



Perception of parents on the effects of acoustically controlled hearing training in children

Percepção dos pais sobre os efeitos do treinamento auditivo acusticamente controlado em crianças

La percepción de los padres sobre los efectos del entrenamiento auditivo acústicamente controlado en niños

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SF: Contributed to the tabulation of the evaluated data before and after auditory processing AP and ACAT; contributed to the analysis, description, and interpretation of the data; and actively participated in writing the text and in defining the parameters and strategies necessary to elaborate the manuscript. SF was responsible for defining the domains, through the analysis of each question in the SAB Table, under the perspective of behavioral psychology.

ROM: Participated in the tabulation of the data that was necessary to perform the study.

PFN and FAG: Participated in the collection of the data that was necessary to perform the study.

LDP: Supervised all members of the group and defined the steps necessary to carry out the scientific work; accompanied, organized, and supervised all procedures that were performed by the members of the group, from the study design to the finalization of the manuscript.

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Abstract

The use of questionnaires can help to verify the perception of parents / guardians about their children's hearing abilities. To compare the perception of the parents of schoolchildren submitted to acoustically controlled auditory training, in the initial and final moments, through a questionnaire called SAB Scale. **Method:** 18 children (66.6% boys) aged 6 to 13 years (mean of 10.4 years) underwent auditory training, 15 sessions of 45 minutes, after being diagnosed with Central Auditory Processing Disorder. This questionnaire contains 12 questions about auditory behavior which total score ranges from 12 (lowest score) to 60 points (highest score). These questions were grouped by domain: attention, hearing, learning, listening comprehension. **Results:** In the perception of parents / guardians through SAB scale, the greatest improvement was perceived in the field of hearing, followed by attention, learning and listening comprehension behaviors. **Conclusion:** The parents perceived evolution of the auditory behavior of their children with satisfactory improvement in the areas of hearing and attention. The understanding and learning domains did not reach the same improvement as before. The evaluation of the SAB scale serves as a guide in the school context if it is worked with teachers or caregivers.

Keywords: Nervous System; Nervous System Diseases; Hearing; Auditory Perception; Hearing Disorders.

Resumo

O uso de questionários pode auxiliar para verificar a percepção de pais/responsáveis sobre as habilidades auditivas dos filhos. **Objetivo:** Comparar a percepção dos pais de escolares submetidos ao treinamento auditivo acusticamente controlado, nos momentos inicial e final, por meio do questionário Scale Auditory Behavior, denominado “escala SAB”. **Método:** 18 crianças (66,6% meninos), após terem sido diagnosticadas com Transtorno do Processamento Auditivo Central (TPAC) com idades entre 6 e 13 anos (média de 10,4 anos) foram submetidas ao treinamento auditivo, que durou 15 sessões de 45 minutos cada. Todos os participantes tiveram melhora na avaliação comportamental pós-intervenção. Os responsáveis foram submetidos à escala SAB antes e depois do treinamento auditivo. O questionário contém 12 questões sobre o comportamento auditivo, cuja pontuação total varia de 12 (score mais baixo) a 60 pontos (score mais alto). As questões foram agrupadas por domínio: atenção, audição, aprendizado e compreensão auditiva. As respostas do questionário foram analisadas por domínio, segundo a pontuação ponderada analisada em valor absoluto, em porcentagem de dificuldade e evolução desse comportamento. **Resultados:** Na percepção dos responsáveis através da escala SAB, a maior melhora foi percebida no domínio da audição, seguida dos comportamentos auditivos de atenção, aprendizado e compreensão auditiva. **Conclusão:** Os pais das crianças submetidas à intervenção perceberam evolução do comportamento auditivo de seus filhos, com melhora satisfatória predominantemente nos domínios audição e atenção. Os domínios de compreensão e aprendizagem não atingiram a mesma melhora dos anteriores. A avaliação da escala SAB pode servir como norteadora no âmbito escolar, se trabalhada com os professores ou cuidadores.

Palavras-chave: Sistema Nervoso; Doenças do Sistema Nervoso; Audição; Percepção Auditiva; Transtornos da Audição.

Resumen

El uso de cuestionarios puede ayudar a verificar la percepción de padres / tutores sobre la capacidad auditiva de sus hijos. **Objetivo.** Comparar la percepción de los padres de escolares sometidos al entrenamiento auditivo acústicamente controlado, en los momentos de inicio y de final, mediante el uso del cuestionario Scale Auditory Behavior, denominado “escala SAB”. **Método:** 18 niños (66,6% varones), después de diagnosticados con Trastorno de Procesamiento Auditivo Central (TPAC), de edades comprendidas entre los 6 y 13 años (promedio 10,4 años) fueron sometidos al entrenamiento auditivo que duró 15 sesiones de 45 minutos cada. Todos los participantes tuvieron una mejoría en la evaluación de la conducta posterior a la intervención. Los responsables fueron sometidos a la escala SAP antes y

después del entrenamiento auditivo. El cuestionario contiene 12 preguntas sobre el comportamiento auditivo, cuya puntuación total oscila entre 12 (puntuación más baja) a 60 puntos (máxima puntuación). Las preguntas fueron agrupadas por dominios: atención, audición, aprendizaje, comprensión auditiva. **Resultados:** En la percepción de los padres / tutores a través de la escala SAB la principal mejora se observó en el dominio de la audición, seguida de los comportamientos auditivos de atención, aprendizaje y comprensión auditiva. **Conclusiones:** Los padres de los niños sometidos a la intervención se dieron cuenta de la progresión de la conducta auditiva de sus hijos con una mejoría satisfactoria predominantemente en los dominios audición y atención. Los dominios de comprensión aprendizaje no alcanzaron la misma mejora de las anteriores. La evaluación de la escala SAB puede servir como una guía en la escuela si trabajada con los maestros o cuidadores.

Palabras claves: Sistema Nervioso; Enfermedades del Sistema Nervioso; Audición; Percepción Auditiva; Trastornos de la Audición.

Introduction

Hearing is a sensorial modality that allows individuals to develop fundamental skills, such as interaction, communication, and learning. From sound appreciation, it is possible to acquire various complex behaviors that, at the same time, are inherent to human nature.¹⁻³ The contribution of the auditory system to these behaviors relies on processes that occur at sensory, cognitive, and linguistic levels, from auditory skills that are acquired and developed from early childhood to adolescence.^{4,5}

Central auditory processing describes these phenomena and can be defined by a set of skills that are necessary to interpret sounds, such as detection, discrimination, recognition, and memory. As such, discrepancies in acquiring these skills can interfere in the daily behaviors of the subject.⁶ Auditory processing evaluation tests might indicate deficits in certain hearing skills.^{7,8}

Studies have shown that Acoustically Controlled Auditory Training (ACAT) improves perceptual learning by means of various acoustic controls. In a stimulation environment, responses are obtained and recorded; and predominantly, the stimuli include silence variations and changes in sound frequency and duration.⁹ The positive results that are obtained with ACAT have been observed in the auditory behaviors of individuals and have repercussions on the communicative and academic sphere.¹⁰ Instruments like the *Scale of Auditory Behavior*, known as “SAB scale” – a questionnaire that is used to assess auditory behavior – can determine the impact of this deficit on the life of an individual, in daily communication, and in learning situations.¹¹

In this pilot study, 12 (twelve) questions of the aforementioned scale were divided and regrouped to identify specific behaviors that relate to attention, listening comprehension, hearing, and learning domains.

The **objective** of this study was to compare the parents’ perception of schoolchildren who were subjected to ACAT, before and after the training sessions, according to different auditory behavior domains that are listed in the SAB scale.

Method

This study was carried out with the approval of the Institutional Ethics Committee and was registered under the number 319.303.

The work was based on data obtained from the medical records of 18 children (66.6% boys), between six and 13 (thirteen) years of age (average age of 10.4 years), who were diagnosed with a central auditory processing disorder. The study included responses that were obtained from the *Scale of Auditory Behaviors* (SAB) questionnaire, which were answered by the respective parents before and after auditory training sessions in a public ambulatory care service. All subjects presented improved auditory processing evaluations after ACAT.

We used the Acoustically Controlled Auditory Training (ACAT) intervention approach, which was performed individually, in 45-minute sessions, once a week. To this end, the individual was asked to remain inside an acoustic cabin, which allowed us to control the noise level in the stimulation environment. The sound levels of the stimuli were acoustically controlled and the responses were recorded. The approach was carried out as proposed in several

studies.¹²⁻¹⁶ The parents submitted questionnaires, which included the SAB scale, a prior ACAT, and “pre-time” and “post-time.” evaluations, the latter of which were given prior to and at the end of ACAT, respectively. The survey contains 12 questions about daily auditory behavior. For each question, there are five answer possibilities, the score of which varies from one to five, being: frequently (1); almost always (2); sometimes (3); sporadically (4); and never (5). The satisfactory auditory behavior score is equal to five points, while a score of one represents an unsatisfactory rating for each question. Thus, the total score can range from 12 to 60 points.

The analysis of the data that was obtained from the SAB Scale was performed through grouping the questions by domains. This new scale configuration was achieved with the support of a psychologist who is a member of the research group. This system proposes four established domains and considers behavioral psychology and audiology approaches, which namely include listening comprehension, learning, attention, and hearing.

In this context, the **Listening comprehension domain** refers to the ability of a participant to understand given instructions, without repeating them, i.e. a greater readiness to follow information. Thus, we selected the domain questions of (3) “difficulty of following oral instructions” and (7) “ask to repeat things.”

The **Learning domain** is related to the ability of a participant to acquire knowledge¹⁷ through reading, writing, verbalizing, and participating in other activities that are common in the academic environment. For this category, questions were selected that included (6) “poor reading skills,” (9) “academic difficulties or of learning,” and (12) “disorganized.”

For the **Attention domain**, considering the definition in a broader context, we selected the following questions: (8) “easily distracted,” (10) “short period of attention,” and (11) “dreams during the day, inattentively.” These aspects of the attention domain are studied in different fields of knowledge, since they are considered as important constructs for understanding perceptive and cognitive processes.^{13,18}

Attention, in a broader conceptualization¹⁹, manages perceived and memorized information derived from other cognitive processes that originate

from the brain’s ability to prioritize a stimulus that is superimposed on several other stimuli.

For the **Audition domain**, we considered an extended concept that involved detection and speech recognition in different low redundancy situations^{20,21}, and the following questions were selected: (1) “difficulty in listening or understanding in a noisy environment,” (2) “not understanding when people talk fast or with a “muffled voice,” (4) “difficulty to identify and discriminate speech sounds,” and (5) “inconsistency of responses to auditory information.”

Thus, the four established domains were: listening and comprehension (2 to 10 points); learning (3 to 15 points); attention (3 to 15 points); and hearing (4 to 20 points). The data were analyzed by counting the occurrences of responses per question, according to the classification and corresponding score. Two nomenclatures were adopted: “Sab total,” for the total score obtained from the 12 questions, and the “SAB_domain,” for the total number of questions per domain. The domains included attention, listening comprehension, learning, and hearing.

The data that was obtained from the scores, before and after implementation of the interventions, were transformed into difficulty percentages. Then, the difference between the expected score, i.e. five points per question or 60 points in total and the observed score, was calculated. This value was termed “percentage of SAB difficulty” (“SAB difficulty”). The difference between the values of SAB difficulty before and after intervention was named the “evolution of the auditory behavior from a parents’ perspective (SAB evolution).”

Descriptive statistics – the mean value, standard deviation, median value, minimum and maximum values – of SAB total, SAB domain, SAB difficulty, and SAB evolution scores were determined. An inferential statistical analysis was performed using nonparametric tests. To analyze the contribution of each domain to the final score, before and after ACAT, we used the Wilcoxon and Kruskal-Wallis tests. A significance level of 5% was adopted.

Results

The individual occurrences of SAB total, SAB difficulty, and SAB evolution scores before and

after the training session are shown in Table 1.

The data of the descriptive statistics for SAB total before and after the training session are shown in Table 2 and those for SAB difficulty and SAB evolution are displayed in Table 3.

Table 1. Individual occurrences of SAB Total, SAB difficulty, and SAB evolution scores.

N	SAB_total (SAB_difficulty in %)		SAB_difference (Post-Pre) (SAB_evolution in %)
	Pre	Post	
1	20 (66.67)	40 (33.33)	20 (33.33)
2	29 (51.67)	37 (38.33)	8 (13.33)
3	15 (75.00)	46 (23.33)	31 (51.67)
4	16 (73.33)	44 (26.67)	28 (46.67)
5	19 (68.33)	46 (23.33)	27 (45.00)
6	14 (76.67)	42 (30.00)	28 (46.67)
7	24 (60.00)	39 (35.00)	15 (25.00)
8	20 (66.67)	31 (48.33)	11 (18.33)
9	42 (30.00)	54 (10.00)	12 (20.00)
10	25 (58.33)	40 (33.33)	15 (25.00)
11	18 (70.00)	26 (56.67)	8 (13.33)
12	33 (45.00)	42 (30.00)	9 (15.00)
13	24 (60.00)	40 (33.33)	16 (26.67)
14	40 (33.33)	47 (21.67)	7 (11.67)
15	27 (55.00)	39 (35.00)	12 (20.00)
16	16 (73.33)	30 (50.00)	14 (23.33)
17	17 (71.67)	44 (26.67)	27 (45.00)
18	23 (61.67)	49 (18.33)	26 (43.33)

Legend: N= number of observations; SAB = Scale of Auditory Behavior

Table 2. SAB total descriptive statistics before and after the training sessions.

	Pre	Post	Score difference	Pre- vs. Post- Wilcoxon test
Minimum	14	26	7 (11.67)	
Maximum	42	54	31 (51.67)	
Mean	23.44	40.88	17.444 (29.074)	p value < 0.0001 *
Variance	67.20	47.75	67.908(188.63)	
Standard deviation	8.19	6.91	8.241 (13.734)	
Median	21.5	41.0	15 (25.0)	

Legend: *statistically significant; SAB = Scale of Auditory Behavior

Table 3. SAB difficulty statistics before and after the training sessions and SAB evolution.

	SAB_difficulty		SAB_evolution
	pre	post	
Minimum	30.00	10.00	11.66
Maximum	76.66	56.66	51.66
Mean	60.92	31.85	29.07
Variance	186.67	132.643	188.63
Standard deviation	13.66	11.51	13.73
Median	64.16	31.66	25.00

Legend: SAB = Scale of Auditory Behavior

Table 4 shows SAB difficulty per domain, and the calculated value, to compare the percentage of SAB difficulty per domain before and after ACAT.

Considering SAB domains separately, the contribution of these groups was analyzed simultaneously by the Kruskal Wallis test, in order to identify if there was any difference between the groups and domains before and after the training session.

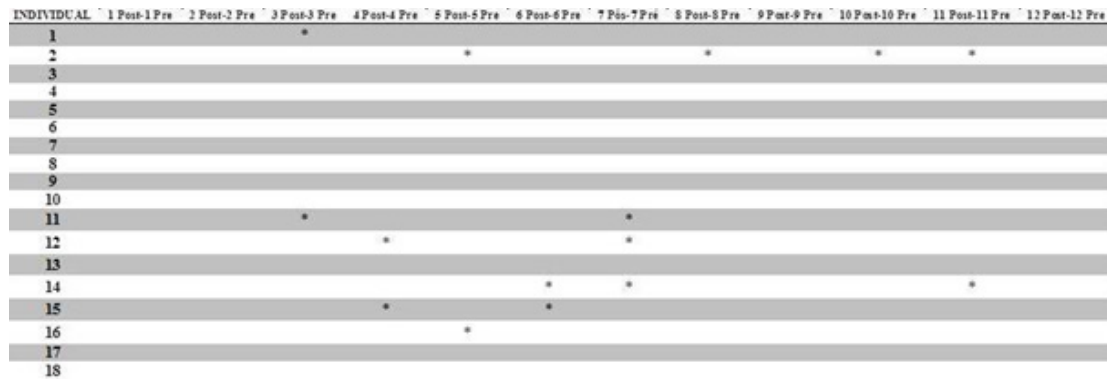
This analysis resulted in p values of 0.1143 and of 0.204, respectively. Thus, the domains before and after the training session contributed to obtaining a final and equal score.

In this study, while answering the survey, a worsening of the parents' perception of some questions after ACAT was observed. The occurrences of this worsening are shown individually in Figure 1.

Table 4. SAB difficulty % score descriptive statistics per SAB scale domain, and the calculated p-value of the comparison of the results that were obtained before and after the training sessions.

	Mean	Median	Standard deviation	Q1	Q3	pre- vs. post-p value
Pre – Total	60.92	64.16	13.66	55.00	71.66	0.00020 *
Post – Total	31.85	31.66	11.51	23.33	35.00	
Pre – Hearing	56.38	55.00	13.26	50.00	65.00	0.00019*
Post – Hearing	27.22	25.00	13.95	15.00	35.00	
Pre – Understanding	60.00	60.00	19.70	50.00	80.00	0.00145*
Post – Understanding	31.11	30.00	14.09	20.00	40.00	
Pre – Attention	61.85	66.66	18.82	53.33	80.00	0.00059*
Post – Attention	32.59	33.33	15.98	26.66	40.000	
Pre – Learning	66.67	76.67	19.80	60.00	80.000	0.00027*
Post – Learning	37.78	33.33	15.842	33.33	46.66	

Legend: SAB = Scale of Auditory Behavior; * statistically significant; p= Wilcoxon test



Legend: * indicates when a certain behavior had worsened, according to the SAB scale, after the treatment period.

Figure 1. A worsening of auditory behavior, from the parents' perspective, was obtained through the SAB Scale per individual.

Discussion

As this is a pilot study, the sample is insufficient to determine populational behavior. Further studies are required to increase the cohort.

After ACAT, the auditory behavior improved, from parents' perspective (Table 1, Table 2, Table 3), and this improvement was significant (Table 5).

As shown in Table 1, when applying the pre-training SAB scale, the 18 participants in the study had a total score for the SAB evaluation that was lower than 46 points. Two had a score between 35 and 46 points, and the remaining 16 presented a score lower than 35 points. After ACAT, all patients improved their auditory behavior, and these improvements varied from 11.67% to 51.67%. Of these patients, three (observations 8, 11, and 16) maintained a score below 35 points, while the remaining achieved higher scores. In the specialized literature, one study¹¹ showed that, according to the SAB scale, scores lower than 35 indicate a high risk for altered auditory processing. In turn, on the same scale, scores over 46 points, suggest a low risk of presenting this alteration. Thus, in this study, only three (16.66%) individuals maintained a high risk for altered auditory processing after ACAT. Therefore, the success of this intervention, as measured through the SAB scale, was noted in 83.33% of the cohort analyzed, according to the parent's perspective.

In the analysis by domains, a similar difficulty was verified in each training session, before and after the intervention.

There was an improvement of auditory behavior, considering each domain (Table 4), and the improvement was significant (around 30%) in each domain. The highest improvements (Table 5) occurred in the hearing and attention domains, while the listening comprehension and learning domains showed less ostensible improvements. One possible justification for the reason why the audit and attention domains performed better than the other two domains could be due to the fact that ACAT is a specific training program for developing auditory skills and attention, as some studies have pointed out.^{6,8,11,12}

Other studies have indicated that through an auditory training program, the central auditory system can be modified, which reveals the plasticity²² of the central nervous system. However, for effective improvements in learning, language, reading,

and writing skills, which are associated with the listening comprehension and learning domains, other global speech-language interventions, besides ACAT, are necessary.^{10,13}

Another important point to consider is that of the parent evaluations in relation to the auditory behavior of some individuals, which indicated a worsening of some questions after the ACAT session (Figure 1). For example, in individuals 11 and 12, the worsening occurred in questions that involved the listening comprehension domain. In individuals 2 and 11, the worsening occurred in questions that involved the attention domain, and in individual 14 in the learning domain. Hence, it is worth asking: can the altered response consistency in listening comprehension, attention, and learning domains result from the therapy or from the questionnaire? One answer takes the positive results of the evaluation after ACAT auditory processing as a reference, and discards the possibility of changes that originate from the acoustically-controlled training session. Nonetheless, we can justify this observation through psychological or attentional aspects, according to the double topicalization below.

Psychological – when parents respond to some questionnaires or scales, as in the case of SAB, through which questions can instigate discomfort to any situation, it is possible to use a coping mechanism, which is a psychic denial of the problem²³. As such, these individuals stop realizing some of the mentioned child difficulties in the scale. This is a strategy that is used by parents or guardians, who are often unaware that they act this way. The task of the psyche²⁴ concerns finding strategies to face the anxieties²⁵ that are caused by increased tension or displeasure and appear in real or imaginary situations that threaten physical or mental integrity, especially situations that are too strong to be ignored, dominated, or discharged. Situations that cause anxiety include the loss of a desired object, which goes beyond rejection or even the failure to obtain the intended target. The observations of this study, from the parents' perspective about the difficulties that are experienced by their children, usually occurs when parents tend to use denial as a strategy to justify behavior disorders that children present. In addition, they tend to adopt tentative denial, which involves not consciously accepting some facts that are capable of destabilizing their ego. Adults who tend to not see real facts imagine

events, which allows them to escape from their problems rather than face them.

Attentional – the parents may not have been aware of some behaviors of their children. However, after exposure to the SAB scale questions, they start to realize behaviors that were not previously observed.

In the specialized literature, several works²⁶⁻²⁹ have demonstrated the effectiveness of ACAT in different populations, and this improvement is due to structural changes. This is supported by a study that demonstrated how neurobiological connections³⁰ are the key auditory processing alteration interventions. In this study, we found that the auditory behavior improvements could be observed by parents through the application of an easy instrument, in this case, the SAB scale, which also raises awareness in parents who contribute to the auditory behavioral development of their children.

To guide the perceptions of parents who respond to SAB scale questions, it is recommended to apply the questionnaire twice before ACAT and to consider the responses of the second application as a reference. Regarding the psychological variable, one can discuss the contribution of a therapeutic approach with parents, in order to sensitize and develop a specific perception in relation to the auditory behavior of their children.

The evaluation of the SAB scale can serve as a guide at school for teachers and caregivers.

Conclusion

The parents of the children who received these training sessions perceived a satisfactory improvement in the auditory behavior of their children. It is possible, through the SAB scale, to realize specific changes in auditory behavior and classify these changes by domains. This allows us to conduct a training that targets each altered domain.

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