Therapy of Newsha Knowledge-Based Foundation, Tehran, Iran.
2. Department of Speech Therapy, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran.

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ABSTRACT

Introduction: Since hearing loss (HL) can lead to linguistic and especially morphosyntactic (MS) delay, creating a method for fostering and facilitating MS development is required. Accordingly, the auditory-based Sayeh Tahbaz Hoseynzadeh (STH)-method has been designed. Accordingly, the present article examines the effectiveness of this treatment.

Case Description: Two hearing-impaired children (HIC) who used hearing aids, with moderately severe and severe HL and older than 3 years of age at the time of study, enrolled in the STH method for 24 weeks. The Persian developmental sentence scoring was used to analyze language samples together with some formal and informal assessments performed within a 12-week interval.

Results: According to the Persian developmental sentence scoring used to analyze spontaneous language samples, the score of participant 1 changed from 0 to 10.6 and the score of participant 2 improved from 5 to 7.4 in the final assessment.

Conclusion: The findings showed that STH-method helped in improving the MS skills of the participants.

*** Corresponding Author:**
Sayeh Tahbaz
Address: *Speech Therapy of Newsha Knowledge-Based Foundation, Tehran, Iran.*
Tel: *+98 (912) 2267340*
E-mail: *tahbaz.sayeh@gmail.com*

Introduction

Hearing loss (HL) negatively affects linguistic and especially morphosyntactic (MS) development [1-15]. Also accelerating language development after some delays is more difficult [7], and neuroplasticity of the central auditory system decreases gradually [16]. Therefore, immediate diagnosing and enrollment of hearing-impaired children (HIC) in suitable auditory/linguistic intervention is crucial.

There are several methods for teaching HIC some emphasize verbal communication and others incorporate signs [17]. Accordingly, HL can lead to linguistic problems which probably necessitate linguistic intervention. Fey and Proctor-Williams (2000) have summarized some grammar facilitation methods [18]. Although good amplification and a rich environment are necessary for linguistic development, sometimes linguistic intervention is inevitable especially in challenging conditions, for instance, little parent participation [4, 12, 19-21], limited residual hearing (RH) [5, 15, 19], and additional disabilities.

Challenging issues necessitate more systematic intervention. Because HL affects linguistic, cognitive, and communicative development, rapid improvement of basic linguistic skills could help therapists cover more aspects of development. Therefore, we created an auditory-based method, namely the Sayeh Tahbaz Hoseynzadeh (STH)-method [22, 23], which concentrates primarily on MS development. The objective is to document the MS progress of 2 congenital HICs, older than 3 years at the beginning.

Case Description

Study participants

The participants were 1 boy and 1 girl with congenital prelingual HL who did not have additional disorders and were in a monolingual Persian environment. Both were enrolled in the STH method in the Newsha Knowledge-Based Foundation (NKF). At first, participant 1 (P1) was 3 years and 4 months and participant 2 (P2) was 4 years and 1 month and had received suitable bilateral amplification. Linguistic, audiologic, and cognitive assessments were undertaken in NKF, where children received the intervention.

Assessment procedure

The assessments included some formal and informal assessments that the examiner performed only through listening in a quiet room in 2 sessions and videotaped. COVID-19 compelled the examiner to use 2 multilayer face masks [24], a ventilator, and open the window which decreased the signal-to-noise ratio. The examiner also completed questionnaires of the Newsha developmental scale (NDS) [25] through parent interviewing. Meanwhile, parents completed a 1000-word checklist [26] which included receptive and expressive vocabulary. After completing the assessment, the participants were enrolled in 24 weeks of treatment, and assessments were repeated at 12-week intervals.

Cognitive assessment

Cognitive evaluations were undertaken initially using an informal checklist by the occupational therapist at NKF which included visual processing (attention, memory), problem-solving, drawing, and copying skills [27]. The evaluation showed that none of the children had cognitive problems in the evaluated fields.

Audiological assessment

Audiometry was undertaken to ensure that children's aided and unaided thresholds before assessment. Speech recognition abilities were assessed using the speech discrimination score (SDS) that included 50 recorded monosyllabic words at children's most comfortable level (MCL) [28].

Language assessment

Receptive language

The comprehension of the 1000-word checklist [26] was completed by mothers during a week.

An informal situation (consistent with STH situations) was used for examining the comprehension of "Wh" questions and linguistic abilities. Correct response (CR), which was extracted from the situation, evaluated understanding questions and answering. The criterion for a correct response was using a target in isolation or context. Receptive language was assessed by NDS [25] which is for the age group from 0-72 months.

Syntax comprehension test (SCT) [29] was used which measures syntactic structure comprehension in 4-6 years; therefore it was not suitable for P1. However, it was used because of the limited formal Persian test in this age.

Expressive language

Mothers completed the expression of 1000 words checklist [26]. The complete linguistic structure (CLS) that examined correct answer formulation as complete utterance, and formulation of utterances using the correct verb (UCV) which related to question tracking and response formulation using suitable verbs with correct tense and inflection, were extracted from the situation. If a response included the target structure in the correct utterance/sentence, the CLS was correct (CLS=1). Only correct CR responses were evaluated for UCV and if the correct verb was used according to the question, UCV was correct (UCV=1).

Story retelling (three goats' stories), photographic storytelling (serial picture story), and spontaneously talking about one topic (park and party) were evaluated. Utterance in our study included one sentence or unit with independent meaning which is separated from the next unit by a pause [30]. The total number of utterances, including verbs was extracted. Also, the mean length of the 5 longest utterances (MLU) in morphemes (m) and words (w) was calculated. Also, these utterances were analyzed according to Persian developmental sentence scoring (PDSS) [31]. PDSS is an evaluation tool for syntactic development in children with 30 to 66 months of age. Because of limited spontaneous language, we selected 5 longest utterances from each sample. Expressive language was assessed using the expressive domain of NDS. In addition, we used the photographic expressive Persian grammar test (PEPGT) [32] which is for Persian children with 4 to 6 years of age, for the assessment of expressive MS characteristics. Although P1 was not in its age range, we used it due to limitations.

Finally, the results of the situation were rated by two examiners and inter-rater reliability was calculated.

Treatment procedure

Following the assessment, the participants were enrolled in an intervention that included weekly 30 min assessment sessions and 60 min treatment sessions. In the assessment sessions, the therapist evaluated previous situations and determined new targets. In the treatment sessions, the targets were practiced systematically. Moreover, half of the sessions were devoted to speech treatment.

P1 in the first 12 weeks had 1 assessment session and 1 treatment session weekly. However, because half of the sessions were presented online and the parent was concerned, after week 12, the sessions were duplicated. Overall, P1 had 39 assessment sessions and 34 treatment sessions. P1 also had 45 min session weekly in which some group session materials were practiced individually. However, P2, because of a poorer prognosis, had 2 assessment sessions and 2 treatment sessions, weekly. Accordingly, P2 had 49 assessment sessions and 46 treatment sessions.

The STH method

The STH method is a systematic step-by-step procedure for fostering MS development for both challenging and ready-to-learn children. It contains the following three parts: a) Direct practice (DP), b) Generalization, and c) STH situations that intermediate between other parts. Therefore, this method supports MS development by eliciting each skill until its generalization to various linguistic contexts (question-answer).

In DP, we try to elicit a target in one utterance, stabilize it, improve the utterance formulation by several words, accelerate utterance formulation, and use utterances quickly as answers to various questions. In the first 3 items, if necessary, we use simpler subskills, prerequisites, cues, or utterance segmentation to simplify the target.

In the STH situations, we put practiced MS targets in meaningful situations as question-answer and primarily use cues and utterance segmentation, if necessary.

During generalization, children rapidly use learned rules in response to questions in several contexts.

Some features of the method include natural development and child's readiness determined MS goals and several goals are treated simultaneously. In DP sessions some goals are at elicitation and others at question-answer level. For elicitation, shaping, and memorizing one skill, tasks are organized systematically, so one challenging task is central, and other tasks are practiced in intervals of returning to it. Meanwhile, when new utterances are formulated rapidly using a rule, this rule should be generalized.

In this study, we followed 3 phases which are presented in Figure 1.

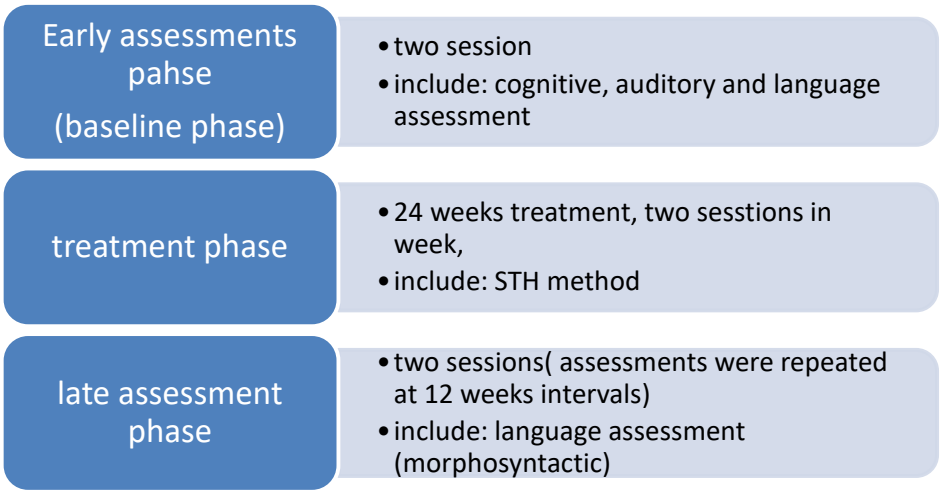

Figure 1. Assessment and treatment phases flowchart

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Results

Participant 1

Diagnosing HL and receiving hearing aids (Oticon bte geno1P) was done at 3 years and 1 month. P1 had moderately severe HL according to auditory brain response (ABR)/audiometry and two of the relatives have HL. After birth for 3 min, he became cyanosis following hypoxia. At the beginning, P1 had 3 years and 4 months and until then, had received 12 h language treatment in NKF.

In terms of auditory skills, the results of the SDS showed that his discrimination improved from 60% in the first assessment to 68% in the second and third assessments.

Participant 2

In P2, HL was diagnosed at 20 months and received hearing aids at 2 years and 2 months. Because of the probability of cochlear implantation, inexpensive poor hearing aids were prescribed. At 3 years, more suitable hearing aids (Widex fastion d220) were prescribed. According to ABR/audiometry, she had bilateral severe HL. In the beginning, she had 4 years and 1 month. Before entering NKF, she had about 22 SLP sessions, that were not auditory-based, and after entering NKF, before study, she had 29 hours of auditory-based language treatment at NKF. Also, one of my relatives had HL. In terms of the auditory skills, initially, SDS was 42%. 12 and after 24 weeks it increased to 54% and 58%. Table 1 shows the results of receptive language assessments.

The results of the expressive language tests are provided in Table 2. Table 3 shows the results of the analysis of language samples. Inter-rater reliability was calculated for the situation and demonstrated more than 80% agreement between the two examiners.

Discussion

In some HICs, MS development does not occur simply during natural development [4, 5], and late diagnosis, limited RH, and poor communicative/linguistic environment exacerbate the condition, also because usually compensating for the language delay is difficult after it occurs [7], we designed the STH-method. This study demonstrated its effectiveness on MS development in 2 congenital HICs.

In auditory-verbal treatment, which is an auditory-based approach [33] there were no detailed suggestions for fostering and speeding up linguistic and MS development. However, the STH method presented a highly systematic, step-by-step method for linguistic and especially MS development. Therefore, this method played an important role in speeding up children's linguistic development, especially those who were in challenging conditions. Because this treatment is auditory-based, children should primarily learn listening and then use it for language learning.

Nevertheless, because COVID-19 compelled us to use 2 multilayer face masks [24], a ventilator, and open the window which decreased the signal-to-noise ratio, listening was challenging. Also, quarantine led to the elimination of group sessions which are important for general-

Table 1. The results of the receptive language assessments

Variables	Participant	%		
		1st Assessment	2nd Assessment (Week 12)	3rd Assessment (Week 24)
RV	P1	40	57.2	66.5
	P2	49	65	70.6
CR	P1	16.6	45.8	91.6
	P2	41.6	70.8	100
Receptive vocabulary (NDS)	P1	46	70	80
	P2	49	57	64
SCT	P1	0	0	0
	P2	0	0	4.1

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Abbreviations: RV: Receptive vocabulary; CR: Correct response; NDS: Newsha developmental scale; SCT: Syntax comprehension test.

ization, mother education, behavior management, learn to listen (LTL), and following directions by children.

The lack of target generalization in group sessions led us to include them in treatment sessions, so treatment slowed down, and working on new targets was delayed. Also, limited family education decreased effective parent participation. Moreover, because family's poor economic status, the cooperation of child psychologists for behavior management was not possible. Therefore,

Table 2. Results of expressive language assessments

Variables	Participant	%		
		1st Assessment	2nd Assessment (Week 12)	3rd Assessment (Week 24)
Expressive vocabulary	P1	28.5	51.2	63.3
	P2	42.5	62.6	70.3
CLS	P1	0	41.6	79.1
	P2	8.3	20.8	75
UCV	P1	0	0	70.8
	P2	0	8.3	62.5
Expressive language (NDS)	P1	61	56	80
	P2	49	57	53
PEPGT	P1	0	2.5	12.5
	P2	0	15	12.5

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Abbreviations: CLS: Complete linguistic structure; UCV: Using correct verb; NDS: Newsha developmental scale; PEPGT: Photographic expressive Persian grammar test.

Table 3. Results of language sample analysis

Variables		Participant	1st Assessment	2nd Assessment (Week 12)	3rd Assessment (Week 24)
Story retelling	Number of utterances	P1	3	5	13
		P2	22	26	37
	MLU (w)	P1	1	3.2	6.8
		P2	4	4	4.4
	MLU (m)	P1	2	4.4	9.6
		P2	6	7.2	8.2
	PDSS	P1	5	5.6	9
		P2	6.2	8.2	13
Photographic storytelling	Number of utterances	P1	0	0	13
		P2	6	7	12
	MLU (w)	P1	0	0	2.2
		P2	3.2	3	3.6
	MLU (m)	P1	0	0	3.2
		P2	4.8	4.4	6.6
	PDSS	P1	0	0	6
		P2	6.6	5.8	9.2
Spontaneous language sample	Number of utterances	P1	0	0	8
		P2	2	2	18
	MLU (w)	P1	0	0	6.4
		P2	2.5	2.5	3.4
	MLU (m)	P1	0	0	8.6
		P2	3.5	3.5	4.8
	PDSS	P1	0	0	10.6
		P2	5	5	7.2

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Abbreviations: MLU: Mean length of 5 longest utterances; M: Morphemes; W: Words; PDSS: Persian developmental sentence scoring; P1: Participant 1; P2: Participant 2.

because of the lack of group sessions, individual sessions are partly devoted to behavior management, so the time for language treatment is reduced. Also, LTL for a child with limited RH and reliance on visual inputs is so difficult. The lack of group sessions made this difficult task more challenging. Also, quarantine limited children's communication with their peers, so generalization became limited. Also, the online presentation of many sessions imposed several challenges, including unskilled mothers, children's noncooperation, and poor internet and voice quality. Also, the devotion of at least 50% of treatment sessions to speech decreased available language sessions.

Our emphasis on the elicitation of one MS target in DP and then its systematic generalization was partly similar to the method suggested by Eisenberg [34] in which each session included some DP for the elicitation target and then entered it into meaningful communication.

Nevertheless, during treatment, we improved their listening skills. Finally, improvement was considerable in the total number of utterances, MLU, and Persian developmental sentence scoring of language samples that indicate MS development. These results were consistent with increasing the use of language in communication, using longer utterances and new/more advanced MS rules.

In addition, CLS improvement showed developing skills in tracking questions, memorizing structure, and response formulation by similar structure using various words, so answering similar questions and catching the speaker's talk during communication improved.

In addition, improving the UCV score indicated that children formulated their answers using correct verb tense and inflection according to question that improves answering to questions.

According to CR, understanding and answering questions improved finally. Also, receptive and expressive vocabulary improved.

As noted above, the poor signal-to-noise ratio and, the elimination of group sessions, and online sessions, made the difficult task of LTL more challenging. We should improve children's LTL so well that enables them to use listening for learning new linguistic skills to recognize and discriminate words. LTL was more difficult in P2 because of her poor environment, lower RH, reliance on lipreading, and lack of suitable amplification and auditory-based treatment at a lower age. Limited auditory familiarity following a poor environment and lack of GSs prevented more auditory development.

In addition, although her language target learning in treatment sessions was reasonable, the lack of group sessions and the mother's proficiency led to slow generalization.

P1 who had more RH, a richer environment, and a lower age, succeeded in learning auditory/linguistic skills better, but P2 who had poorer condition, encountered more difficulties.

Because increasing the MS complexity of photographic storytelling and spontaneous language samples is more difficult than answering or story retelling, poor results obtained from analyzing these samples in the second assessment may indicate that then, participants did not achieve the necessary skill for using those developing rules in spontaneous language. This result is consistent with our expectations from treatment, because we stabilized a target in practice, practiced it toward automaticity, entered it into question-answer, and, after systematic generalization, the target gradually entered in spontaneous language. Accordingly, children's skills should increase more, before changes become observable in spontaneous language. However, finally, these scores showed remarkable improvement.

STH-method principally is based on practicing each target toward automaticity and minimal response latency and then systematic generalization. Therefore, this method is similar to the theory proposed by Ling [35]. Although speech development and feedforward mechanisms involved in speech are different from language development, some similarities can be observed between them.

The results of formal assessments did not show a significant and continuous improvement. Although NDS showed relative improvement in RL, SCT showed no improvement and only P2 finally obtained a minimal score. Also, although children showed improvement according to the photographic expressive Persian grammar test, expressive language scores of NDS were fluctuating.

SCT's complexity for HIC and rigid rating, probably led to poor scores, although P1 was younger than the test's age.

The deduction of the normal range score from the child's score led to fluctuating results of NDS.

Therefore, probably in more challenging cases, 24 weeks of treatment is not sufficient for emerging significant changes in these formal tests and some small changes in these tests could better suit them for HIC.

Also, the evaluation of imitation accuracy and rate of learning could be useful.

The results of analyzing language samples, CLS, and UCV showed that STH-method could improve MS development in these participants. Although the MS skills of both children were improved, the existence of all parts

of treatment is important for satisfactory improvement, especially in challenging children.

Because all HICs are not simply ready to acquire language following amplification, we suggest using a systematic procedure for MS treatment. So, after an exact evaluation, we determine which skills, and how should be treated and therefore start treatment from suitable skills using suitable methods and after generalization, progress toward more advanced skills.

Conclusion

The findings showed that STH-method helped in improving the MS skills of the participants.

Study limitations

COVID-19 compelled us to use 2 multilayer face masks, and a ventilator and open the window which decreased the signal-to-noise ratio, so the difficult task of learning to listen became more challenging.

Ethical Considerations

Compliance with ethical guidelines

This study has been conducted with the consent of families and NKF.

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Authors' contributions

Conceptualization, methodology, supervision, data analysis, and writing the original draft: Sayeh Tahbaz; Review and editing: Sayeh Tahbaz and Azar Mehri.

Conflict of interest

The authors declared no conflict of interest.

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