THE EFFECT OF SOUND AMPLIFICATION SYSTEMS ON MONOSYLLABIC NON-WORDS PERCEPTION IN CHILDREN

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The successful educational process could be impacted by poor classrooms' acoustics which decreases children's listening skills and attention, and consecutively decrease the comprehension of verbal instructions.[1] The accurate transmission of acoustical information in a classroom is imperative for optimal academic achievement. [2] The quality of classroom instruction has an association with children's achievement results especially in early primary grades. [3;4] Students with language disorders and students learning in a language that is not their native language need greater SNR than other children. Classroom amplification systems are designed with the aim to improve the SNR in the classroom and to provide uniform amplification through the classroom. Therefore they promote better comprehension of verbal instructions in children.
The aim of the study was to investigate the improvement of monosyllabic non-word perception in children educated in the classrooms equipped with sound field amplification systems (SFAS).

Methods & Participants

The ability to write monosyllabic non-word dictation was tested in 151 pupils of first to fourth grade in classrooms with or without sound field amplification systems. Twenty monosyllables were used in the tests of 1st grade, and 50 monosyllables were used for the 2 to 4-grade children. The children had no hearing problems. The omnidirectional sound field amplification system Certes PentaClass Runa was installed at a distance of 2.3 m from the floor at the back of each classroom. During the first task, the examiner read the non-words in front of the classroom without the support of SFAS. The second task had a different set of monosyllabic non-words and was provided one week later with the use of the SFAS by the same examiner. The background noise of the unoccupied classroom (LAeq), as well as activity noise (LAeq activity) and Speech Transmission Index (STI), were measured in 8 classrooms by Acoustic Analyzer XL2 and Audio Talk-Box (NTi Audio AG).
The acquired data were not normally distributed, and nonparametric statistic analysis methods were used. Related Samples Wilcoxon Signed Rank Test was used for analysing the non-word perception score in classrooms with or without amplification. The Mann-Whitney test was used for comparison of the performance of two groups.

Results

One hundred fifty-one elementary school pupils were included in the study, 77 (51.0%) male, 30 (19.9%) bilingual. Fifty-one (33.8%) monolingual students and 18 (60.0%) bilingual students had language disorders. First grade attended 33 students (Mage 7.33, SD 0.54), 2nd grade 36 students (Mage 8.25, SD 0.44), 3rd grade 42 pupils (Mage 9.55, SD 0.59), and 4th grade had 40 children (Mage 10.2, SD 0.41). The classroom acoustics date are presented in Table 1.

Table 1.
The mean acoustic parameters of the classrooms

N of classroom	Volume [m3]	RT60 [s]	Unoccupied background noise level LAeq [dB(A)]	Activity noise level LAeq [dB(A)]	STI
1	176	0.73	31.0	48.6	0.63
2	180	0.77	38.6	53.5	0.61
3	178	1.00	32.9	55.0	0.64
4	175	0.83	37.2	50.6	0.62
5	180	0.85	31.2	54.5	0.63
6	180	0.70	32.1	47.9	0.62
7	176	0.73	30.7	47.3	0.68
8	165	0.77	32.9	49.1	0.68

The mean perception score of monosyllabic non-words gradually increases with the age of children (Figure 1). The statistically significant difference between the mean perception score in the first task (without the support of SFAS) and second task (with the SFAS) was found in children of the 1st and 2nd grades ($p<0.001$, $p=0.013$)

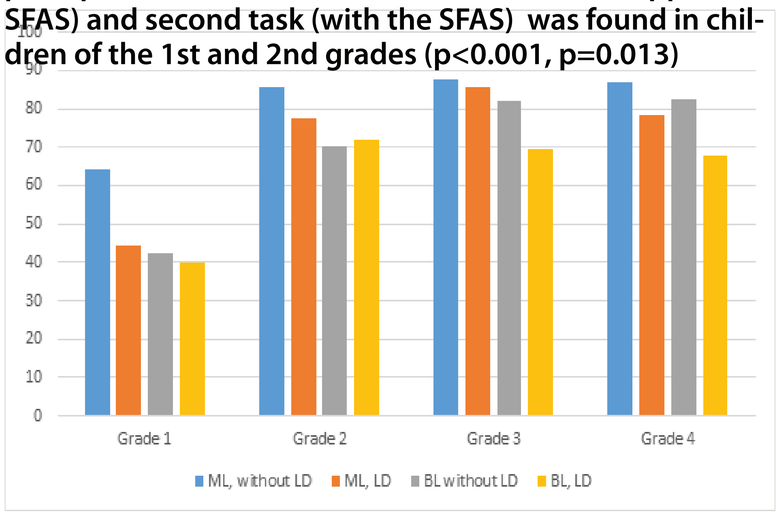

Figure 1.
Mean non-word perception score (in % correct) of monolingual children of 1 to 4 grade without and with language disorders (ML, without LD & ML, LD) and bilingual children without and with language disorders (BL without LD & BL, LD) in the classrooms without sound field amplification.

The statistically significant differences were found between monolingual children with and without language disorders in the results of the first and second task: $p=0.003$, $p<0.001$ (Figure 2, A & B). First-grade pupils with language disorders demonstrated statistically significant improvement of the non-word perception score in the task with using of SFAS ($p=0.016$).
Bilingual children had lower non-word perception score than the same age monolingual children. The lowest perception score was found in the 1st-grade bilingual children with language disorders (40%). The use of SFAS improved non-words perception score in bilingual children ($p=0,014$). The statistically significant effect of SFAS on the increasing of speech perception ability was not observed in bilingual children with language disorders (Figure 2 C & D).

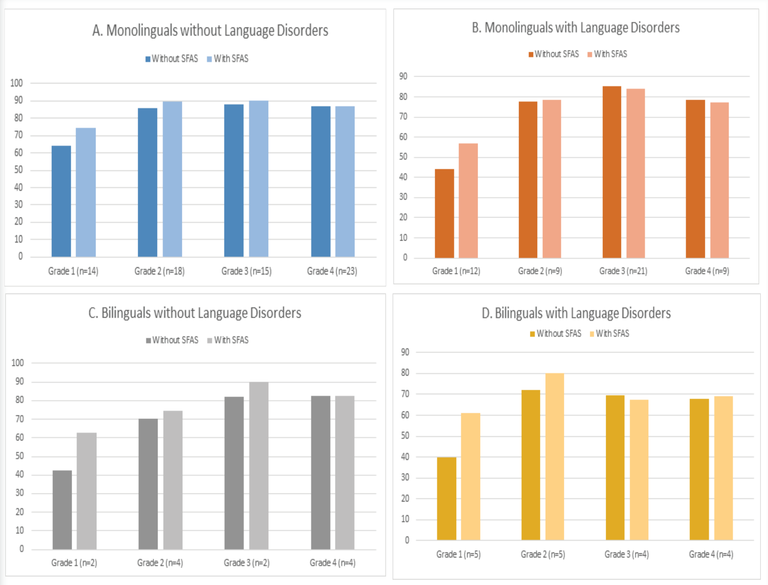

Figure 2.
Mean non-word perception score (in % correct) of monolingual children without and with language disorders and bilingual children without and with language disorders in the classrooms without and with classroom amplification.

Almost in all classrooms in the last rows, the STI was below the recommended value (Figure 3). The perception score of non-words decreased if the distance between examiner and pupils increased (r_s =0.198-0.211, $p=0.009$, $p=0.015$). The using of SFAS increased non-words perception score in monolingual children sitting at the end of the classroom ($p=0.049$). Such kind of improvement was not observed in bilingual children as well as in children with language disorders.

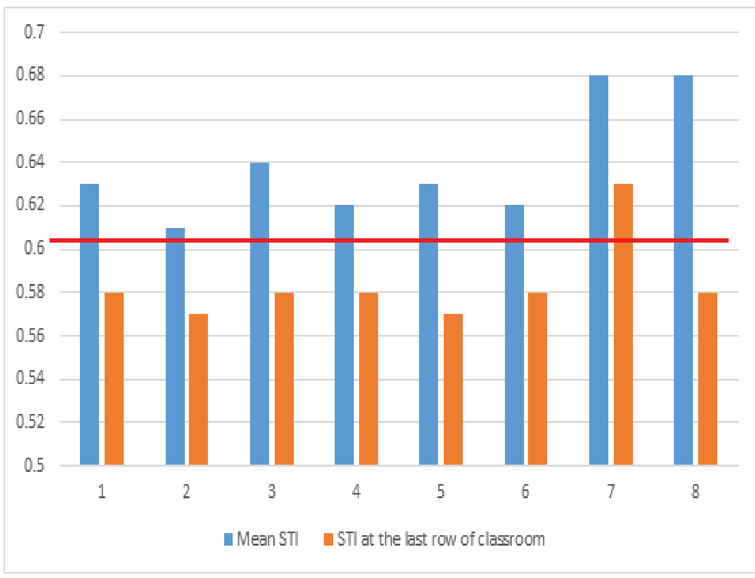

Figure 3.
The mean Speech Transmission Index (STI) in the classrooms and STI at the last desk row of the classroom. 0.60-0.64 recommended STI values for the classrooms.

Discussion

The SFAS is one of the options on how to improve classroom acoustics. Our study confirmed the assumptions that classroom amplification benefit to younger children [4], children sitting in the back of the class [2] and second language learners children [5]. The sound field amplification systems improved monosyllable non-words perception score in pupils of the first and second grade but did not have a statistically significant effect on children of the 3rd and 4th grade. The sound field amplification systems enhance the non-word perception score of bilingual students. We did not observe a statistically significant effect of classroom amplification in mono and bilingual children with language disorders. SFAS improves listening skills and attention but not impact directly to the pathological language processing. The coding of sounds in letters is related to language processes, and adequate SNR is an essential factor in promoting this function. However, it is not enough for reaching positive effect. Children with language disorders need regular assistance in the classroom.

References

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