Explorative and comparative study of the audition in children of 3rd grade of Primary with reading difficulties.

Implementation of the PROLEC-R test.

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RESUM: Aquest estudi transversal tracta d'establir una relació directa entre la percepció auditiva i l'habilitat lectora, explorar si la qualitat de l'audició condiciona la velocitat i comprensió lectora. Tanmateix, comprova si la variable socioeconòmica influeix en l'adquisició i/o desenvolupament d'aquesta competència. 24 alumnes de 3r de Primària, 12 d'una escola privada de Sant Cugat i 12 d'una escola pública de Badalona, són avaluats en comprensió i velocitat lectora per mitjà de l'aplicació del PROLEC-R per constituir tres grups segons el nivell de lectura (resultats bons, amb dificultats, dificultats severes). A tots els participants, a cada escola, se'ls administra la següent bateria de proves: linguistic background test, per saber les llengües que coneixen i l'ús que en fan; audiometria, per avaluar la qualitat de l'audició i enquestes de percepció, per conèixer l'opinió sobre la recerca. Els resultats de l'estudi han destacat diferències significatives entre el grup amb bons resultats i el grup amb severes dificultats respecte al llindar i la linearitat de l'oïda dreta. Existeix una correlació directa entre els resultats en lectura i el llindar i linearitat de les dues oïdes, també amb la fusió binaural. Comparant ambdues escoles, la gran majoria dels participants de baix nivell sòcio-econòmic han obtingut resultats inferiors tan en lectura com amb la sensibilitat i discriminació auditiva.

Paraules clau: Audició, lectura, comprensió lectora, velocitat lectora, audiometria, PROLEC-R.

ABSTRACT: This interdisciplinary study aims to establish a direct relationship between the auditory perception and reading skills. Specifically, to explore if the quality of hearing determines speed and comprehension. Moreover, it aims to check whether the socio-economic variable influences the acquisition and/or development of this competence. 24 students of 3rd grade of Primary School, 12 of a private school of Sant Cugat and 12 of a state school in Badalona, are evaluated internally in comprehension and reading speed by means of the application of PROLEC-R tests to constitute three groups of reading competence (good results, with difficulties and with severe difficulties). All the participants, in each school, were administered the following battery of tests: the linguistic background test, the audiometry, and the perception questionnaire. The outcome reflects significant differences between the group with good results and the one with severe difficulties regarding the right ear threshold and linearity. There is a direct

correlation between the reading performance and both ears' linearity, threshold and the binaural fusion. Comparing schools, the vast majority of the participants of low socioeconomic level had poorer results in reading and also less hearing sensitivity.

Key words: Audition, reading, reading speed, reading comprehension, audiometry, PROLEC-R

INTRODUCTION

Reading competence is the foundation of learning in Primary Education. It is important to develop the language, to improve the way we communicate and to acquire new knowledge to achieve an integral education.

PIRLS (Progress in International Reading Literacy Study) defines reading comprehension as the ability to understand and use the required linguistic forms, the ability to construct meanings from a variety of texts or the participation of readers in reading communities in the school environment, daily life or for one's own enjoyment. To evaluate this reading comprehension, PIRLS provides data about performance according to two reading purposes: literary purpose and informational purpose. The processes carried out to acquire this understanding are also taken into consideration, that is, obtaining information and the realization of direct inferences, and the integration and evaluation of the content.

Taking into account the results of the PIRLS (2016) we can see that Spain presents an intermediate level (528 points), a result that is significantly different in comparison with the group of countries belonging to the OCDE (540), but not significantly different from Catalonia (522).

Regarding the purpose of reading, the difference between reading for enjoyment (530 points) and reading for information (527 points) is not significant in Spain. On the contrary, we can appreciate a difference of 7 points that favours reading for enjoyment in Catalonia (526 points) against reading for information (519 points).

Concerning the social, economic and cultural context, the research concludes that, in Spain, having more than 200 books in higher socioeconomic classes against having less than 10 in the lower ones means a difference of 62 points and, concretely, in Catalonia this difference increases to 68 points. That relevant difference indicates the influence of the socioeconomic environment concerning reading.

In our study we put the focus on the causes of these results, the reason why there are reading difficulties to know how we can overcome them. We consider that one of these causes can be the audition. Lately, some research on the topic of the audition and its influence into the reading acquisition process has been published. However, more investigations should be done in order to establish a connection between the reading process and the auditory perception.

The aim of the study is to explore if there is a relation between the quality of the audition and the reading speed and comprehension. Moreover, to check if the socio-economic variable influences the outcome. First of all, we explore the audition and neurology of reading, also the different studies related to this field. Then, we explain the method and the instruments we used and to sum up, we gather data, discuss the results and present the conclusions of the research.

THEORETICAL FRAMEWORK

The senses are responsible for the survival of the species. They allow us to capture, translate, interpret and anticipate the signals from the environment. The environment speaks the language of vibrations and waves, a mechanical language. The brain, however, only understands the language of electrical or nervous impulses. For this reason, the senses act as mechanisms of signal transduction. These same mechanisms are those that help us learn.

The senses have the function of recognition and adaptation to the environment for survival, learning and cognition. These functions are carried out in our brain thanks to ratings, comparisons and logical mathematics operations. To be successful requires a system to capture the peripheral stimulus, and a central system to interpret them.

The auditory pathway is a complex path with several stations, connections and crossings. Here below we present briefly the route since this knowledge is needed in order to understand both the associated malfunctions and the data provided through the different instruments of exploration.

Peripheral Auditory System

The peripheral auditory system is responsible for capturing, amplifying, analyzing and transducing sound waves that come from outside. This sequence is divided into three parts:

1. The external ear captures and channels the sound stimulus.

2. The middle ear amplifies the pressure of the sound waves to move efficiently in the inner ear, which is a liquid medium.
3. The inner ear decodes the signals and sends them to the brain in the form of electric impulses. The inner ear decomposes the sounds in all the frequencies that they form and send them to the cortex. The auditory signal is not encoded at the same point, it varies according to the frequencies.

Central Auditory System

The auditory system is made up of acoustic nerves and the brain, from the cochlea to the cortex. The auditory nerve contains approximately 30,000 nerve fibers and their main function is to transmit electrical impulses from hair cells to the brain. These impulses from the cochlea will continue on their path of transmission through all the parts that make up the central hearing, using the synapses following a parallel transmission.

The first synapsis in the organ of Corti and the auditory nerve

The organ of Corti is located in the cochlea (inner ear). The first synapsis occurs when the ear captures sound, hair cells at the organ of Corti are activated, there is an action of chemical agents and, therefore, the stimulus is sent to the axon of the cochlear nuclei, which are inserted within the medulla oblongata in the trunk of the brain.

Cochlear nuclei

Cochlear nuclei are located in the trunk of the brain. They are monaural because the left nucleus only receives information from the left ear, and the same happens with the right one. Cochlear nuclei have a tonotopic distribution, each space corresponds to a certain frequency that responds to the physical characteristics of sound: intensity, frequency, duration, pitch and sequencing. The information takes 1 ms to get there. If the stimulus does not produce panic to us, the sound continues its path.

Second synapsis in Superior Olivary Complex (SOC)

There are two SOC: the right and the left. The information takes 3 ms to reach these nuclei. 33% of the received information for hearing will happen in the ipsilateral part of the body, which is on the same side, and 67% in the contralateral part, which is on the opposite side. Once you got this information, this information is exchanged. The comparison of the information serves to localize the sound source. The difference of intensity between the two ears and the difference of time to reach the both SOC let you know where the origin of the sound source is.

From here, all the cores will analyze both the what and the how of this information. The following relay nuclei connects with the nerves III, IV, VI, that allow mobility of the eyes.

<u>Third synapsis in the Nuclei of the Lateral Lemniscus (NLL)</u>

NLL receives the information from the COS. At this point, information is exchanged again, crossing from one side to the other. This information is used for the control of the eye movement (CMO) and also goes to the inferior colliculus (IC). There are two NLL: the right and the left. They get the 100% of the information in 4 ms.

<u>Fourth synapses in the Inferior Colliculus (IC)</u>
There are two IC, the right and the left. The information takes 5 ms to reach these nuclei. If some stimulus freaks, the body reacts without a notion of what has been played. These nuclei will generate a mental map that will locate the sound sources. Ignoring background sounds and selecting the sounds we are interested in, allows selective attention. The IC allows a motor response to auditory stimuli. There is also an integration of visual stimuli with hearing. At this point, the route goes to the limbic system.

<u>Thalamus</u>
Between the limbic system and the cortex, the reticular thalamus nucleus acts as a filter to know what information needs to get to the cortex. The stimulus goes through the limbic system, a set of brain structures located on both sides of the thalamus. This consists of an anatomical structure with different parts: medial, ventral and dorsal. The tonotopic distribution is interaural and analyses the intensity and time. The medial and dorsal structure send projections to the amygdala and, therefore, relates to the emotional processing of sound.

<u>Hippocampus, amygdala and hypothalamus</u>
The amygdala filter processes pleasure, pain and also fear. The signal will be sent to the hypothalamus, causing a motor response. Finally, the hippocampus is where the reaction that the individual has had in front of a stimulus is recorded and stored. So, it is recorded in the memory. What activates the limbic system is the motivation as it represents the memory for survival and, therefore, we do not forget the information that is important and is stored in our long-term memory.

<u>The auditory cortex auditory cortex</u>
Primary Auditory area (Brodmann area 41) receives afferences from the limbic system. This area is a replica of the sound analyzed by the cochlea and the cochlear nucleus.

From the Primary Auditory area, sound arrives to the secondary auditory area (Brodmann area 42) where sound of low complexity will be analyzed and there will be the phenomenon of habituation, sound and interferences inhibition to allow attention. Moreover, in the Auditory Cortex the space awareness perception is generated. Through the corpus callosum, both hemispheres share information to create a spatial map through the auditory system. If the sound is language, it will go to Wernicke area (Brodmann area 22) to recognize it and have access to the meaning. Also, Wernicke area receives afferences from the frontal lobe to control attention and from the occipital lobe for reading and writing processes.

Reading

Spanish is considered a transparent language because there is agreement between the oral and written form. For this reason, the method of learning the literacy skills is phonological. The circuit of reading begins with writing: the orthographic units that allow us to access the vocabulary, spelling, semantic lexicon (fragments of meaning), pronunciation and speech production. First, we need to discriminate and recognize the reading graphs, for their invariance. Subsequently, we identify the words and finally, the message is interpreted according to the context. The different language tracks are phonetic, which can be syllabic or sequential; the semantics, which are global; and contextual, which are integrative.

Neurology of reading

There is an area in the cortex which detects if that symbol that has come to the primary visual area corresponds to a phonological code or not. If it corresponds, the word will be formed as an acoustic image. The image of the word through the twist angle is projected in the Wernicke's area. Therefore, in the reading, when our visual code recognizes that this set of symbols is a phonological code, it activates the Wernicke's area, that generates the sound of the word, active in the parietal lobe area of meaning. Therefore, between the entrance of visual information and understanding, there is the auditory area. When the Wernicke area is activated, at the same time the drill area through a bundle of nerve fibers, the arcuate fascicle, is activated. The drill area (Brodmann areas 44 and 45) sends a signal to the motor cortex to begin to articulate if we read aloud or move your hand if it is necessary to write.

Nowadays, several studies are investigating the connection and influence of audition in reading. Further studies must be done and there is information missing yet about the neurological pathways of audition. Recently, a study that analyses the relationship

between eye movements, auditory perception and phonemic awareness with the reading process has been published: 52 students of first grade of Primary Education participated. The results of this study showed that pupils with difficulties related to eye movements or in auditory perception obtained lower reading levels (Megino-Elvira, Martín-Lobo and Vergara-Moragues, 2016).

In another study, where cortical-auditory-evoked potentials were used to find differences between poor and good readers, the researchers concluded that the finding of worse performance on the Auditory Processing tasks for the poor compared to the good group is a demonstration that intact central auditory function is fundamental for reading development (Barker, Kuruvilla-Mathew and Purdy, 2017).

Finally, another important study assessing children with auditory processing disorder reported a relationship between communication difficulties in children with language-based learning impairments and auditory processing disorders (Kraus and Anderson, 2016).

OBJECTIVES

Research question:
Is there a direct relationship between the quality of hearing, comprehension and reading speed?

Specific objectives:
1. To establish a relationship between reading and hearing.
2. To explore whether quality of hearing determines the acquisition of literacy skills.
3. To check if the socio-economic variable influences the outcome.

METHODS

Comparative and exploratory study of hearing in children with high and low reading skills in 3rd grade in two different socio-economic environments.

Participants

The sample consists of 24 students aged from 8.5 and 9.25 (mean age ± SD (standard deviation) = 8.91 ± 0.23 years old) from the 3rd grade of Primary Education. 12 students come from the private school: 6 girls and 6 boys, and 12 from the state school: 5 girls and 7 boys. There are no age differences between the age of students from both schools (t(22)=0.99; p>0.05) neither dividing the participants into three groups based on the

reading level ($F(2,21)=0.35$; $p>0.05$). None of the participants had a learning pathology diagnosed or any impairment.

Analysis' dimensions

- · Reading comprehension and speed.
- · Audition: auditory threshold, linearity and binaural integration.
- · Perceptions of the participants.

Instruments

1. Linguistic background test

To explore the language and context of the participants we use a linguistic test based on the one validated by the Interlinguistic and Intercultural Competence in Language Teaching and Learning (CILCEAL) research group (FFCEE-B-URL). This test collects information about the L1 (mother tongue), when the child begins to learn Catalan and/or Spanish, the languages he/she knows and when they are used.

2. PROLEC-R (Evaluación de los Procesos Lectores, Revisada)

In order to find out the different reading levels of the participants, we administered the tests of comprehension and reading speed PROLEC-R. The application of this test is individual, and its scope of application is from 6 to 12 years old. It takes about 20 minutes to apply the recommended version, 4 tests out of 9. The material includes the manual, a tests' notebook and a notebook for annotation.

Its purpose is to evaluate the processes of readers regarding to reading speed and comprehension. It Includes scaling, cutting points to diagnose the presence of mild difficulty (D) or severe difficulty (SD) in the processes represented by the main index, and the side precision to determine the reading speed (from very slow to very fast) in the secondary speed index and the reader level (low, medium high) in subjects with normal reading ability.

The tests are the following:

a) Letter's name: the aim is to check if the child recognizes all the letters and their pronunciation. The measurement of time helps us to assess their automaticity. 23 letters are presented on a sheet (the first three, training, vowel) and the subject has to name or issue the corresponding sound.

b) Pseudowords reading: Indicates the ability to pronounce unknown words. It evaluates the sublexical decoding. The list consists of 40 words. Many mistakes in the reading of pseudo-words makes it clear that they are not well acquired the conversion rules grapheme-phoneme.

c) Grammatical structures: it consists of 16 items, each consisting of four drawings and a sentence. Only one of the sketches corresponds to the sentence. The task is to read the sentence and note it down. Syntactic roles assigned to the words that make up the sentence is the preliminary step to be able to understand sentences of varying length and complexity.

d) Text comprehension: the goal is to check whether the reader is able to extract the message that appears in the text and integrate it to their previous knowledge. It is measured by means of questions referring to the text. It uses 4 texts (two narrative and two expository) of 90 words and more than 130 words each one. For each text there are 4 questions.

3.   Audiometry

All participants were evaluated by means of auditory perception with a Maico MA53 audiometer. The task has been carried out in a controlled sound environment with a level of sound inferior to 30dB.

It measures the answer in sensitivity that the ear has for each frequency of the sound, the minimum intensity required to activate the response of the auditory system in front of each frequency. This audiometric exam is done by using a calibrated audiometer and specific headphones. Pure tones are presented for each frequency, measured in Hertz (Hz; 125 Hz, 250 Hz, 500 Hz, 750 Hz, 1 kHz, 1.5 kHz, 2 kHz, 4 kHz, 3 kHz, 6 kHz and 8 kHz) in different intensities until you find the minimum intensity (threshold) at which the subject responds, that is, is aware of the sound. This is evaluating the cortical response.

The audiometric exam does not only measure the amount of hearing loss and its origin, the audition involves complex processes of the central nervous system, which is responsible for the analysis of the information captured by the ear and its interpretation. It has to do with perception and discrimination of sound, location and spatial orientation, selective attention and learning.

The ordinate axis which is reflected in the test corresponds to the intensity of sound expressed in decibels (dB) and the abscises axis corresponds to the different frequencies expressed in Hertz (Hz). The frequencies between 125 Hz and 750 Hz form the major record and are related to the functions of the sound source localization, spatial orientation, balance and motor coordination, corresponding to the analysis carried out by the trunk of the brain. The frequencies between 750 Hz and 4 kHz form the central registry and are involved in higher cognitive processes such as the language, writing,

and mathematics. The frequencies between 4 kHz and 8 kHz form the upper register and it is where the upper harmonic language is.

Due to de age of the participants, their auditory curve should be similar to that of an adult. Thus, we should observe a line that is practically straight and as close to 0 as possible. An average of hearing between 0 and 15 dB is considered correct; between 15 and 30 represents hearing difficulties; and above 30 we can suppose there is some damage in the peripheral level. We will work with participants with a hearing threshold between 0 and 29. Any participant with a mean threshold above 30, will not be part of the study. Despite having a normal hearing threshold, if the standard deviation of the minimal intensity of these frequencies with respect to the mean is higher than -5, it indicates difficulties in the discrimination that can affect language. Finally, regarding the lack of binaural integration, if the differences between right and left are greater than 5 dB in the three records (low pitch, high pitch and mid pitch), this indicates an auditory processing disorder. According to the distortion of the chart, you can see affected central auditory functions that are related to basic psychological processes and consequently, to the academic performance.

4.   Perception questionnaires.

This instrument is useful to know the opinion of the participants and their teachers about the research carried out. Each group (the teachers and the students) had their own questionnaires composed by 5 questions and they could add a comment.

RESULTS AND DISCUSSION

The Linguistic Background Test

The linguistic background test showed that the language used in PROLEC-R, Spanish, was known for all the participants. Moreover, the vast majority of the participants in both schools used Spanish to communicate with friends. Spanish is the mother tongue of 58% of the private school participants and 83% of the State School. The perception about the language more used is Spanish including at the same level in the Private School Catalan or English, and in the state school Catalan or another mother tongue not official in the Catalan Educational System. Over 50% of the State School pupils prefer reading in Catalan rather than in another language as they read in the school, but they present several difficulties regarding comprehension in Catalan. Regarding the language of their thoughts, Spanish is the one highlighted by the state school (91,6%) because they use less languages and there is more variability in the preference of the participants from the

Private School (41,6%) as they all know and use more than three languages (see Annex 1).

PROLEC-R

The results obtained are written in a grid where participants are codified with a J (State school) and M (Private School). There figures the age, different classifications according to the reading levels explained after the image, and the results of the participants in the 4 different tasks. Speed is measured in seconds in test 1 and 2 and there is also the amount of right answers obtained.

PARTICIPANTS	AGE	3 GROUPS	P1V	P1E	P2V	P2E	P3	P4
J1	abr-09	2	18	16	42	34	11	11
J2	mar-09	3	22	18	178	19	11	11
J3	ene-09	3	21	20	57	11	12	13
J4	may-09	3	24	25	66	19	12	8
J5	abr-09	2	24	19	80	37	12	14
J6	ago-09	3	38	13	900	0	0	0
J7	feb-09	2	14	12	100	11	14	12
J8	oct-09	3	22	15	154	19	4	0
J9	oct-09	2	19	20	81	36	6	5
J10	mar-09	3	14	19	76	32	8	8
J11	sept-09	1	16	14	47	33	10	12
J12	sept-09	1	13	13	53	30	8	4
M1	mar-09	1	15	20	37	37	14	15
M2	ago-09	2	21	20	190	32	14	5
M3	ene-09	3	25	18	116	37	11	9
M4	may-09	1	18	19	53	37	14	12
M5	mar-09	2	23	18	97	34	14	13
M6	mar-09	1	17	19	83	39	15	13
M7	may-09	3	29	18	80	32	11	10
M8	jun-09	2	21	18	78	36	8	7
M9	1-jul	1	11	20	39	35	16	14
M10	may-09	2	16	17	104	30	14	9
M11	abr-09	1	16	20	70	39	13	12
M12	may-09	1	17	20	75	39	14	14

Image 1. PROLEC results grid. Letter's name speed (P1V) and right answers (P1E). Pseudowords reading speed (P2V) and right answers (P2E). Grammar Structures (P3) and Text comprehension (P4). J6 participant presents an outlier score in P2V as there is more than three standard deviations compared to the group average. This value was removed from the analyses as the results could be distorted.

According to the results, we divided the 24 participants into three reading levels, having 8 students in each level (see Annex 2):

N (normal performance), those who obtained 75% or more good results in the PROLEC-R, having 3 or 4 tests with a normal or good score.
D (showed difficulties), obtained 50% of normal results in the PROLEC-R, having 2 out of 4 tests with a normal score.

SD (several difficulties), obtained 25% or less good results in the PROLEC-R, having 1 test out of 4 with normal results or none.

NAME	P1 V E	P2 V E	P3	P4
J1	D N M	? R B	D	N
J2	¿? N B	DD ML B	D	N
J3	DD N B	DD N B	D	D
J4	DD N B	DD N B	D	D
J5	N N B	N N M	D	N
J6	DD ML B	DD ML B	DD	DD
J7	DD N M	DD L B	N	N
J8	DD N B	DD ML B	DD	DD
J9	N N A	N	DD	DD
J10	N N M	? N B	DD	D
J11	DD N M	? R M	D	N
J12	DD N M	D N M	N	N
M1	N N M	N R A	N	N
M2	N N M	¿? ML B	N	DD
M3	¿? N B	¿? ML B	D	D
M4	N N M	N N M	N	N
M5	¿? N B	¿? L B	N	N
M6	N N M	N N M	N	N
M7	¿? L B	¿? N B	D	N
M8	¿? N M	N N M	DD	D
M9	N R A	N R M	N	N
M10	¿? N M	D L B	N	D
M11	N N M	N N M	N	N
M12	N N M	N N M	N	N

Image 2. Results classification according to PROLEC-R scales.

- Group N (1) was formed by 6 students from the Private School and 2 from the State School.
- Group D (2) was formed by 4 students from the Private School and 4 students from the State School.
- Group SD (3) was formed by 2 students from the Private School and 6 students from the State School.

PROLEC-R results reflect that the 50% of the private school participants have good results opposite to the results of the state school participants that only 25% of them had good results.

An analysis of variance (ANOVA) was carried out in order to assess possible differences among groups. Comparing the 3 classifications of the participants, we see a significant difference between the results obtained in the Letter's Name speed (P1V; $F_{(2,23)}=7.25$, $p<0.05$), in the Pseudowords Reading speed (P2V; $F_{(2,22)}=3.51$, $p<0.05$) and in the amount of answers in the Pseudowords Reading (P2E; $F_{(2,23)}=6.03$, $p<0.05$). In the

Grammar Structures (P3) test there were marginally significant difference among groups ($F_{(2,23)}=3.31$, $p=0.056$).

P1 V Letter's Name Speed

P1 E Letter's Name Right Answers

P2 V Pseudoword Reading Speed

P2 E Pseudoword Right Answers

P3 Grammar structures Right Answers

P4 Text Comprehension
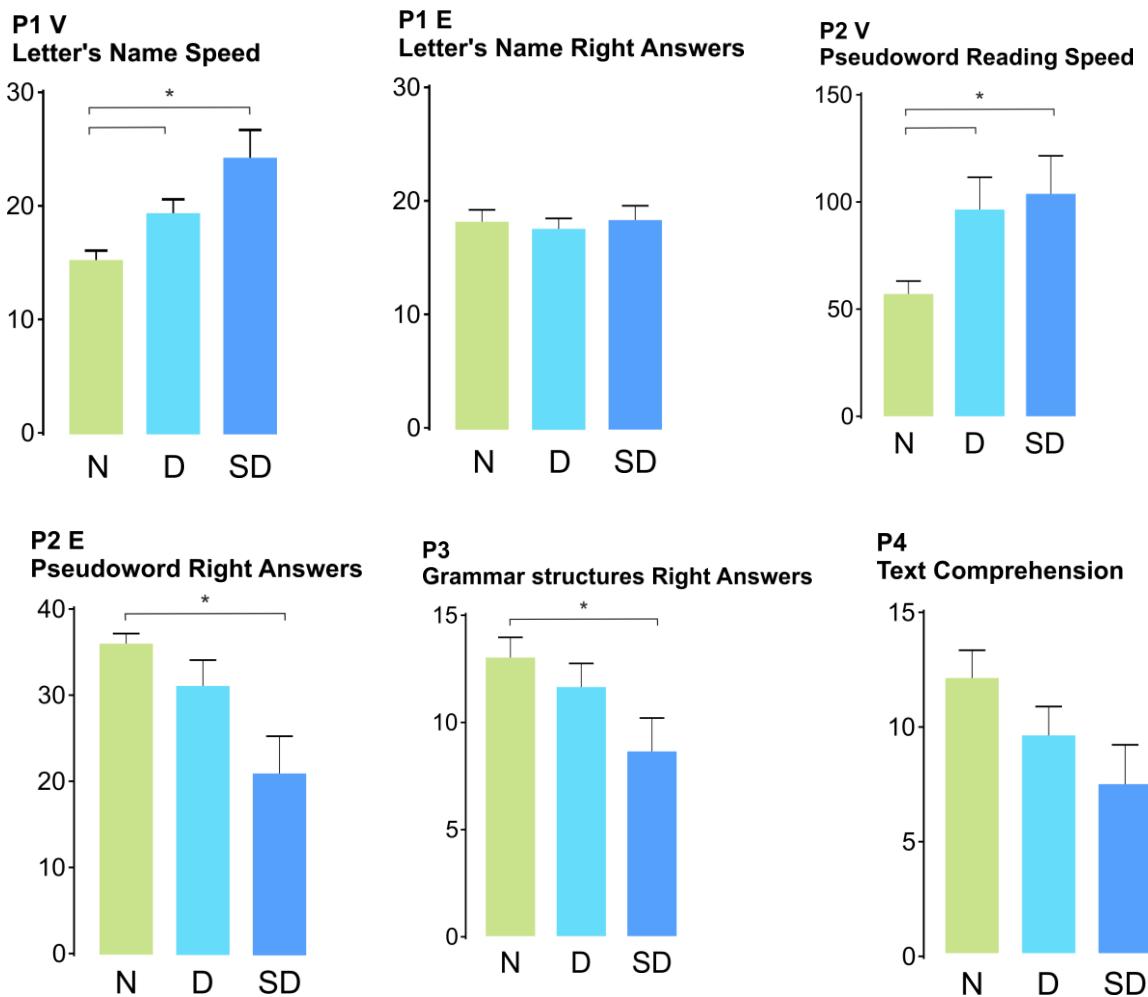
Image 3. These graphics show the mean values of the results on PROLEC-R tests out of the three groups divided by level. Error bars show the standard error of the mean. (* = significant differences; $p<0.05$).

Subsequent independent samples t-tests between groups showed significant differences between group N (1) and group D (2) in P1V (Letter's Name speed; $t(14)=2.82$, $p<0.05$) and P2V (Pseudoword Reading Speed; $t(14)=2.43$; $p<0.05$). For both tests, students from group N (1) were faster than students in group D (2).

When comparing group N (1) and group SD (3), significant differences were present in the Letters' Name Test Speed (P1V; $t(14)=4.47$, $p<0.05$), in the right answers of the Grammar Structures test (P3; $t(14)=2.40$, $p<0.05$), Pseudoword Reading Speed; P2V; $t(13)=2.64$, $p<0.05$) and the right answers to the Pseudo Words Reading test (P2E;

t(14)=3.35, *p*<0.05). Students from group N (1) were faster at P1V and P2V reading tests and presented a larger number of correct answers in P2 E and P3.

No differences were found between group D (2) and group SD (3) in none of the PROLEC-R tests.

Audiometry

The results obtained were:

PARTICIPANTS	AGE	3 GROUPS	THRESHOLD R	THRESHOLD L	LINEARITY R	LINEARITY L	AMBLYAUDIA	BINAURAL FUSION	SPATIAL ORIENTATION	LANGUAGE
J1	abr-09	2	18,18	17,73	5,13	6,84	0,45	5,91	-8,33	6
J2	mar-09	3	19,55	30	7,23	7,75	-10,45	11,36	-11,67	-13
J3	ene-09	3	23,64	15	7,45	7,42	8,64	8,64	10	10
J4	may-09	3	26,82	30,45	9,02	9,61	-3,63	10	-1,67	-6
J5	abr-09	2	17,27	15,91	6,07	3,75	1,36	4,09	-1,66	3
J6	ago-09	3	35,91	20,45	8,89	8,79	15,46	17,27	26,67	16
J7	feb-09	2	23,18	27,27	6,03	6,4	-4,09	7,73	-1,67	-3
J8	oct-09	3	10,45	20,45	5,22	10,36	-10	10	-20	-6
J9	oct-09	2	12,27	18,64	6,84	10,27	-6,37	10	-5	-11
J10	mar-09	3	13,64	13,18	5,52	7,17	0,46	4,09	3,33	-2
J11	sept-09	1	14,09	44,09	7,35	8,31	-30	30	-23,33	-33
J12	sept-09	1	10,91	20	8,89	13,04	-9,09	11,82	-20	-2
M1	mar-09	1	10	10	4,47	4,47	0	0,91	0	1
M2	ago-09	2	5,45	11,36	8,79	9,24	-5,91	6,82	-10	-4
M3	ene-09	3	7,73	2,73	8,17	7,2	5	5	8,34	6
M4	may-09	1	3,18	6,36	4,05	5,52	-3,18	4,09	-6,67	-2
M5	mar-09	2	5,91	4,09	5,84	6,25	1,82	3,64	3,33	2
M6	mar-09	1	7,27	5,45	2,61	5,22	1,82	2,73	0	2
M7	may-09	3	10	10,91	7,75	6,64	-0,91	3,64	1,66	0
M8	jun-09	2	8,18	3,64	6,81	5,95	4,54	5,45	3,33	6
M9	1-jul	1	-0,45	-0,91	4,16	3,02	0,46	1,36	1,66	1
M10	may-09	2	10,45	10,45	5,22	3,5	0	2,73	1,66	-1
M11	abr-09	1	10	7,27	5,92	6,07	2,73	2,73	5	1
M12	may-09	1	3,64	5	3,93	3,87	-1,36	1,36	0	-2

Image 4. Audiometry results chart.

We have chosen an audiometry of a participant of each group taking into account both ears threshold and binaural fusion, where there is a greater difference between the three groups. The 24 audiometry tasks and their statistics can be seen in the Annex (see Annex 3).
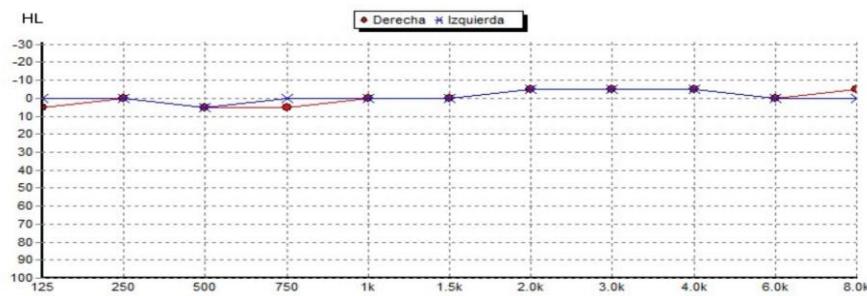
Image 5. M9 audiometry of group N (1). Right ear threshold of 0 and left ear threshold of -1. Binaural fusion of 1'36.
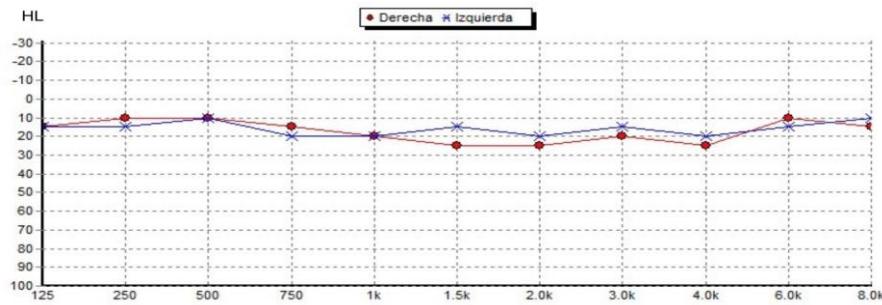
Image 6. J5 audiometry of group D (2). Right ear threshold of 16 and left ear threshold of 15. Binaural fusion of 4.
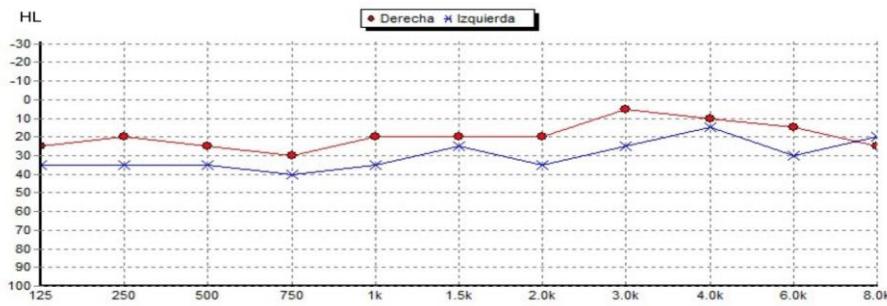
Image 7. J2 audiometry of group SD (3). Right ear threshold of 18 and left ear threshold of 28. Binaural fusion of 11.
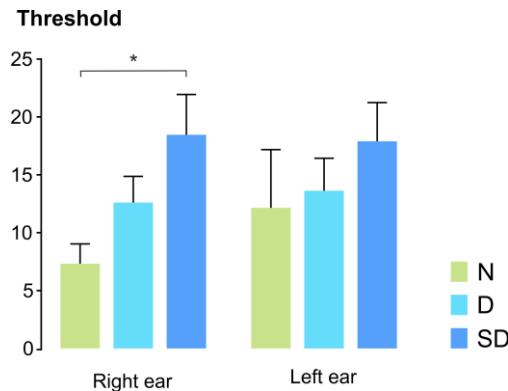
Image 8. This graphic shows the group mean values and error bars (standard error of the mean) of both ears' threshold.

The threshold is the average of hearing. In the right ear, group N (1) show an average threshold under 10 dB which is correct, group D (2) an average between 10dB and 15dB and group SD (3) an average between 15 dB and 30dB that implies difficulties in hearing in the school. It is similar in the left ear threshold, showing a gradually reduction of sensibility if we move from the group N to the group SD.

Statistical differences among groups were found for right ear threshold ($F(2,23)=4.63$, $p<0.05$). Independent sample t-test between groups showed differences in right ear threshold between group N (1) and SD (3) ($t(14)=2.87$, $p<0.05$), the threshold being lower for N (1) group. No differences were found for the other group comparisons.
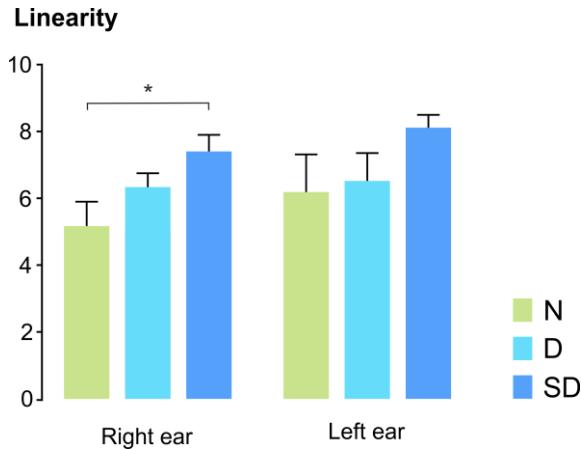
Linearity

Image 9. This graphic shows the group mean values and error bars of the linearity of both ears.

The linearity is the standard deviation of all the frequencies. Obtaining a result higher than 5 or lower than -5, implies a difficulty in discrimination, making slower the auditory process, attached to phonological problems and sound confusion. The analysis of variance (ANOVA) showed a significant difference in linearity of the right ear among groups ($F(2,23)=3.92$, $p<0.05$). In the comparison between groups, independent sample t-tests showed significant lower (better) linearity values for group N (1) compared to group SD (3) ($t(14)=2.52$, $p<0.05$).

Other measures
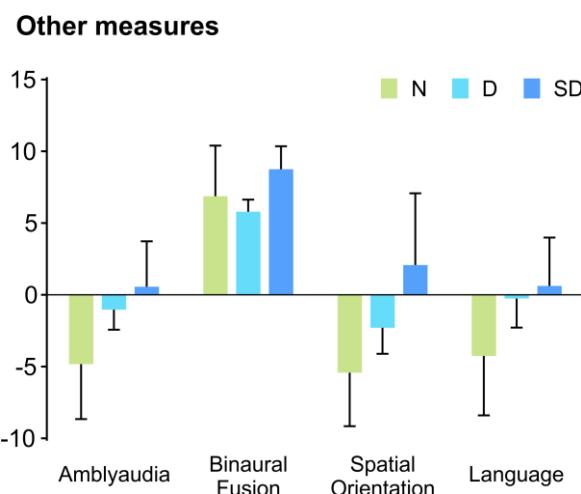
Image 10. This graphic shows the mean values and error bars of the amblyaudia, binaural fusion, spatial orientation and language patterns.

Amblyaudia is the difference of threshold between both ears. Obtaining a result higher than 5 or lower than -5 might imply a difficulty in spatial orientation and language. The results showed no difficulties among groups.

Binaural fusion is the difference of linearity between both ears. Obtaining a result higher than 5 or lower than -5 might imply a difficulty in hemispheric integration affecting the spatial orientation and the auditory processing speed. The outcome showed no differences among the three groups.

Spatial orientation is the difference of threshold between both ears focusing on low pitch frequencies. Obtaining a result higher than 5 or lower than -5 might imply difficulties in sound source localization but there are no differences among the three groups.

Language is the difference of threshold between both ears focusing on mid pitch frequencies. Obtaining a result higher than 5 or lower than -5 might imply the predominance of the functions of one hemisphere above the other, but there are no differences among groups.

Therefore, there are no differences between groups regarding the complementary studied audiometry patterns. The main and significative differences that we want to highlight are in the right ear threshold and in the right ear linearity. The left ear obtained lower results compared with the right ear in group N (1) and also there is more variability between the participants as the error bars show. The right ear is related to the left hemisphere, where the language is located and where the significant differences are found.

Correlation of the audiometry results with PROLEC-R results

To explore if there is a relationship between the reading results and audition, we carried out correlation analyses to find a significance within them. We used Spearman's and Pearson's correlation coefficient with the SPSS Statistical Software depending of the distribution of the studied variables (Spearman is used for non-normally distributed data). (See Annex 4).

The left ear threshold and the binaural fusion present a significant correlation with the right answers of the 4 tests ($r > 0.35$, $p<0.05$ for all correlations). The higher the average

of threshold is, the worse the results in reading comprehension are. In other words, presenting lower left ear threshold and binaural fusion is related to a better performance.

The right ear threshold correlates with the right answers of Pseudowords Reading test and the Grammar Structures test ($r > 0.52$, $p < 0.05$). The better the results are, the better the average hearing of right ear frequencies is.

The linearity of both ears reflects a significant correlation with the right answers of the Pseudowords test, Grammar Structures test and Text Comprehension test. Moreover, the linearity of the right ear correlates with the Letters' Name speed ($r > 0.47$, $p < 0.05$ for all correlations). Therefore, the better the results are, the better are the average hearing and standard deviation of frequencies.
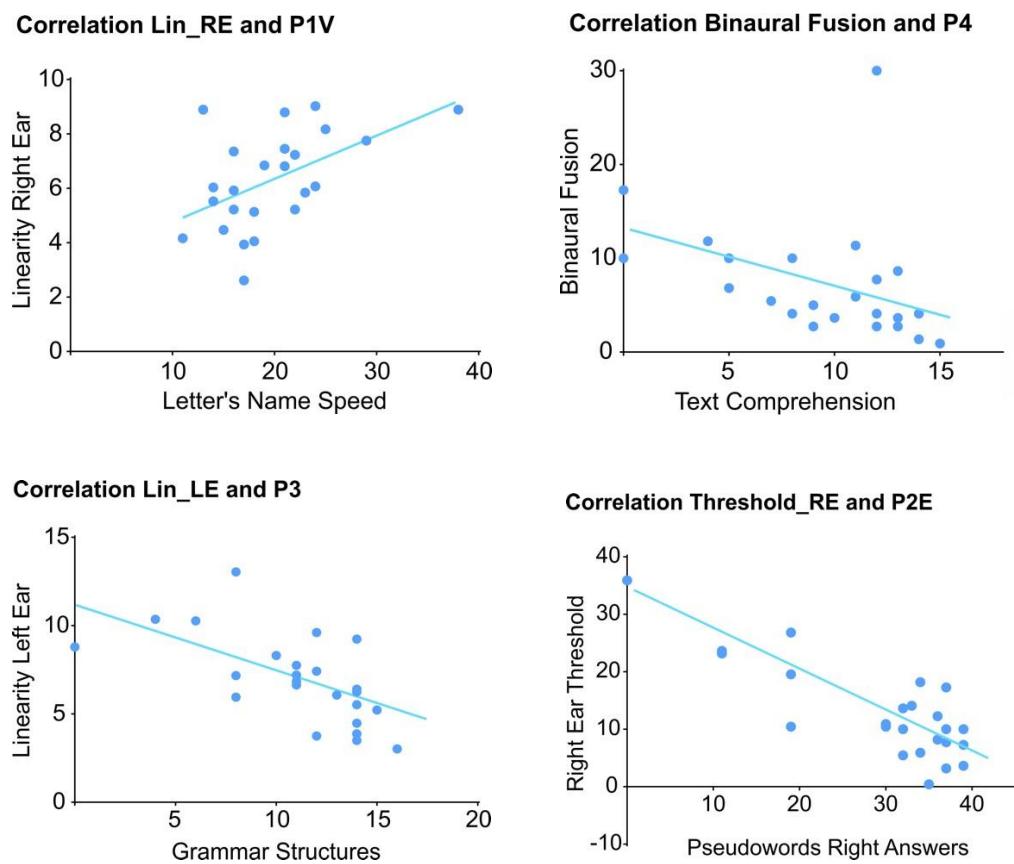
Image 11. Scatterplots selection of a significant correlations between PROLEC-R results and audition patterns.

Correlation Lin_RE and P1V: Lower right ear linearity values are related to faster (better) results on reading task P1V.

Correlation Binaural Fusion and P4: The lower the binaural fusion is higher (better performance) the values on text comprehension are.

Correlation Lin_LE and P3: Lower left ear linearity values are related to better results in grammar structures test.

Correlation Threshold_RE and P2E: The lower the values on right ear threshold are, the larger the number of correct answers in P2E test participants obtained.

As a final conclusion of this section we underline the great differences between group N (1) and group SD (3) regarding to the right ear, which is related to the language. The analysis shows a significant correlation between the threshold and linearity of both ears and the binaural fusion. Moreover, there are significant differences between the subjects of state school and the private school.

Perception questionnaires

The questionnaires of students and teachers have not been meaningful for the aim of the research. Nevertheless, the participants questionnaires showed a positive attitude towards the research development although the tasks were difficult for some of them. According to the teacher's responses, they shared interest in the results and conclusions of the research and underlined the idea of evaluating more students. (See Annex 5)

CONCLUSIONS

One of the goals of this study was to establish the relation between reading and audition. Hereby, we evaluated reading and audition and we have found notable divergence in the reading results when identifying letters speed, decoding pseudo words and reading different grammar structures linked to its meaning. Likewise, there are wide differences in the right ear threshold and right ear linearity. The right ear is connected to the left hemisphere, where language is located. Sensibility and discrimination are linked to the reading performance and comprehension. Hence, we can conclude that there is a relation between audition and reading speed and comprehension.

Another purpose of this study was exploring if the quality of the audition conditions the acquisition of the reading competence. Left ear threshold and linearity have been found significantly related to decoding and comprehension. They are linked to the right hemisphere, which gives meaning to language and obtains the general message when we read. Better results in binaural fusion implies having a similar linearity in both ears, so it is directly related to reading too, as the results have underlined. On the other hand, right ear threshold and linearity have a direct relation with reading and with reading speed

as the left hemisphere is in charge of processing the language and sequencing. The speed of processing and the test of grammar structures implied following a sequence and ordering it. Thence, the results lead us to verify the hypothesis that there is a direct relation between audition quality and reading speed and comprehension. Nevertheless, in order to validate the current results, it would be helpful to have a wider and more homogeneous sample.

The present results show that the socio-economic level of the student families has a huge influence in the academic results of the participants. That was reflected when we classified the participants into 3 groups depending on the reading level. The 75% of group N (1) is composed by private school participants and only 25% of the state school. Among the whole sample, 25% of the participants from the private school had good results and only 8,33% of the state school. Focusing on group D (2), the number of participants is balanced, 50% of each one, a 16,66% respectively among the sample. To sum up, looking to the group SD (3) there is a 25% of the private school participants and the rest are 75% from the state school, just the opposite case of group N (1). The 41,66% of the private school participants show a good level or with few difficulties whereas only a 25% from the state school do. Although the sample is not homogenous, comparing both schools we can state that there are huge differences in reading competence. Furthermore, we underline the fact that the participants from the state school show a lower threshold. Recent studies dealt in Brazil universities of phonoaudiology show lower threshold on participants from lower socioeconomic context (Nunes and Soares, forthcoming). We were not expecting to find this result and we want to highlight it as we did not find previous research on this issue.

LIMITATIONS AND PROSPECTIVE

During the production of this investigation several limitations have arisen that were not expected at the time of initially considering the work.

First of all, one of the most important limitations that emerged was the language that students command: the mother tongue. Initially, we considered using the TALEC to try to evaluate the reading and the comprehension level of the subjects, but when seeing that in one of the schools the Catalan language was not the mother tongue of the students and even in some of the cases they did not have a minimum level, we considered PROLEC-R that is a broadly known and validated reading test in Spanish.

The second important limitation was the sample, the number of participants that were necessary to carry out the different tests. First of all, it was proposed to have a sample of 20 students per school, but the repeated absenteeism of the students of one of the two schools made it impossible, so it was decided to pass the tests to a number of 12 students per school in order to be able to do all the tests to all the participants and have a balanced number of participants. Also related to the sample size, the results in both reading and audiometric tests presented a high variability among subjects, so in some tests differences among groups did not reach significance. With higher samples the effect of variability would be less influential.

The third limitation with which this investigation was encountered was the difficulty of removing students from the classroom. When doing the tests during the school hours, he had to stay and set the days to be able to do the tests. In addition, the availability of adequate spaces to be able to do the tests in a satisfactory way had to be prepared in advance and taking into account the use of other school professionals.

The fourth limitation with which we met was the short time to be able to do the tests and the investigation. Initially, we considered to use both, TALEC and PROLEC-R, as well as adding vision tests (DEM test) and more auditory tests related to short-memory and dichotic audition. However, seeing how little time we had before, we decided to do few tasks, the ones that provide the needed information. If we had had more time the investigation would have been wider and other variables would have been taken into account.

At the end of this research we have seen that in the future this study that has been carried out for the TFG could be repeated in order to rule out other variables that might have conditioned reading results. We propose considering the vision variable with the Development Eye Movement (DEM) test to measure child's eye movements and oculomotor ability, as vision problems can have a negative effect on reading. In addition, we propose to include all PROLEC-R tests in order to have more scales to rate the reading quality. In addition, a middle socio-economic level school could be selected in order to have more students and increase the sample.

It would be necessary to add more students to the sample and to have rooms better prepared to be able to carry out the tests in a more adapted atmosphere, making sure there is no noise and that students can focus on the tasks without interruptions.

In addition, we propose for a future research to go one step further, apply the treatment as a pedagogical approach and, once the students have been properly trained, evaluate again the reading and the audition. It would be convenient to show that many variables are really involved in the reading process and that taking them into account can help many teachers and students that struggle with reading acquisition.

More research on this field and area should be done in order to continue exploring the causes of poor results and the audition influence. Improving audition can lead to improve the reading speed and comprehension, changing not only the academic results but also making the self-esteem rise.

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CONGRESSES/CONFERENCES
"IX Congreso SENA: Estimulación neuroauditiva y dificultades de aprendizaje". Abba Sants Hotel, 25th of November of 2017.

Training on audition and language by SENA SYSTEM, the 3rd of November of 2017 and 3rd and 4th of January of 2018.

WEBPAGE
Complementary information of the TFG
https://sites.google.com/a/blanquerna.url.edu/tfgaudicioilectura/

LES MEVES LLENGÜES

Participant: ....

Data: ....

Respon amb sinceritat les següents preguntes. La resposta pot ser més d'un idioma.

1. Quines llengües coneixes?

   ....

2. Quina llengua fas servir més?

   ....

3. A casa parles en...

   ....

4. Amb els amics parles en...

   ....

5. A l'escola utilitzes més....

   ....

6. Quina llengua de totes les que coneixes prefereixes per llegir?

   ....

7. En quina llengua penses?

   ....

Moltes gràcies per la teva col·laboració!

Student	Llengües que coneix	Llengua més utilitzada	A casa parla	Amb els amics parla	A l'escola utilitza	Per llegir prefereix	Pensa en
PRIVATE SCHOOL PARTICIPANTS							
M1	Castellà Català Anglès Xinès	Castellà	Català Castellà	Català	Català	Castellà	Castellà
M2	Castellà Català Anglès Xinès Japonès	Castellà	Castellà	Català Castellà	Català Castellà	Castellà	Castellà
M3	Castellà Català Anglès Xinès	Català	Castellà	Català Castellà	Català Castellà	Castellà	Català
M4	Castellà Català Anglès Xinès Alemany	Castellà Català Anglès	Català	Castellà Català Anglès	Català Castellà	Alemany	Anglès
M5	Castellà Català Anglès Xinès	Anglès Català	Anglès Català	Català Castellà	Català Castellà	Català	Català
M6	Castellà Català Anglès Xinès	Castellà Català	Castellà	Català Castellà	Català	Castellà	Castellà
M7	Castellà Català Anglès Xinès	Català	Català	Català Castellà	Castellà Català	Castellà	Castellà
M8	Castellà Català Anglès	Castellà	Castellà	Castellà	Català	English	English
M9	Castellà Català Anglès Xinès	Castellà	Castellà	Castellà Anglès Català	Català	Català i castellà	Català
M10	Castellà Català Anglès Xinès	Català Castellà	Català	Català Castellà	Català	Català Castellà	Català Castellà
M11	Xinès Francès Català	Català	Català	Català Castellà	Català	Castellà	Català

	Castellà						
M12	Castellà Català Anglès Francès Xinès	Català Anglès	Castellà Català Anglès	Català	Català	Castellà	Anglès

STATE SCHOOL PARTICIPANTS							
Student	**Llengües que coneix**	**Llengua més utilitzada**	**A casa parla**	**Amb els amics parla**	**A l'escola utiitza**	**Per llegir prefereix**	**Pensa en**
J1	Català Castellà Anglès	Castellà	Castellà	Castellà	Català	Català	Castellà
J2	Castellà	Castellà	Castellà	Castellà	Català	Català	Castellà
J3	Castellà Rus Català Anglès	Castellà Rus	Castellà	Castellà	Castellà	Català	Castellà
J4	Castellà Català Anglès	Castellà	Castellà	Castellà	Castellà	Català	Castellà
J5	Castellà Català	Castellà	Castellà	Castellà	Castellà	Castellà	Castellà
J6	Castellà Català Anglès Calé	Castellà	Castellà Calé	Castellà	Català	Català	Castellà
J7	Castellà Anglès Català	Català	Català	Castellà	Castellà Català	Català	Castellà
J8	Castellà Català Anglès	Castellà	Castellà	Castellà	Català	Català	Castellà
J9	Castellà Català	Castellà	Castellà	Castellà	Català	Català	Castellà
J10	Castellà Català Urdú	Urdú	Urdú	Urdú Castellà	Català	Català	Urdú
J11	Castellà Català Anglès	Castellà	Castellà	Castellà	Català	Català	Castellà
J12	Castellà Català Anglès	Català	Castellà	Castellà	Català	Català	Castellà

PRIVATE SCHOOL

Legend: Català, Castellà, Anglès, Altres

STATE SCHOOL

Legend: Català, Castellà, Anglès, Altres
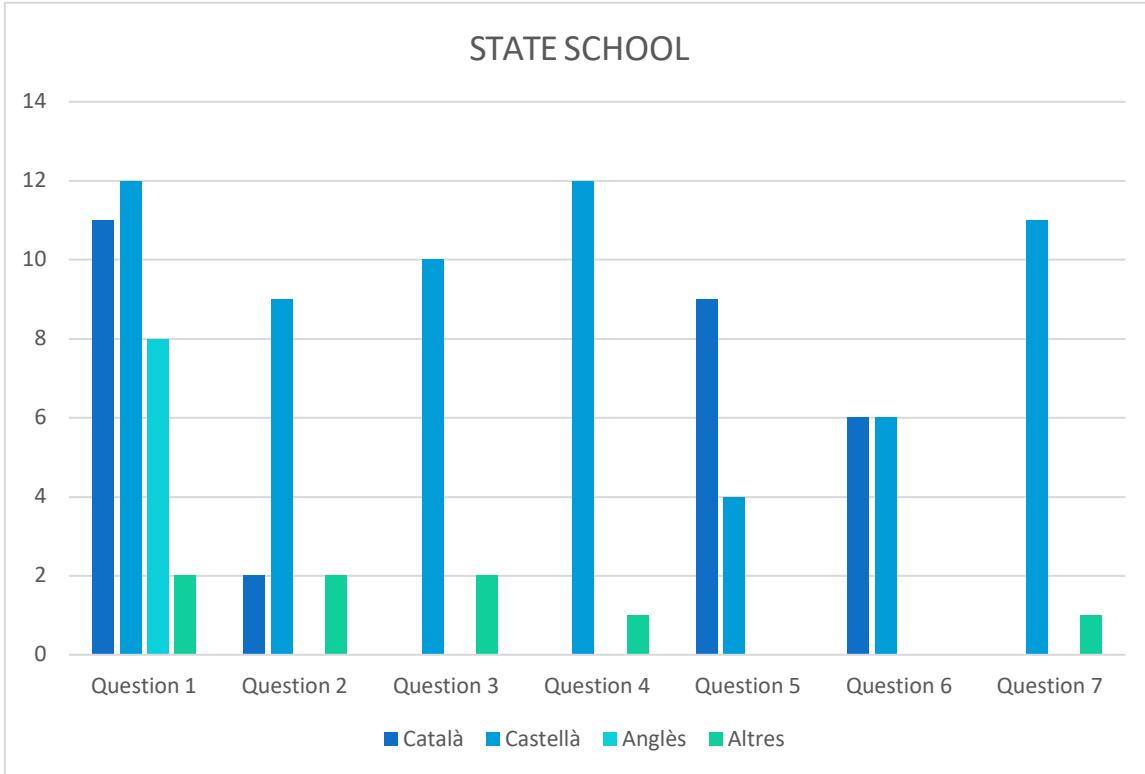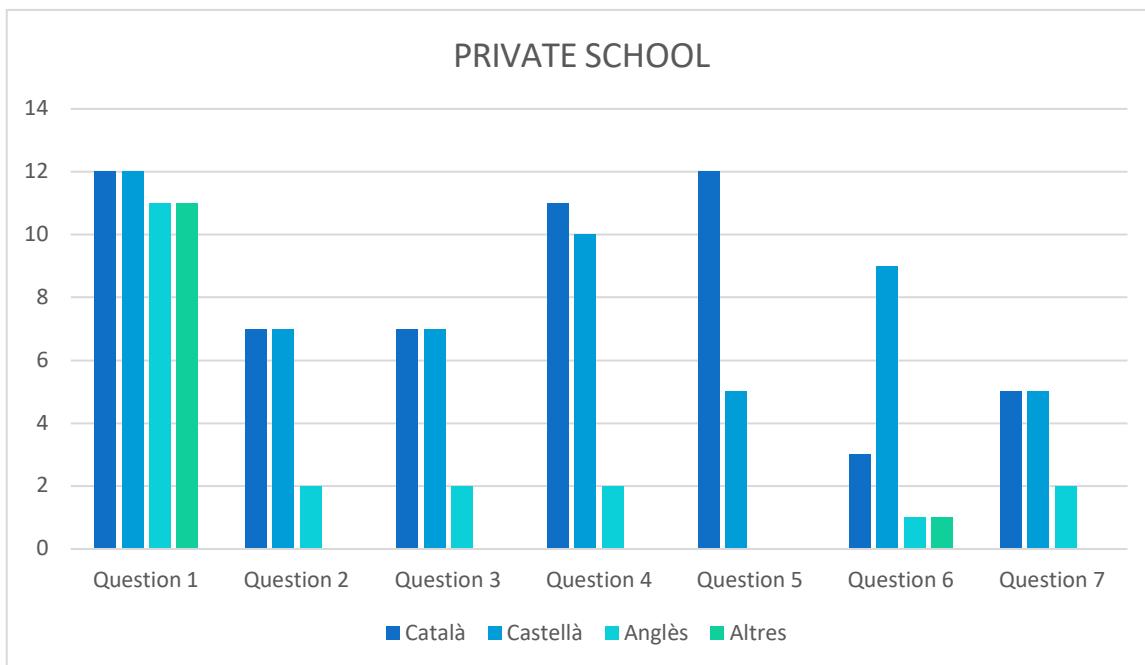
CLASSIFICATION SCALES

Primary 3:

CORRECT ANSWERS	DD	D	?	N
Letter's name	0-15	16	17-18	19-20
Pseudoword reading	0-28	29-30	31-34	34-40

SPEED	ML	L	N	R	MR
Letter's name	38 o +	29-37	13-25	5-12	0-4
Pseudoword reading	117 o +	95-116	52-94	30-51	0-29

READING ABILITY	B	M	A
Letter's name	70-84	85-143	144 o +
Pseudoword reading	38-44	45-75	76 o +

CORRECT ANSWERS	DD	D	N
Grammar structures	0-9	10-12	13-16
Text comprehension	0-5	6-9	10-16

DD = great deficiency
D = deficiency
? = between deficient and normal
N = normal

ML = very slowly
L = slowly
N = normal
R = fast
MR = very fast

B = low
M = medium
A = high

ANNEX 3

AUDIOMETRIES

Informe de Estimulación

J1

-

Fecha : 10 Abril 2018

HL

Derecha ✕ Izquierda

Promedio OD : 17   Promedio OI : 16
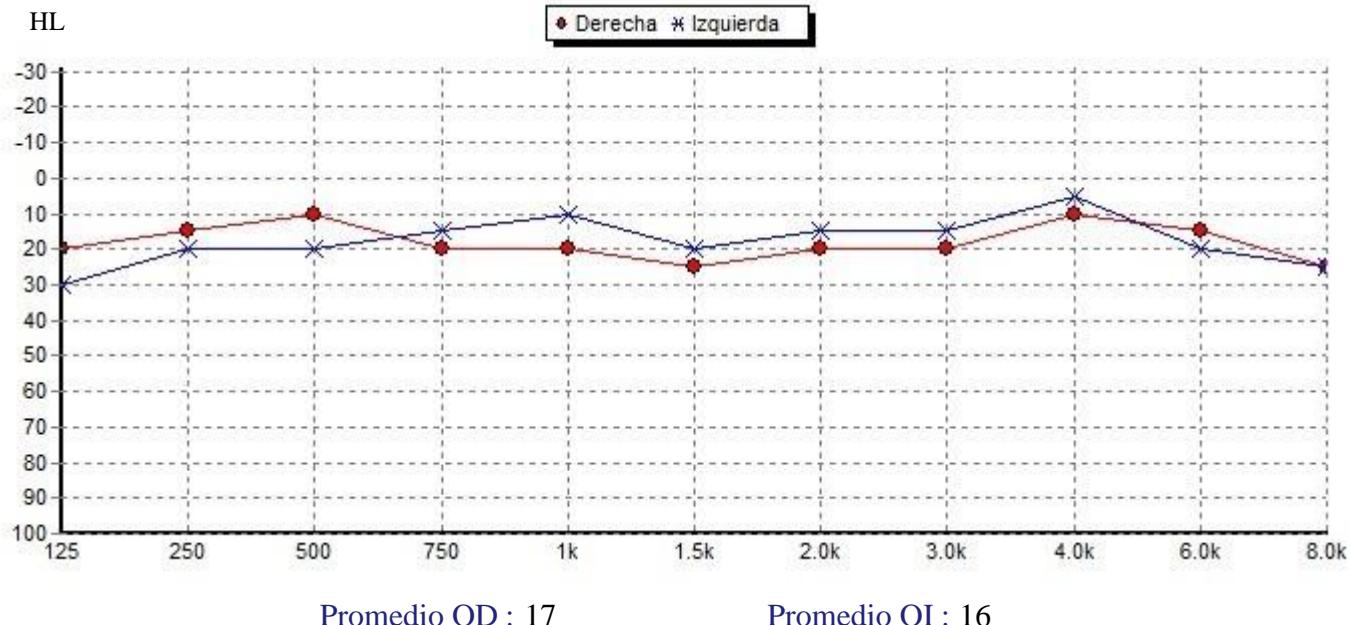
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	17,73	Bajo rendimiento auditivo	18,18	Bajo rendimiento auditivo
Linearidad	6,84	Alteración moderada	5,13	Alteración leve

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Coordinación motora	5,77	Alteración leve	5	Correcta
Fonología F1, F2/lógica/ritmo/memoria			2,24	Correcta
Prosodia/entonación/ memoria global	3,54	Correcta		
Fonología F3	-5	Correcta	6	Alteración leve
Localización/figura-fondo	8,33	Localización	-6	Figura-fondo
Cierre fonológico/ inhibición de estímulos	-1,67	Correcta	4,33	Correcta

EVALUACIÓN INTERAURAL

Ambliaudía	0,45	Correcta
Fusión/integración binaural	5,91	Alteración leve
Orientación Espacial	-8,33	Alteración severa
Lenguaje	6	Predominio de las funciones del hemisferio derecho

Informe de Estimulación

J2

-

Fecha : 10 Abril 2018

HL

Promedio OD : 18   Promedio OI : 28

EVALUACIÓN GENERAL
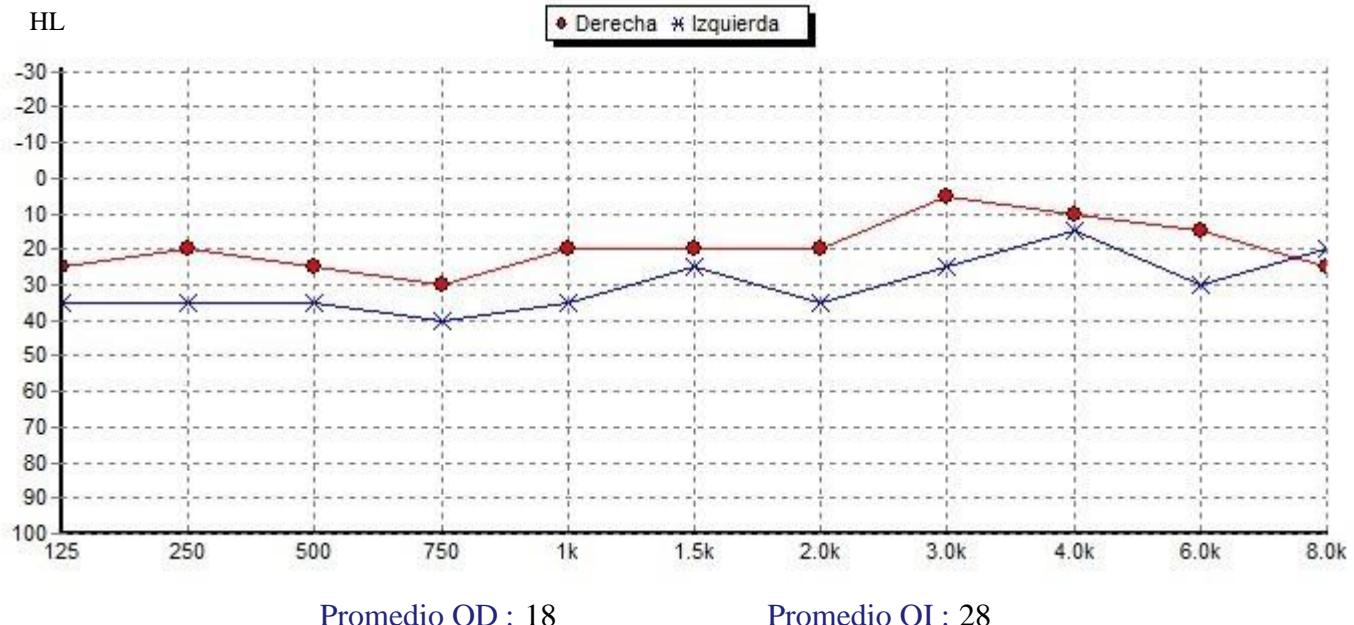
	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	30	Bajo rendimiento auditivo	19,55	Bajo rendimiento auditivo
Linearidad	7,75	Alteración moderada	7,23	Alteración moderada

18/05/2018

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Coordinación motora	0	Correcta	2,89	Correcta
Fonología F1, F2/lógica/ritmo/memoria			8,94	Alteración severa
Prosodia/entonación/ memoria global	6,71	Alteración moderada		
Fonología F3	2	Correcta	4	Correcta
Localización/figura-fondo	3	Correcta	4,33	Correcta
Cierre fonológico/ inhibición de estímulos	10,33	Inhibición de estímulos	2,33	Correcta

EVALUACIÓN INTERAURAL

Ambliaudía	-10,45	Alteración profunda
Fusión/integración binaural	11,36	Alteración profunda
Orientación Espacial	-11,67	Alteración profunda
Lenguaje	-13	Predominio de las funciones del hemisferio izquierdo

Informe de Estimulación

J3

-

Fecha : 09 Abril 2018

HL

Promedio OD : 22   Promedio OI : 14

EVALUACIÓN GENERAL
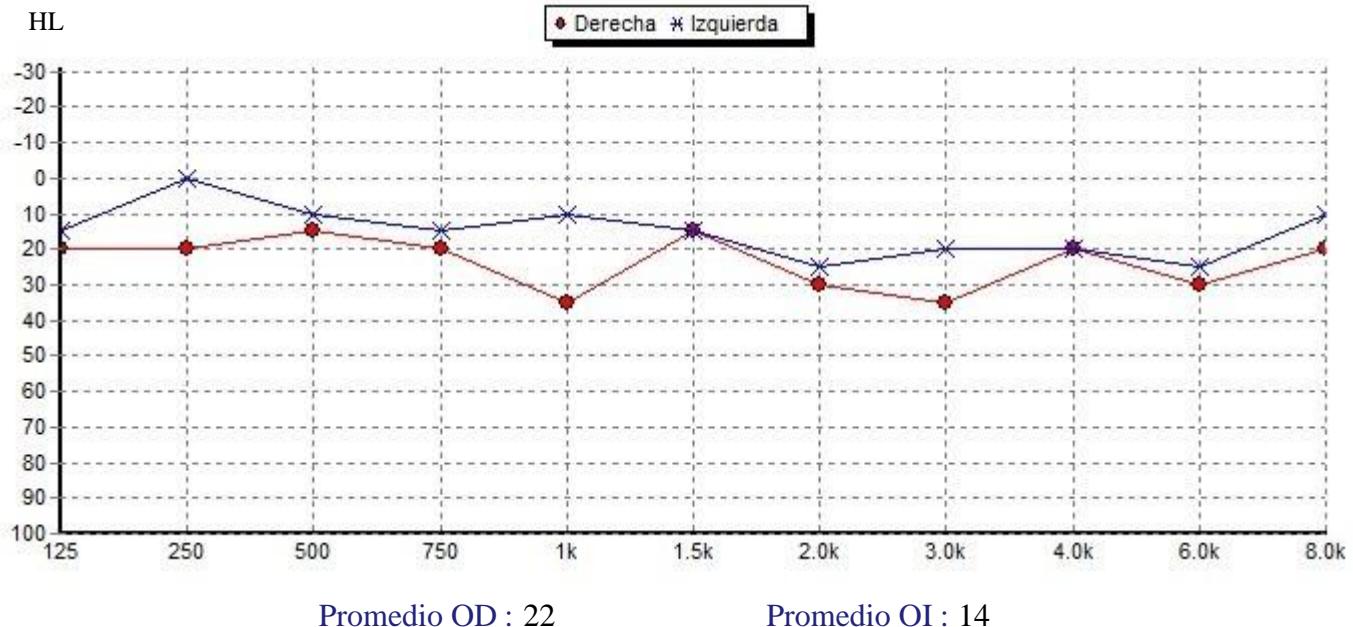
	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	15	Correcta	23,64	Bajo rendimiento auditivo
Linearidad	7,42	Alteración moderada	7,45	Alteración moderada

18/05/2018

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Coordinación motora	7,64	Alteración moderada	2,89	Correcta
Fonología F1, F2/lógica/ritmo/memoria			9,08	Alteración severa
Prosodia/entonación/ memoria global	5,7	Alteración leve		
Fonología F3	-8	Alteración moderada	-3	Correcta
Localización/figura-fondo	-8,67	Figura-fondo	-8,67	Figura-fondo
Cierre fonológico/ inhibición de estímulos	-1,33	Correcta	3,67	Correcta

EVALUACIÓN INTERAURAL

Ambliaudía	8,64	Alteración severa
Fusión/integración binaural	8,64	Alteración severa
Orientación Espacial	10	Alteración severa
Lenguaje	10	Predominio de las funciones del hemisferio derecho

Informe de Estimulación

J4

-

Fecha : 10 Abril 2018

HL

Promedio OD : 25   Promedio OI : 28
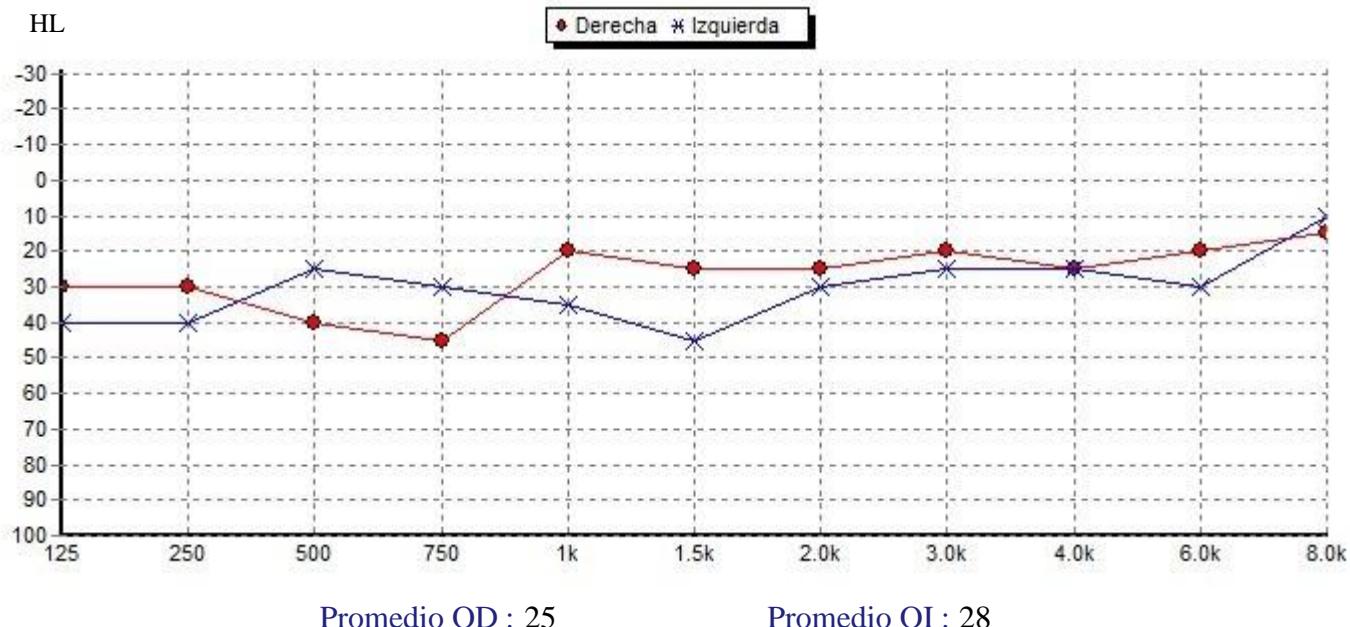
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	30,45	Sugerir revisión audiológica	26,82	Bajo rendimiento auditivo
Linearidad	9,61	Alteración severa	9,02	Alteración severa

18/05/2018

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Coordinación motora	8,66	Alteración severa	5,77	Alteración leve
Fonología F1, F2/lógica/ritmo/memoria			10,37	Alteración profunda
Prosodia/entonación/ memoria global	7,58	Alteración moderada		
Fonología F3	3	Correcta	7	Alteración moderada
Localización/figura-fondo	2	Correcta	6,33	Localización
Cierre fonológico/ inhibición de estímulos	11,33	Inhibición de estímulos	7	Inhibición de estímulos

EVALUACIÓN INTERAURAL

Ambliaudía	-3,63	Correcta
Fusión/integración binaural	10	Alteración severa
Orientación Espacial	-1,67	Correcta
Lenguaje	-6	Predominio de las funciones del hemisferio izquierdo

Informe de Estimulación

J5

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Fecha : 11 Abril 2018

HL

Promedio OD : 16   Promedio OI : 15
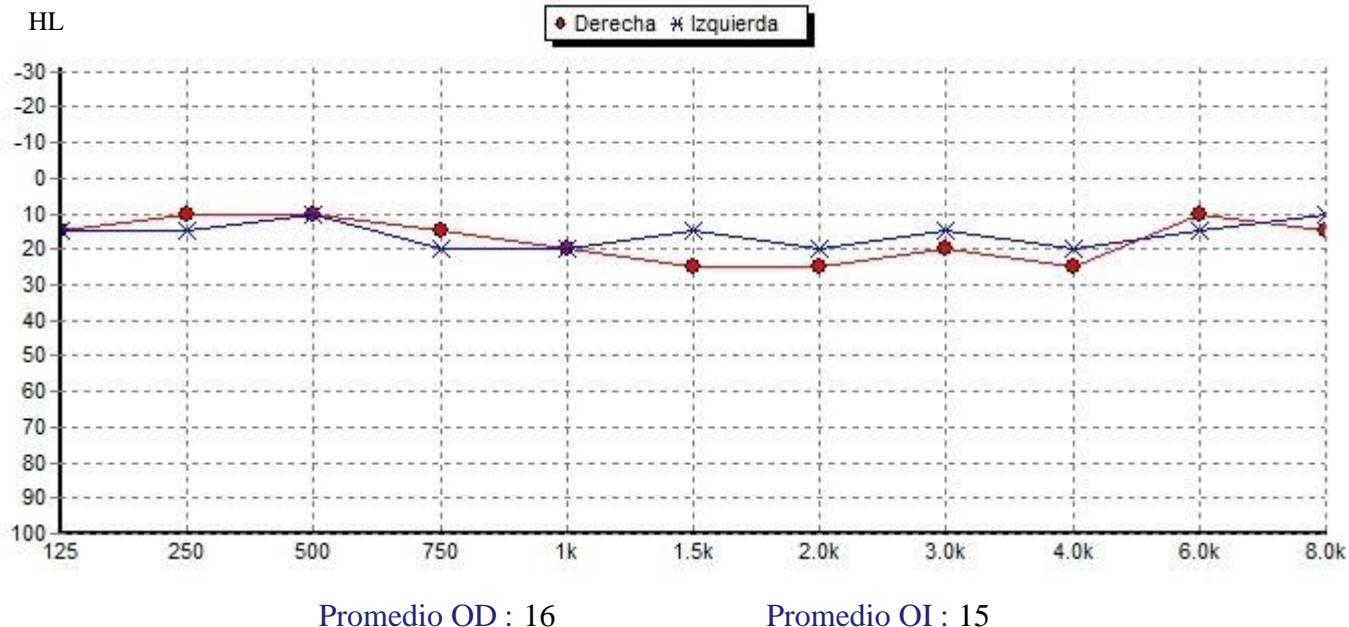
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	15,91	Bajo rendimiento auditivo	17,27	Bajo rendimiento auditivo
Linearidad	3,75	Correcta	6,07	Alteración moderada

18/05/2018

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO	OÍDO DERECHO
Coordinación motora	2,89 Correcta	2,89 Correcta
Fonología F1, F2/lógica/ritmo/memoria		4,18 Correcta
Prosodia/entonación/ memoria global	2,74 Correcta	
Fonología F3	3 Correcta	11 Alteración profunda
Localización/figura-fondo	-4,67 Correcta	-9,33 Figura-fondo
Cierre fonológico/ inhibición de estímulos	3 Correcta	4,33 Correcta

EVALUACIÓN INTERAURAL

	OÍDO IZQUIERDO
Ambliaudía	1,36 Correcta
Fusión/integración binaural	4,09 Correcta
Orientación Espacial	-1,66 Correcta
Lenguaje	3 Correcta

Informe de Estimulación

J6

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Fecha : 11 Abril 2018
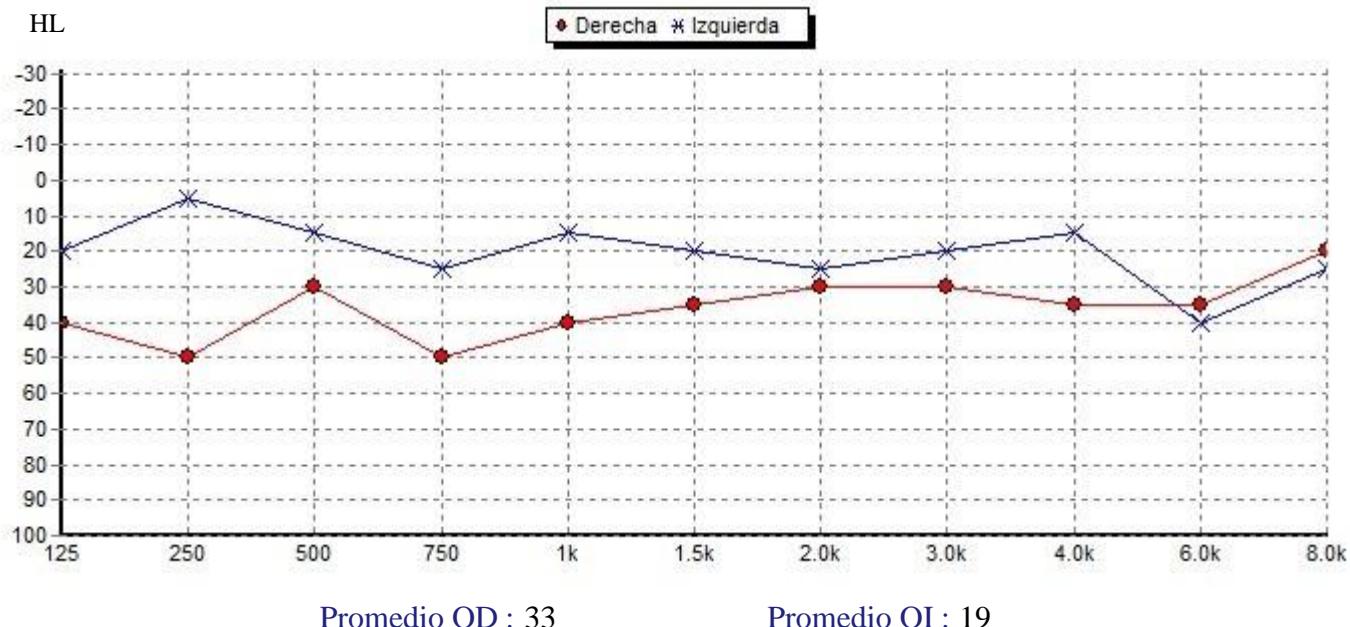
HL

Promedio OD : 33   Promedio OI : 19

EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	20,45	Bajo rendimiento auditivo	35,91	Sugerir revisión audiológica
Linearidad	8,79	Alteración severa	8,89	Alteración severa

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Coordinación motora	7,64	Alteración moderada	10	Alteración severa
Fonología F1, F2/lógica/ritmo/memoria			8,37	Alteración severa
Prosodia/entonación/ memoria global	4,18	Correcta		
Fonología F3	-19	Alteración profunda	2	Correcta
Localización/figura-fondo	-7,67	Figura-fondo	3	Correcta
Cierre fonológico/ inhibición de estímulos	-5,67	Cierre fonológico	7	Inhibición de estímulos

EVALUACIÓN INTERAURAL

Ambliaudía	15,46	Alteración profunda
Fusión/integración binaural	17,27	Alteración profunda
Orientación Espacial	26,67	Alteración profunda
Lenguaje	16	Predominio de las funciones del hemisferio derecho

Informe de Estimulación

J7

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HL

Promedio OD : 21   Promedio OI : 25

EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	27,27	Bajo rendimiento auditivo	23,18	Bajo rendimiento auditivo
Linearidad	6,84	Alteración moderada	6,03	Alteración moderada

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO	OÍDO DERECHO
Coordinación motora	5 Correcta	2,89 Correcta
Fonología F1, F2/lógica/ritmo/memoria		7,91 Alteración moderada
Prosodia/entonación/ memoria global	4,47 Correcta	
Fonología F3	-12 Alteración profunda	5 Correcta
Localización/figura-fondo	-3 Correcta	-1,67 Correcta
Cierre fonológico/ inhibición de estímulos	-0,33 Correcta	5 Correcta

EVALUACIÓN INTERAURAL

Ambliaudía	-4,09 Correcta
Fusión/integración binaural	7,73 Alteración moderada
Orientación Espacial	-1,67 Correcta
Lenguaje	-3 Correcta

Informe de Estimulación

J8

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Fecha : 11 Abril 2018
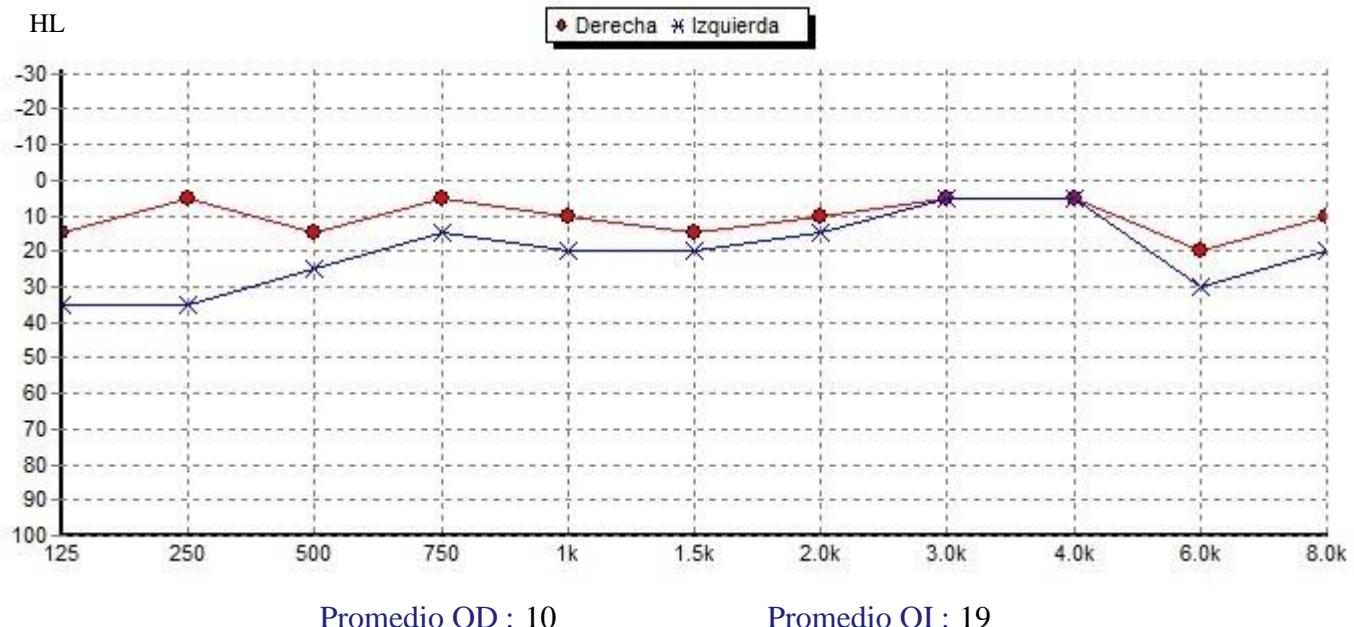
HL

Derecha ✦ Izquierda ✳

Promedio OD : 10   Promedio OI : 19

EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	20,45	Bajo rendimiento auditivo	10,45	Correcta
Linearidad	10,36	Alteración profunda	5,22	Alteración leve

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO	OÍDO DERECHO
Coordinación motora	5,77 Alteración leve	5,77 Alteración leve
Fonología F1, F2/lógica/ritmo/memoria		4,18 Correcta
Prosodia/entonación/ memoria global	6,12 Alteración moderada	
Fonología F3	-15 Alteración profunda	-11 Alteración profunda
Localización/figura-fondo	16,67 Localización	2,67 Correcta
Cierre fonológico/ inhibición de estímulos	-3,33 Correcta	-2,67 Correcta

EVALUACIÓN INTERAURAL

Ambliaudía	-10	Alteración severa
Fusión/integración binaural	10	Alteración severa
Orientación Espacial	-20	Alteración profunda
Lenguaje	-6	Predominio de las funciones del hemisferio izquierdo

Fecha : 11 Abril 2018

HL

Promedio OD : 11   Promedio OI : 17
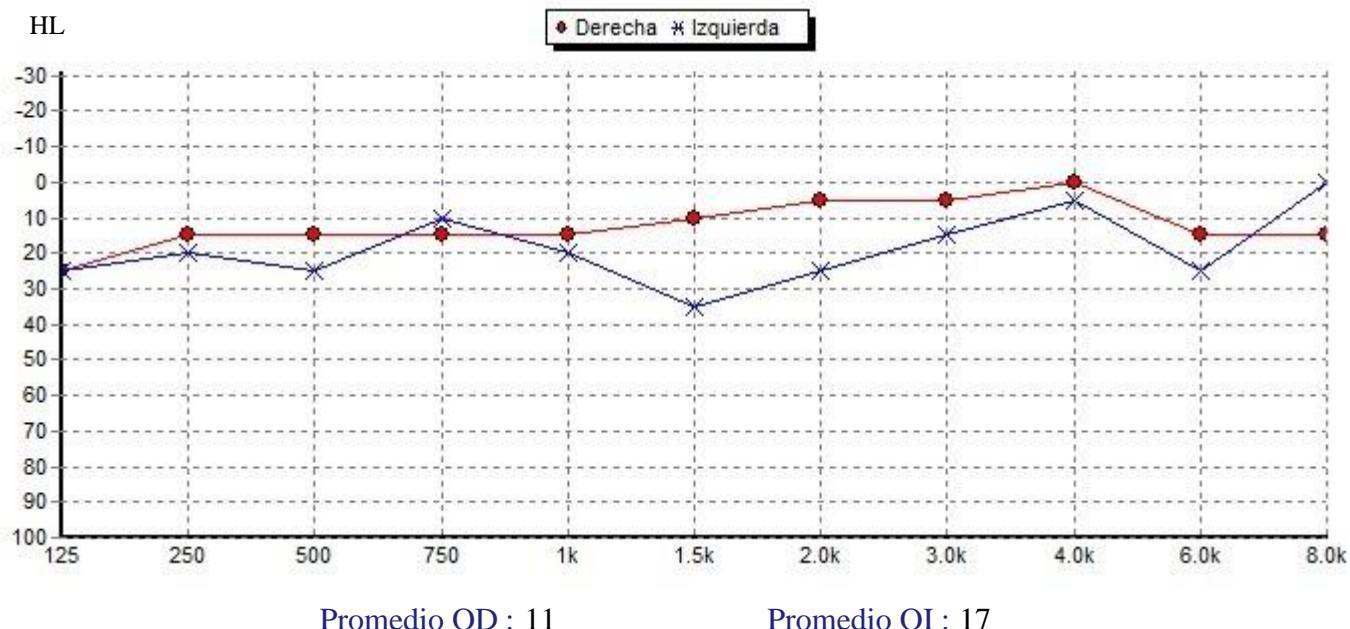
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	18,64	Bajo rendimiento auditivo	12,27	Correcta
Linearidad	10,27	Alteración profunda	6,84	Alteración moderada

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Coordinación motora	2,89	Correcta	5,77	Alteración leve
Fonología F1, F2/lógica/ritmo/memoria			5	Correcta
Prosodia/entonación/ memoria global	9,62	Alteración severa		
Fonología F3	-4	Correcta	-5	Correcta
Localización/figura-fondo	2,33	Correcta	8,33	Localización
Cierre fonológico/ inhibición de estímulos	11	Inhibición de estímulos	0	Correcta

EVALUACIÓN INTERAURAL

| Ambliaudía	-6,37	Alteración moderada
Fusión/integración binaural	10	Alteración severa
Orientación Espacial	-5	Correcta
Lenguaje	-11	Predominio de las funciones del hemisferio izquierdo

Informe de Estimulación

J10

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Fecha : 11 Abril 2018

HL

Legend: ◆ Derecha ✳ Izquierda

Promedio OD : 12   Promedio OI : 12
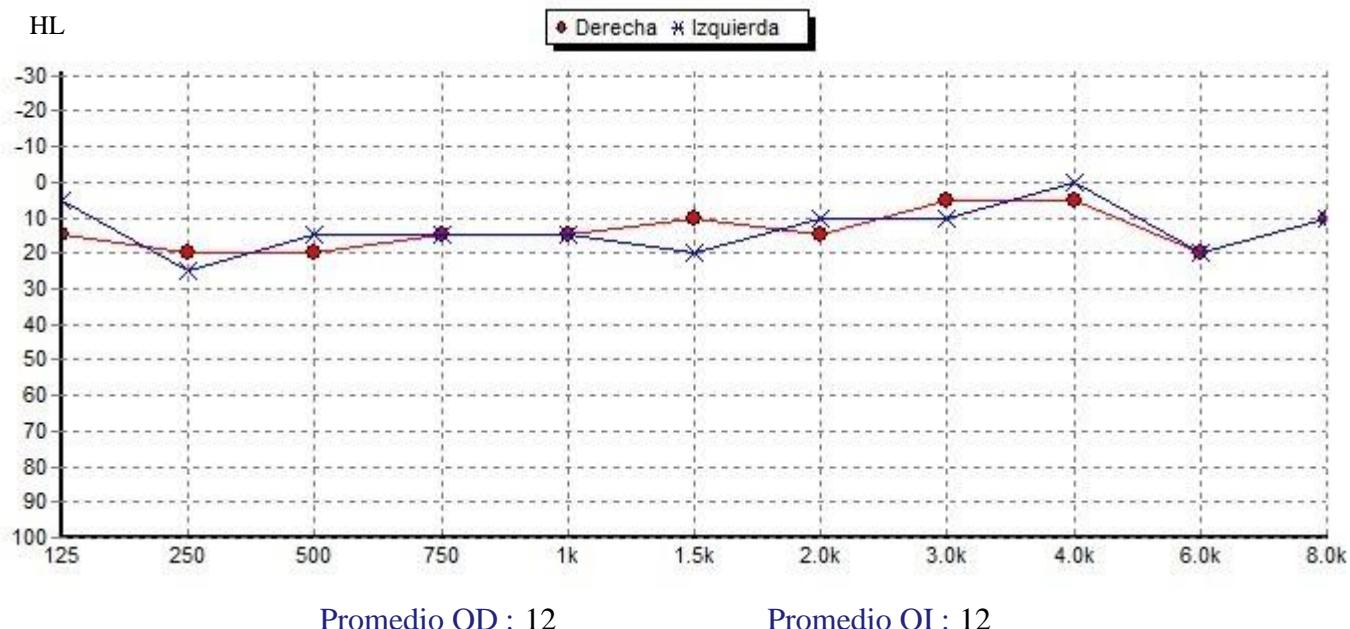
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	13,18	Correcta	13,64	Correcta
Linearidad	7,17	Alteración moderada	5,52	Alteración leve

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO	OÍDO DERECHO
Coordinación motora	10 Alteración severa	2,89 Correcta
Fonología F1, F2/lógica/ritmo/memoria		4,47 Correcta
Prosodia/entonación/ memoria global	4,18 Correcta	
Fonología F3	-6 Alteración leve	-8 Alteración moderada
Localización/figura-fondo	1 Correcta	6,33 Localización
Cierre fonológico/ inhibición de estímulos	4 Correcta	0,33 Correcta

EVALUACIÓN INTERAURAL

Ambliaudía	0,46 Correcta
Fusión/integración binaural	4,09 Correcta
Orientación Espacial	3,33 Correcta
Lenguaje	-2 Correcta

Informe de Estimulación

J11

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Fecha : 11 Abril 2018

HL

● Derecha ✳ Izquierda

Promedio OD : 13   Promedio OI : 40
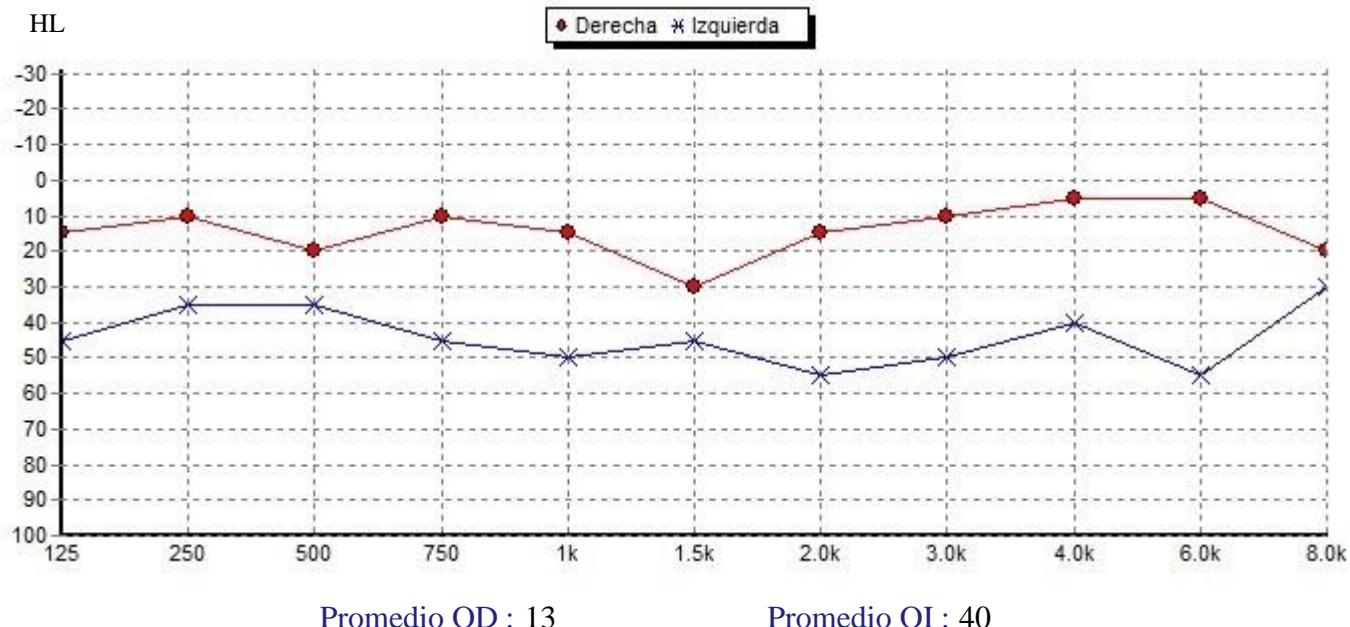
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	44,09	Sugerir revisión audiológica	14,09	Correcta
Linearidad	8,31	Alteración severa	7,35	Alteración moderada

18/05/2018

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Coordinación motora	5,77	Alteración leve	5	Correcta
Fonología F1, F2/lógica/ritmo/memoria			8,22	Alteración severa
Prosodia/entonación/ memoria global	4,18	Correcta		
Fonología F3	-6	Alteración leve	11	Alteración profunda
Localización/figura-fondo	-10,67	Figura-fondo	-1	Correcta
Cierre fonológico/ inhibición de estímulos	7,33	Inhibición de estímulos	6	Inhibición de estímulos

EVALUACIÓN INTERAURAL

Ambliaudía	-30	Alteración profunda
Fusión/integración binaural	30	Alteración profunda
Orientación Espacial	-23,33	Alteración profunda
Lenguaje	-33	Predominio de las funciones del hemisferio izquierdo

Informe de Estimulación

J12

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HL

Promedio OD : 10   Promedio OI : 18
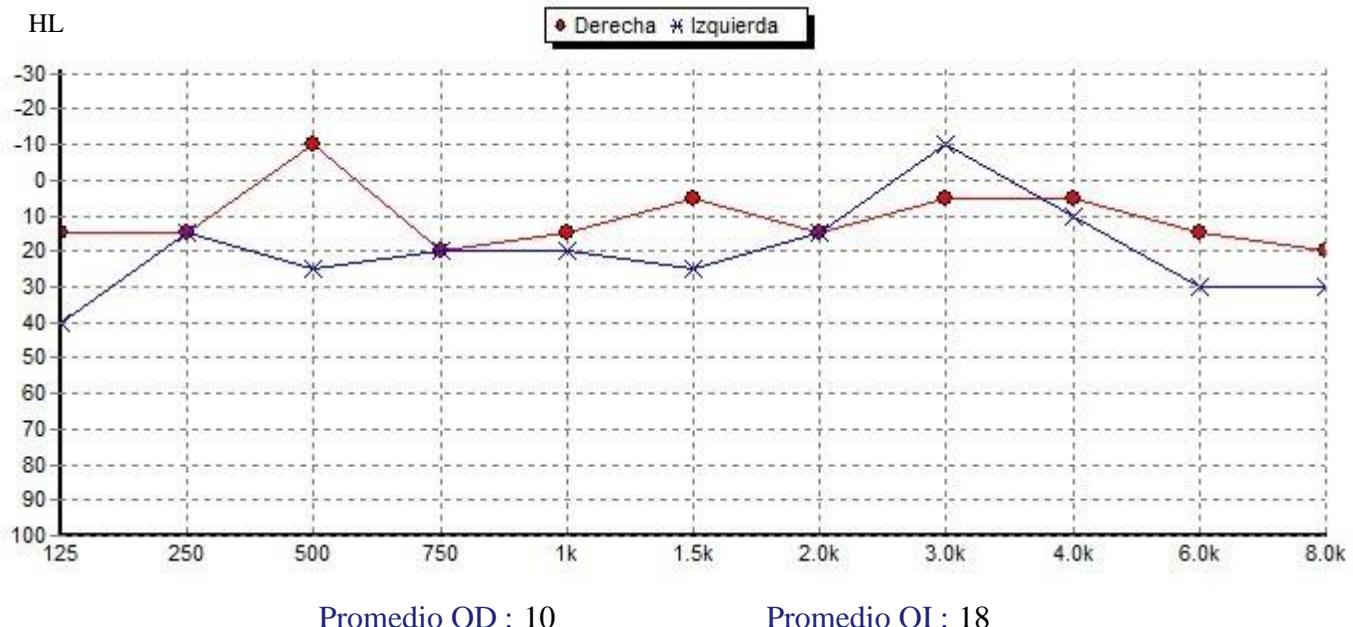
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	20	Bajo rendimiento auditivo	10,91	Correcta
Linearidad	13,04	Alteración profunda	8,89	Alteración severa

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Coordinación motora	12,58	Alteración profunda	14,43	Alteración profunda
Fonología F1, F2/lógica/ritmo/memoria			6,71	Alteración moderada
Prosodia/entonación/ memoria global	13,87	Alteración profunda		
Fonología F3	-16	Alteración profunda	-3	Correcta
Localización/figura-fondo	12,67	Localización	-5,33	Figura-fondo
Cierre fonológico/ inhibición de estímulos	-9,33	Cierre fonológico	-1,33	Correcta

EVALUACIÓN INTERAURAL

Ambliaudía	-9,09	Alteración severa
Fusión/integración binaural	11,82	Alteración profunda
Orientación Espacial	-20	Alteración profunda
Lenguaje	-2	Correcta

Informe de Estimulación

M1

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Fecha : 16 Abril 2018

HL

Promedio OD : 9   Promedio OI : 9

EVALUACIÓN GENERAL
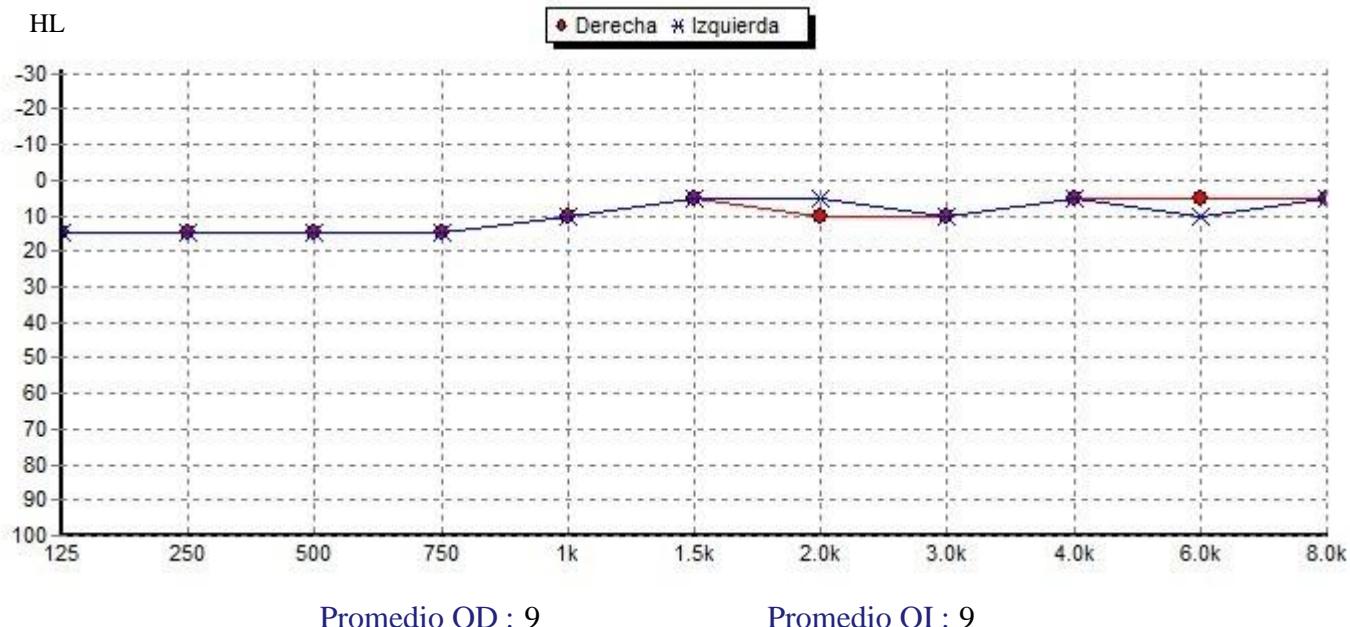
	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	10	Correcta	10	Correcta
Linearidad	4,47	Correcta	4,47	Correcta

18/05/2018

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Coordinación motora	0	Correcta	0	Correcta
Fonología F1, F2/lógica/ritmo/memoria			3,54	Correcta
Prosodia/entonación/ memoria global	4,18	Correcta		
Fonología F3	-1	Correcta	5	Correcta
Localización/figura-fondo	6	Localización	5	Correcta
Cierre fonológico/ inhibición de estímulos	2,33	Correcta	5	Correcta

EVALUACIÓN INTERAURAL

Ambliaudía	0	Correcta
Fusión/integración binaural	0,91	Correcta
Orientación Espacial	0	Correcta
Lenguaje	1	Correcta

Informe de Estimulación

M2

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HL

Promedio OD : 5　　　　**Promedio OI : 10**
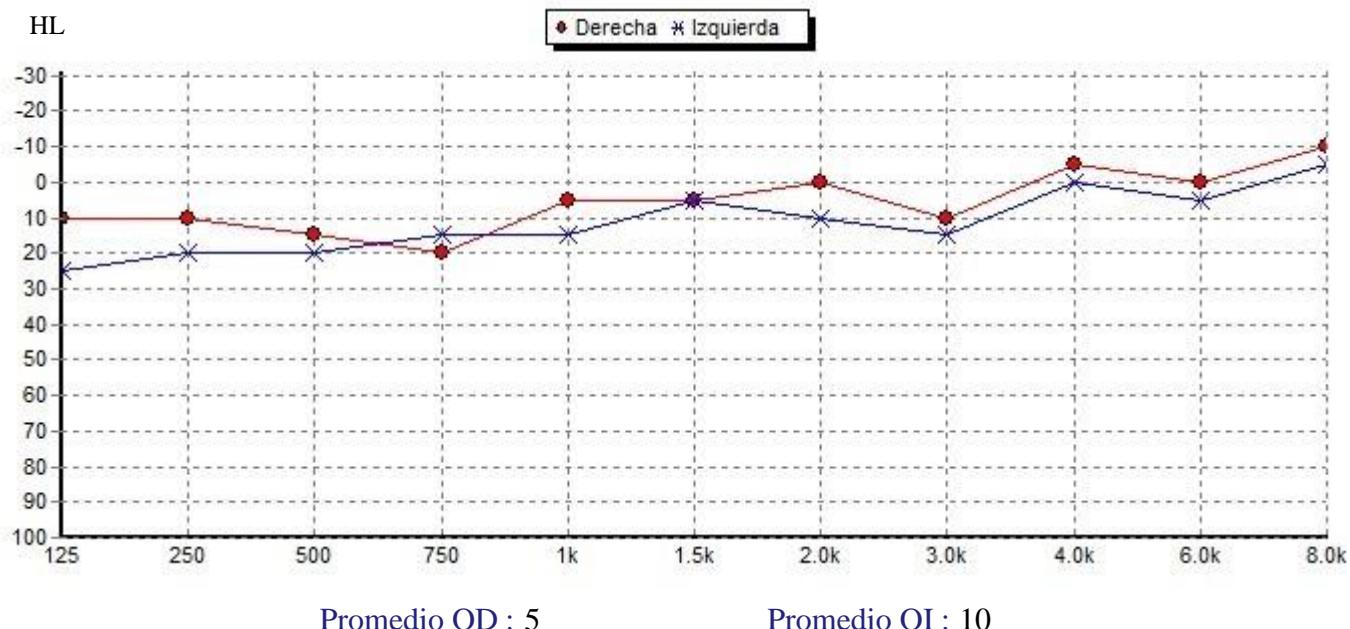
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	11,36	Correcta	5,45	Correcta
Linearidad	9,24	Alteración severa	8,79	Alteración severa

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO	OÍDO DERECHO
Coordinación motora	2,89 Correcta	2,89 Correcta
Fonología F1, F2/lógica/ritmo/memoria		7,58 Alteración moderada
Prosodia/entonación/ memoria global	4,47 Correcta	
Fonología F3	7 Alteración moderada	8 Alteración moderada
Localización/figura-fondo	9,67 Localización	3,67 Correcta
Cierre fonológico/ inhibición de estímulos	12 Inhibición de estímulos	13 Inhibición de estímulos

EVALUACIÓN INTERAURAL

|		
Ambliaudía	-5,91	Alteración leve
Fusión/integración binaural	6,82	Alteración moderada
Orientación Espacial	-10	Alteración severa
Lenguaje	-4	Correcta

Informe de Estimulación

M3

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HL

Promedio OD : 7   Promedio OI : 2

EVALUACIÓN GENERAL
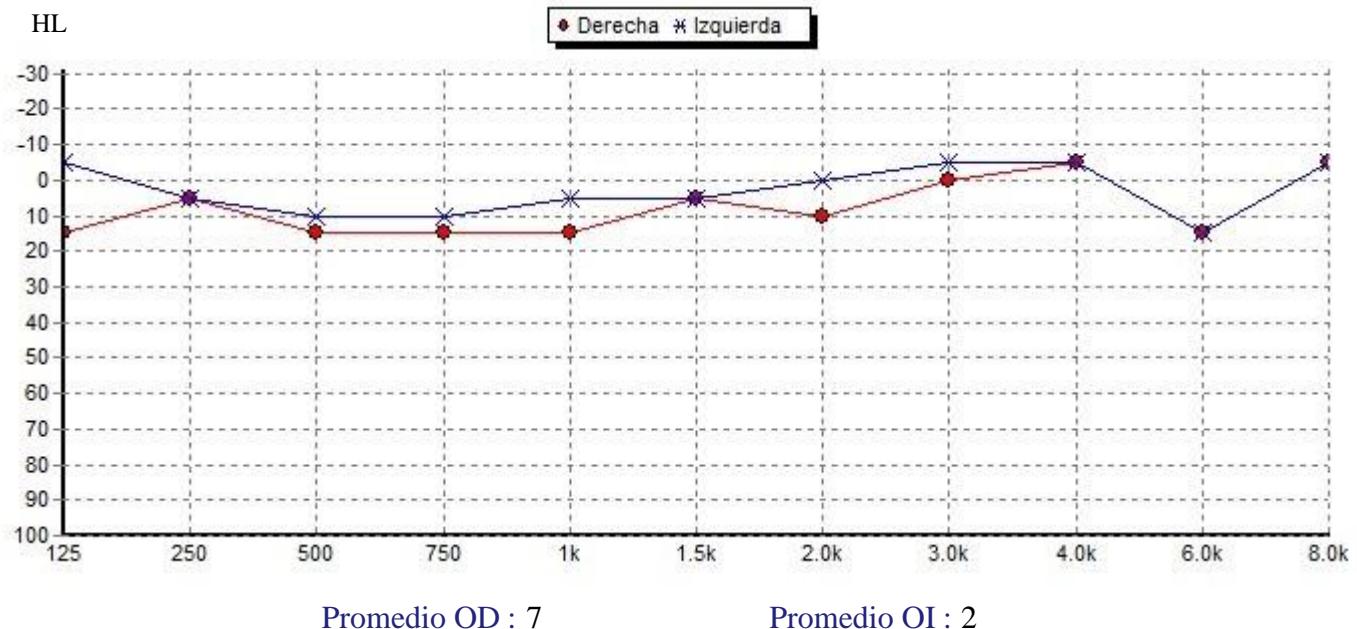
	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	2,73	Correcta	7,73	Correcta
Linearidad	7,2	Alteración moderada	8,17	Alteración severa

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO	OÍDO DERECHO
Coordinación motora	7,64 Alteración moderada	5,77 Alteración leve
Fonología F1, F2/lógica/ritmo/memoria		6,52 Alteración moderada
Prosodia/entonación/ memoria global	5,7 Alteración leve	
Fonología F3	-12 Alteración profunda	-6 Alteración leve
Localización/figura-fondo	0,33 Correcta	2,67 Correcta
Cierre fonológico/ inhibición de estímulos	1,33 Correcta	7,33 Inhibición de estímulos

EVALUACIÓN INTERAURAL

Ambliaudía	5	Correcta
Fusión/integración binaural	5	Correcta
Orientación Espacial	8,34	Alteración severa
Lenguaje	6	Predominio de las funciones del hemisferio derecho

Informe de Estimulación

M4

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HL

Promedio OD : 3   Promedio OI : 6
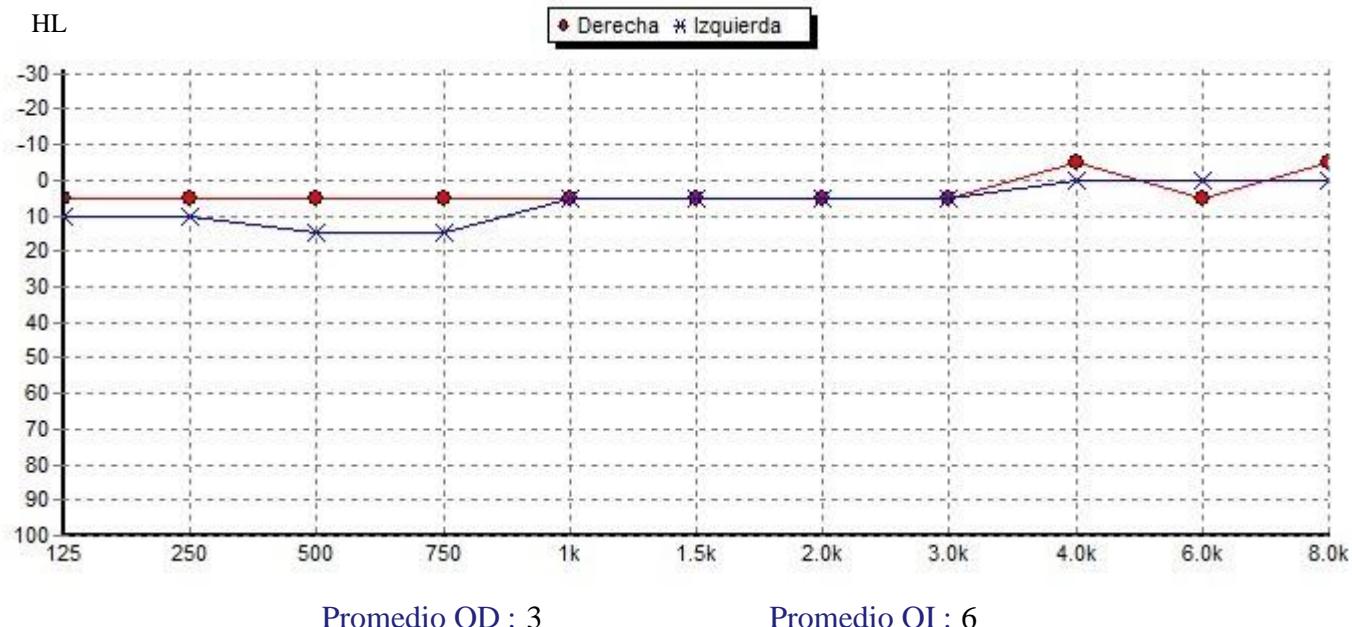
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	6,36	Correcta	3,18	Correcta
Linearidad	5,52	Alteración leve	4,05	Correcta

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Coordinación motora	2,89	Correcta	0	Correcta
Fonología F1, F2/lógica/ritmo/memoria			0	Correcta
Prosodia/entonación/ memoria global	4,47	Correcta		
Fonología F3	7	Alteración moderada	0	Correcta
Localización/figura-fondo	4,67	Correcta	0	Correcta
Cierre fonológico/ inhibición de estímulos	7	Inhibición de estímulos	6,67	Inhibición de estímulos

EVALUACIÓN INTERAURAL

Ambliaudía	-3,18	Correcta
Fusión/integración binaural	4,09	Correcta
Orientación Espacial	-6,67	Alteración moderada
Lenguaje	-2	Correcta

Informe de Estimulación

M5

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Fecha : 16 Abril 2018

HL

Promedio OD : 5   Promedio OI : 4
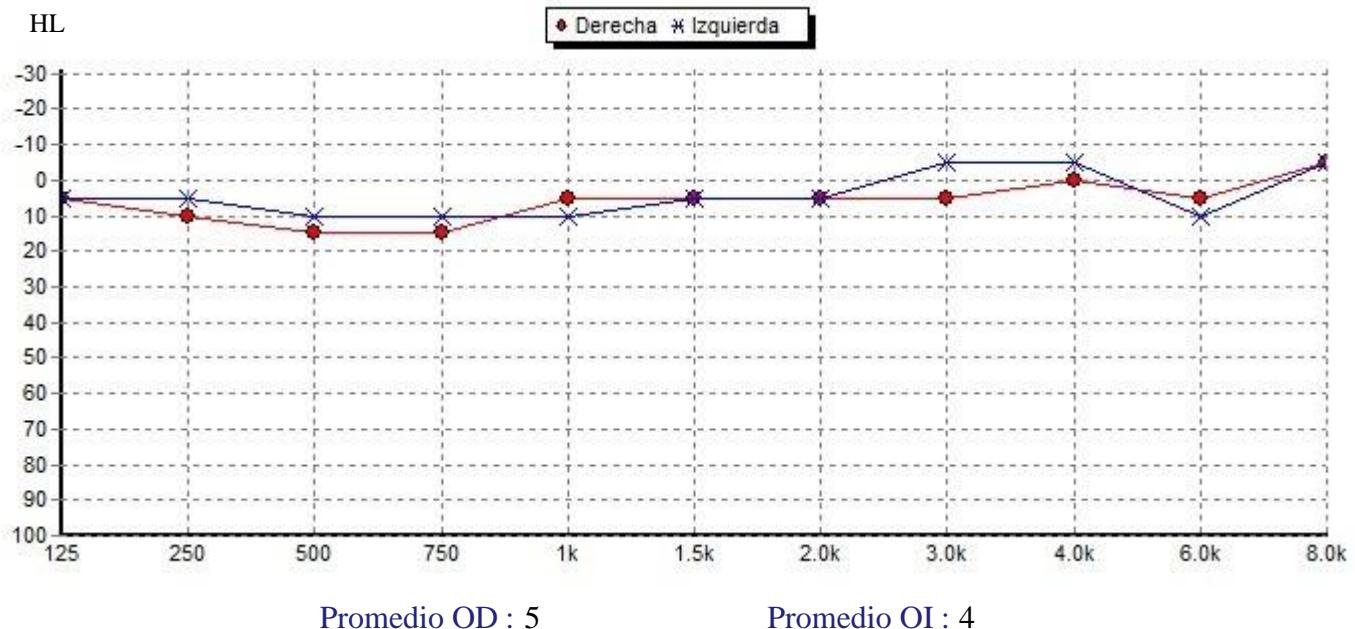
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	4,09	Correcta	5,91	Correcta
Linearidad	6,25	Alteración moderada	5,84	Alteración leve

18/05/2018

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO	OÍDO DERECHO
Coordinación motora	2,89 Correcta	5 Correcta
Fonología F1, F2/lógica/ritmo/memoria		4,47 Correcta
Prosodia/entonación/ memoria global	6,12 Alteración moderada	
Fonología F3	-5 Correcta	2 Correcta
Localización/figura-fondo	1,67 Correcta	3 Correcta
Cierre fonológico/ inhibición de estímulos	5 Correcta	7 Inhibición de estímulos

EVALUACIÓN INTERAURAL

Ambliaudía	1,82 Correcta
Fusión/integración binaural	3,64 Correcta
Orientación Espacial	3,33 Correcta
Lenguaje	2 Correcta

Informe de Estimulación

M6

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Fecha : 16 Abril 2018

HL

Derecha ✖ Izquierda

Promedio OD : 7   Promedio OI : 5
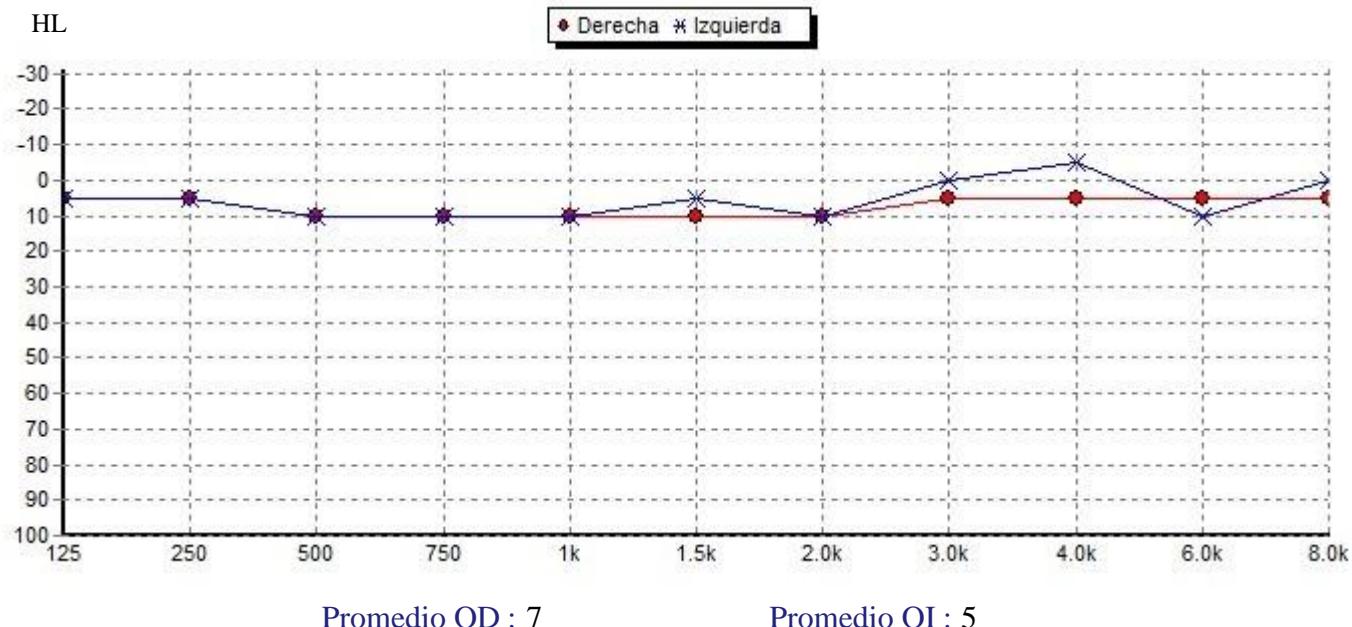
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	5,45	Correcta	7,27	Correcta
Linearidad	5,22	Alteración leve	2,61	Correcta

18/05/2018

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO	OÍDO DERECHO
Coordinación motora	2,89 Correcta	2,89 Correcta
Fonología F1, F2/lógica/ritmo/memoria		2,24 Correcta
Prosodia/entonación/ memoria global	4,47 Correcta	
Fonología F3	-3 Correcta	4 Correcta
Localización/figura-fondo	-0,33 Correcta	-2,33 Correcta
Cierre fonológico/ inhibición de estímulos	5,33 Inhibición de estímulos	4 Correcta

EVALUACIÓN INTERAURAL

Ambliaudía	1,82	Correcta
Fusión/integración binaural	2,73	Correcta
Orientación Espacial	0	Correcta
Lenguaje	2	Correcta

Informe de Estimulación

M7

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Fecha : 16 Abril 2018

HL

Promedio OD : 9   Promedio OI : 10
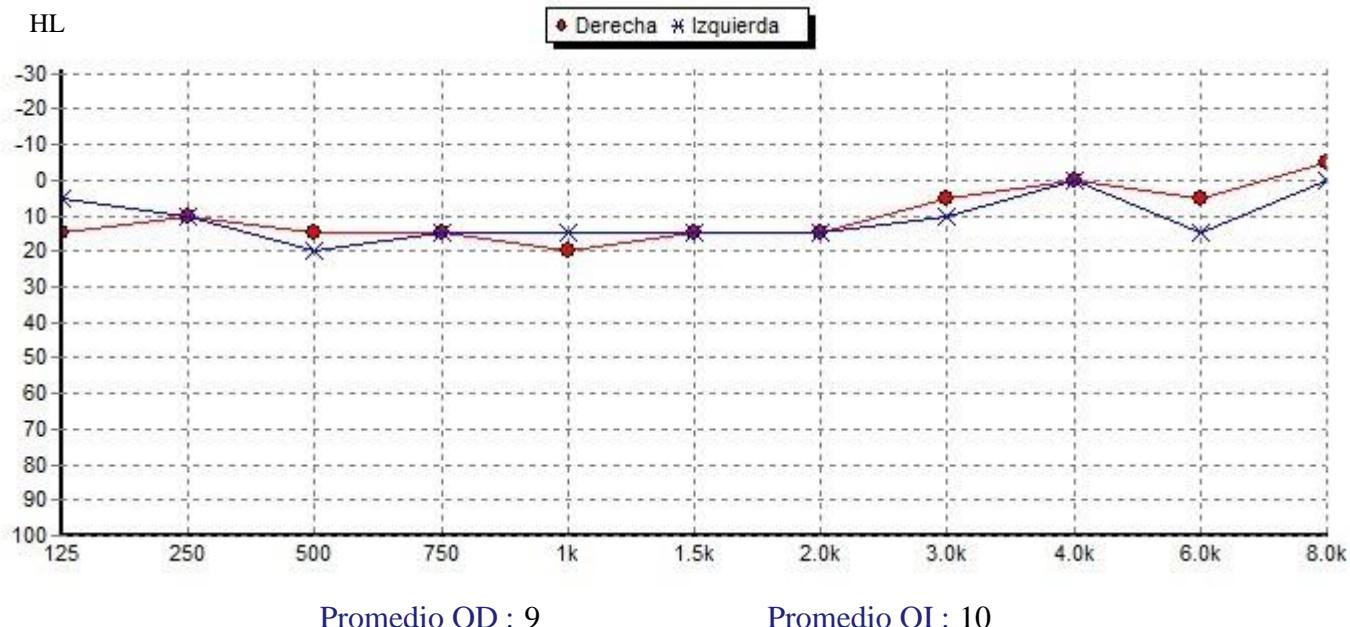
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	10,91	Correcta	10	Correcta
Linearidad	6,64	Alteración moderada	7,75	Alteración moderada

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Coordinación motora	7,64	Alteración moderada	2,89	Correcta
Fonología F1, F2/lógica/ritmo/memoria			5,48	Alteración leve
Prosodia/entonación/ memoria global	2,24	Correcta		
Fonología F3	-1	Correcta	9	Alteración severa
Localización/figura-fondo	-2,33	Correcta	-0,67	Correcta
Cierre fonológico/ inhibición de estímulos	9	Inhibición de estímulos	14	Inhibición de estímulos

EVALUACIÓN INTERAURAL

Ambliaudía	-0,91	Correcta
Fusión/integración binaural	3,64	Correcta
Orientación Espacial	1,66	Correcta
Lenguaje	0	Correcta

Informe de Estimulación

M8

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HL

Promedio OD : 8   Promedio OI : 3

EVALUACIÓN GENERAL
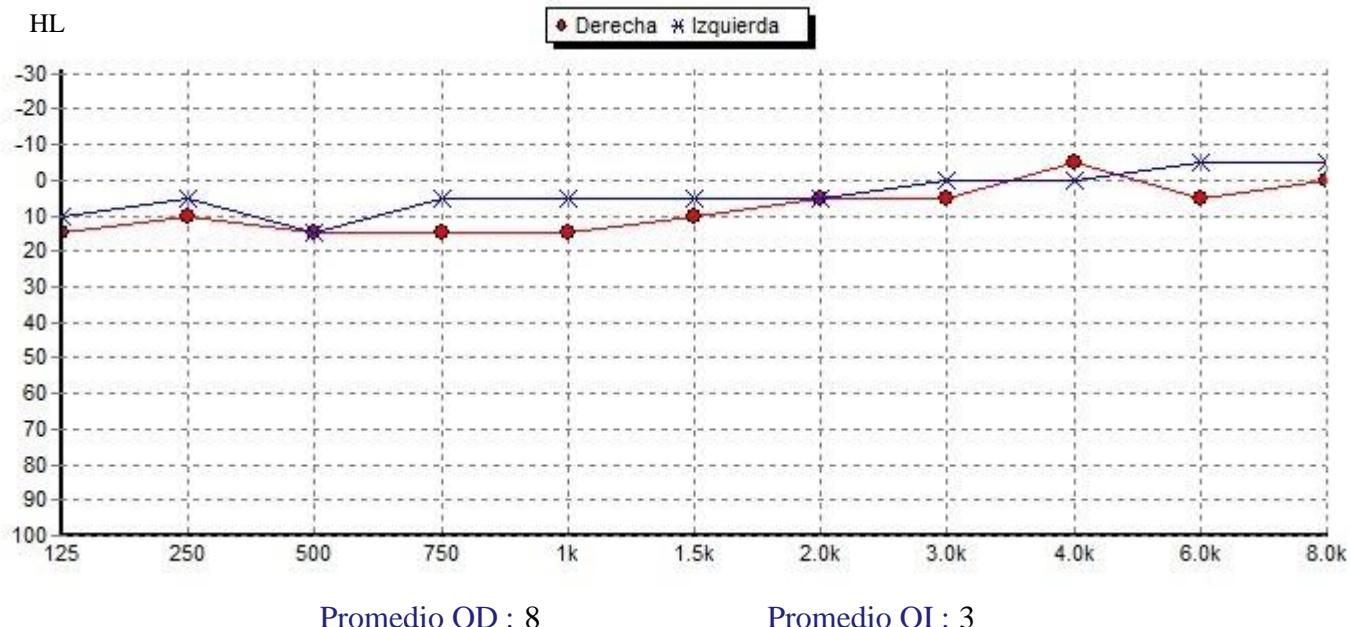
	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	3,64	Correcta	8,18	Correcta
Linearidad	5,95	Alteración leve	6,81	Alteración moderada

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO	OÍDO DERECHO
Coordinación motora	5 Correcta	2,89 Correcta
Fonología F1, F2/lógica/ritmo/memoria		5 Correcta
Prosodia/entonación/ memoria global	2,24 Correcta	
Fonología F3	9 Alteración severa	5 Correcta
Localización/figura-fondo	6 Localización	3,33 Correcta
Cierre fonológico/ inhibición de estímulos	7,33 Inhibición de estímulos	10 Inhibición de estímulos

EVALUACIÓN INTERAURAL

| Ambliaudía	4,54 Correcta
Fusión/integración binaural	5,45 Alteración leve
Orientación Espacial	3,33 Correcta
Lenguaje	6 Predominio de las funciones del hemisferio derecho

Informe de Estimulación

M9

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HL

Promedio OD : 0   Promedio OI : -1
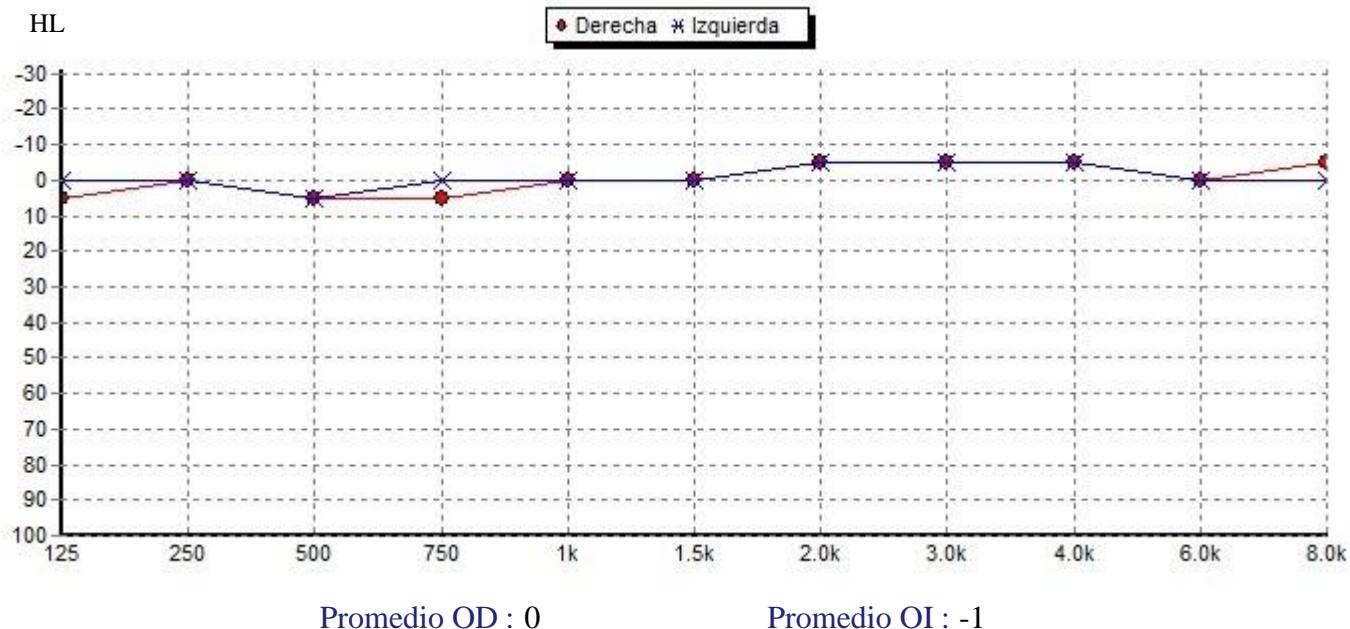
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	-0,91	Hipersensibilidad	-0,45	Hipersensibilidad
Linearidad	3,02	Correcta	4,16	Correcta

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO	OÍDO DERECHO
Coordinación motora	2,89 Correcta	2,89 Correcta
Fonología F1, F2/lógica/ritmo/memoria		4,18 Correcta
Prosodia/entonación/ memoria global	2,74 Correcta	
Fonología F3	-2 Correcta	-1 Correcta
Localización/figura-fondo	3,67 Correcta	4,33 Correcta
Cierre fonológico/ inhibición de estímulos	-0,33 Correcta	2,33 Correcta

EVALUACIÓN INTERAURAL

Ambliaudía	0,46 Correcta
Fusión/integración binaural	1,36 Correcta
Orientación Espacial	1,66 Correcta
Lenguaje	1 Correcta

Informe de Estimulación

M10

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Fecha : 16 Abril 2018

HL

Legend: ● Derecha ✳ Izquierda

Promedio OD : 10   Promedio OI : 10
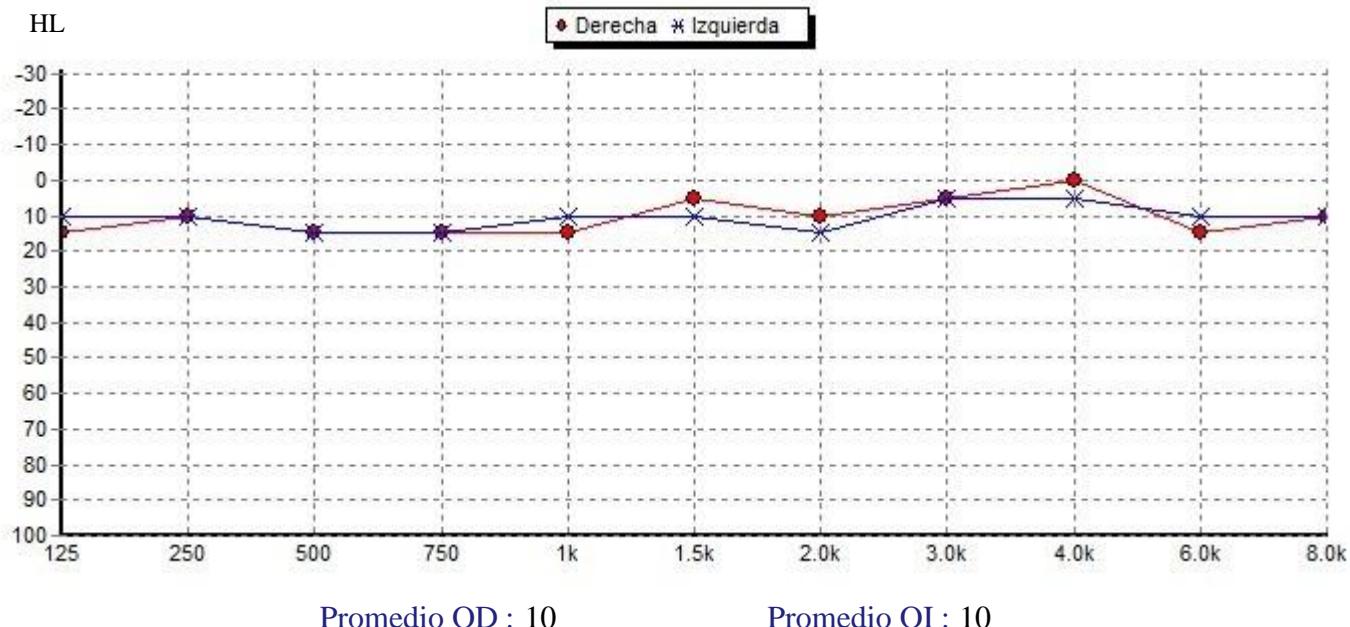
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	10,45	Correcta	10,45	Correcta
Linearidad	3,5	Correcta	5,22	Alteración leve

18/05/2018

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Coordinación motora	2,89	Correcta	2,89	Correcta
Fonología F1, F2/lógica/ritmo/memoria			5	Correcta
Prosodia/entonación/ memoria global	4,18	Correcta		
Fonología F3	1	Correcta	-5	Correcta
Localización/figura-fondo	0,67	Correcta	3,33	Correcta
Cierre fonológico/ inhibición de estímulos	2,67	Correcta	1,67	Correcta

EVALUACIÓN INTERAURAL

Ambliaudía	0	Correcta
Fusión/integración binaural	2,73	Correcta
Orientación Espacial	1,66	Correcta
Lenguaje	-1	Correcta

Informe de Estimulación

M11

-

Fecha : 16 Abril 2018

HL

Promedio OD : 9   Promedio OI : 7
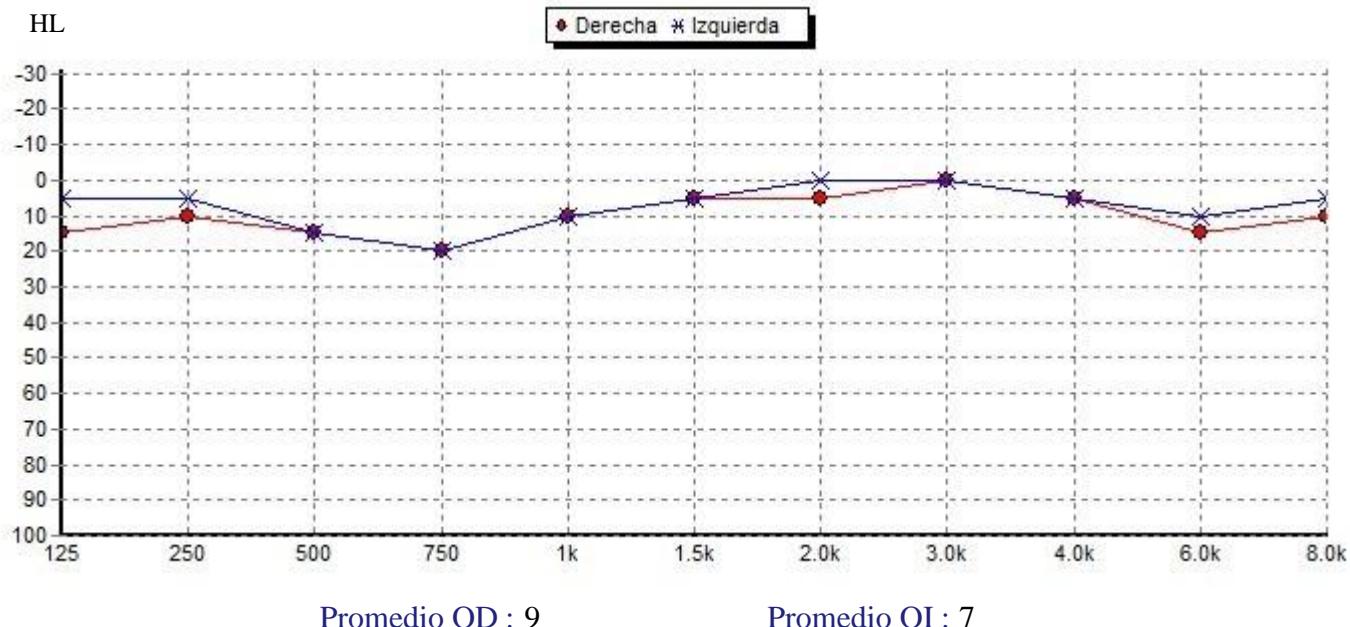
EVALUACIÓN GENERAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	7,27	Correcta	10	Correcta
Linearidad	6,07	Alteración moderada	5,92	Alteración leve

18/05/2018

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO		OÍDO DERECHO	
Coordinación motora	5,77	Alteración leve	2,89	Correcta
Fonología F1, F2/lógica/ritmo/memoria			7,58	Alteración moderada
Prosodia/entonación/ memoria global	8,37	Alteración severa		
Fonología F3	-3	Correcta	-7	Alteración moderada
Localización/figura-fondo	1,33	Correcta	5,33	Localización
Cierre fonológico/ inhibición de estímulos	0,33	Correcta	-2	Correcta

EVALUACIÓN INTERAURAL

Ambliaudía	2,73	Correcta
Fusión/integración binaural	2,73	Correcta
Orientación Espacial	5	Correcta
Lenguaje	1	Correcta

Informe de Estimulación

M12

-

Promedio OD : 3   Promedio OI : 5

EVALUACIÓN GENERAL
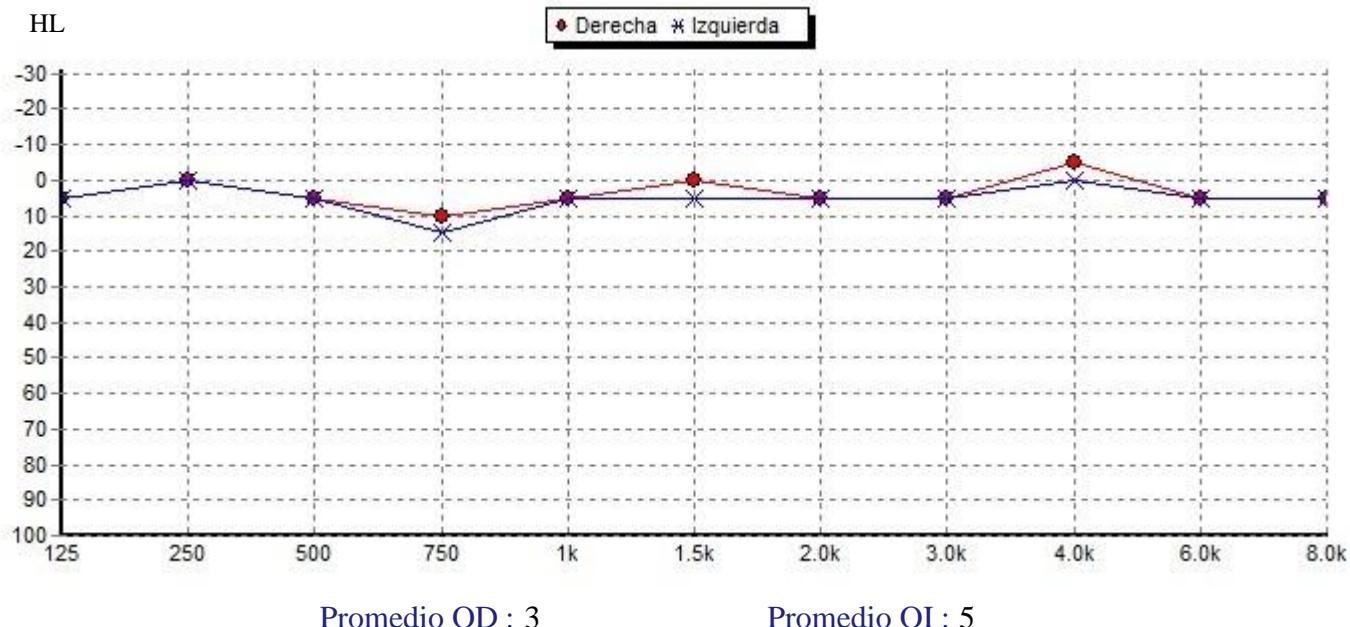
	OÍDO IZQUIERDO		OÍDO DERECHO	
Umbral	5	Correcta	3,64	Correcta
Linearidad	3,87	Correcta	3,93	Correcta

EVALUACIÓN INTRAAURAL

	OÍDO IZQUIERDO	OÍDO DERECHO
Coordinación motora	2,89 Correcta	2,89 Correcta
Fonología F1, F2/lógica/ritmo/memoria		3,54 Correcta
Prosodia/entonación/ memoria global	4,47 Correcta	
Fonología F3	2 Correcta	0 Correcta
Localización/figura-fondo	-3,67 Correcta	-1,67 Correcta
Cierre fonológico/ inhibición de estímulos	3,67 Correcta	3,33 Correcta

EVALUACIÓN INTERAURAL

Ambliaudía	-1,36 Correcta
Fusión/integración binaural	1,36 Correcta
Orientación Espacial	0 Correcta
Lenguaje	-2 Correcta

Correlations summary

1. Audiometries and PROLEC-R tests

Umbral_OD: P2E; P3

Umbral_OE: P1E; P2E; P3; P4

Lin_OD: P1V; P2E; P3; P4

Lin_OE: P2E; P3; P4

Binaural: P1E; P2E; P3; P4

Spearman:

		P1V	P1E	P2V	P2E	P3	P4
Umbral_OD	Coeficiente de correlación	0,202	-0,303	0,100	-,666**	-,523**	-0,279
	Sig. (unilateral)	0,172	0,075	0,321	0,000	0,004	0,094
	N	24	24	24	24	24	24
Umbral_OE	Coeficiente de correlación	0,101	-,345*	0,123	-,671**	-,502**	-,389*
	Sig. (unilateral)	0,319	0,049	0,284	0,000	0,006	0,030
	N	24	24	24	24	24	24
Lin_OD	Coeficiente de correlación	,475**	-0,149	0,285	-,542**	-,524**	-,562**
	Sig. (unilateral)	0,009	0,243	0,089	0,003	0,004	0,002
	N	24	24	24	24	24	24
Lin_OE	Coeficiente de correlación	0,287	-0,225	0,258	-,564**	-,693**	-,739**
	Sig. (unilateral)	0,087	0,146	0,111	0,002	0,000	0,000
	N	24	24	24	24	24	24
Ambliau	Coeficiente de correlación	0,230	0,146	0,023	0,236	0,111	0,220
	Sig. (unilateral)	0,139	0,248	0,457	0,133	0,302	0,151
	N	24	24	24	24	24	24
Binaural	Coeficiente de correlación	0,284	-,443*	0,250	-,655**	-,701**	-,635**
	Sig. (unilateral)	0,089	0,015	0,119	0,000	0,000	0,000
	N	24	24	24	24	24	24
Orient	Coeficiente de correlación	0,201	0,199	0,108	0,108	0,088	0,157
	Sig. (unilateral)	0,173	0,176	0,307	0,307	0,341	0,232
	N	24	24	24	24	24	24
Llenguatge	Coeficiente de correlación	0,240	-0,031	-0,060	0,199	0,076	0,228
	Sig. (unilateral)	0,129	0,443	0,390	0,175	0,361	0,142
	N	24	24	24	24	24	24

General Results

Estadísticos descriptivos

	N	Mínimo	Máximo	Media	Desviación estándar
Anys	24	8,50	9,25	8,9063	,22544
N válido (por lista)	24				

Students with an age between 8.5 i 9.25 years old (mean ± SD = 8.91 ± 0.23)

No age differences between both schools (t(22)=0.99; p=0.34)

No age differences between the three groups (F(2,21)=0.35; p=0.71)

ANOVA

P2V

	Suma de cuadrados	gl	Media cuadrática	F	Sig.
Entre grupos	9763,224	2	4881,612	3,513	,049
Dentro de grupos	27793,732	20	1389,687		
Total	37556,957	22			

Dif between group N (1) and group D (2)

Estadísticas de grupo

	Grups3	N	Media	Desviación estándar	Media de error estándar
P1V	1,00	8	15,3750	2,32609	,82240
	2,00	8	19,5000	3,42261	1,21008
P2E	1,00	8	36,1250	3,27054	1,15631
	2,00	8	31,2500	8,49790	3,00446
P3	1,00	8	13,0000	2,67261	,94491
	2,00	8	11,6250	3,11391	1,10093
Umbral_OD	1,00	8	7,3300	4,84241	1,71205
	2,00	8	12,6113	6,38108	2,25605
Lin_OD	1,00	8	5,1725	2,07051	,73203
	2,00	8	6,3413	1,17174	,41427

Prueba de muestras independientes

		Prueba de Levene de igualdad de varianzas		prueba t para la igualdad de medias						
		F	Sig.	t	gl	Sig. (bilateral)	Diferencia de medias	Diferencia de error estándar	95% de intervalo de confianza de la diferencia	
									Inferior	Superior
P1V	Se asumen varianzas iguales	1,546	,234	-2,819	14	,014	-4,12500	1,46309	-7,26301	-,98699
	No se asumen varianzas iguales			-2,819	12,329	,015	-4,12500	1,46309	-7,30337	-,94663
P2E	Se asumen varianzas iguales	1,466	,246	1,514	14	,152	4,87500	3,21929	-2,02969	11,77969
	No se asumen varianzas iguales			1,514	9,029	,164	4,87500	3,21929	-2,40396	12,15396
P3	Se asumen varianzas iguales	,332	,574	,948	14	,359	1,37500	1,45083	-1,73672	4,48672
	No se asumen varianzas iguales			,948	13,685	,360	1,37500	1,45083	-1,74345	4,49345
Umbral_OD	Se asumen varianzas iguales	,833	,377	-1,865	14	,083	-5,28125	2,83212	-11,35554	,79304
	No se asumen varianzas iguales			-1,865	13,054	,085	-5,28125	2,83212	-11,39707	,83457
Lin_OD	Se asumen varianzas iguales	3,108	,100	-1,390	14	,186	-1,16875	,84113	-2,97279	,63529
	No se asumen varianzas iguales			-1,390	11,067	,192	-1,16875	,84113	-3,01870	,68120

Prueba de muestras independientes

		Prueba de Levene de igualdad de varianzas		prueba t para la igualdad de medias						
		F	Sig.	t	gl	Sig. (bilateral)	Diferencia de medias	Diferencia de error estándar	95% de intervalo de confianza de la diferencia	
									Inferior	Superior
P2V	Se asumen varianzas iguales	1,086	,315	-2,434	14	,029	-39,37500	16,18028	-74,07824	-4,67176
	No se asumen varianzas iguales			-2,434	9,187	,037	-39,37500	16,18028	-75,86390	-2,88610

Dif between group N (1) and SD (3)

Estadísticas de grupo

	Grups3	N	Media	Desviación estándar	Media de error estándar
P1V	1,00	8	15,3750	2,32609	,82240
	3,00	8	24,3750	6,94751	2,45631
P2E	1,00	8	36,1250	3,27054	1,15631
	3,00	8	21,1250	12,25255	4,33193
P3	1,00	8	13,0000	2,67261	,94491
	3,00	8	8,6250	4,40576	1,55767
Umbral_OD	1,00	8	7,3300	4,84241	1,71205
	3,00	8	18,4675	9,83078	3,47570
Lin_OD	1,00	8	5,1725	2,07051	,73203
	3,00	8	7,4063	1,40803	,49781

Prueba de muestras independientes

		Prueba de Levene de igualdad de varianzas		prueba t para la igualdad de medias						
		F	Sig.	t	gl	Sig. (bilateral)	Diferencia de medias	Diferencia de error estándar	95% de intervalo de confianza de la diferencia	
									Inferior	Superior
P1V	Se asumen varianzas iguales	2,806	,116	-3,474	14	,004	-9,00000	2,59033	-14,55571	-3,44429
	No se asumen varianzas iguales			-3,474	8,550	,008	-9,00000	2,59033	-14,90710	-3,09290
P2E	Se asumen varianzas iguales	7,138	,018	3,346	14	,005	15,00000	4,48360	5,38363	24,61637
	No se asumen varianzas iguales			3,346	7,992	,010	15,00000	4,48360	4,65910	25,34090
P3	Se asumen varianzas iguales	2,097	,170	2,401	14	,031	4,37500	1,82187	,46749	8,28251
	No se asumen varianzas iguales			2,401	11,537	,034	4,37500	1,82187	,38777	8,36223
Umbral_OD	Se asumen varianzas iguales	4,595	,050	-2,875	14	,012	-11,13750	3,87449	-19,44744	-2,82756
	No se asumen varianzas iguales			-2,875	10,208	,016	-11,13750	3,87449	-19,74661	-2,52839
Lin_OD	Se asumen varianzas iguales	1,567	,231	-2,523	14	,024	-2,23375	,88526	-4,13245	-,33505
	No se asumen varianzas iguales			-2,523	12,334	,026	-2,23375	,88526	-4,15680	-,31070

Prueba de muestras independientes

	Prueba de Levene de igualdad de varianzas		prueba t para la igualdad de medias						
	F	Sig.	t	gl	Sig. (bilateral)	Diferencia de medias	Diferencia de error estándar	95% de intervalo de confianza de la diferencia	
								Inferior	Superior
P2V Se asumen varianzas iguales	10,246	,007	-2,644	13	,020	-46,73214	17,67246	-84,91118	-8,55311
No se asumen varianzas iguales			-2,502	7,383	,039	-46,73214	18,67741	-90,43667	-3,02762

Dif between group D (2) and SD (3) (no dif)

Estadísticas de grupo

	Grups3	N	Media	Desviación estándar	Media de error estándar
P1V	2,00	8	19,5000	3,42261	1,21008
	3,00	8	24,3750	6,94751	2,45631
P2E	2,00	8	31,2500	8,49790	3,00446
	3,00	8	21,1250	12,25255	4,33193
P3	2,00	8	11,6250	3,11391	1,10093
	3,00	8	8,6250	4,40576	1,55767
Umbral_OD	2,00	8	12,6113	6,38108	2,25605
	3,00	8	18,4675	9,83078	3,47570
Lin_OD	2,00	8	6,3413	1,17174	,41427
	3,00	8	7,4063	1,40803	,49781

Prueba de muestras independientes

		Prueba de Levene de igualdad de varianzas		prueba t para la igualdad de medias						95% de intervalo de confianza de la diferencia	
		F	Sig.	t	gl	Sig. (bilateral)	Diferencia de medias	Diferencia de error estándar		Inferior	Superior
P1V	Se asumen varianzas iguales	1,198	,292	-1,780	14	,097	-4,87500	2,73821		-10,74787	,99787
	No se asumen varianzas iguales			-1,780	10,209	,105	-4,87500	2,73821		-10,95924	1,20924
P2E	Se asumen varianzas iguales	1,474	,245	1,921	14	,075	10,12500	5,27185		-1,18200	21,43200
	No se asumen varianzas iguales			1,921	12,469	,078	10,12500	5,27185		-1,31365	21,56365
P3	Se asumen varianzas iguales	,953	,345	1,573	14	,138	3,00000	1,90746		-1,09109	7,09109
	No se asumen varianzas iguales			1,573	12,597	,141	3,00000	1,90746		-1,13426	7,13426
Umbral_OD	Se asumen varianzas iguales	1,913	,188	-1,413	14	,179	-5,85625	4,14370		-14,74361	3,03111
	No se asumen varianzas iguales			-1,413	12,009	,183	-5,85625	4,14370		-14,88383	3,17133
Lin_OD	Se asumen varianzas iguales	,281	,604	-1,644	14	,122	-1,06500	,64764		-2,45405	,32405
	No se asumen varianzas iguales			-1,644	13,553	,123	-1,06500	,64764		-2,45837	,32837

Prueba de muestras independientes

		Prueba de Levene de igualdad de varianzas		prueba t para la igualdad de medias						
		F	Sig.	t	gl	Sig. (bilateral)	Diferencia de medias	Diferencia de error estándar	95% de intervalo de confianza de la diferencia	
									Inferior	Superior
P2V	Se asumen varianzas iguales	,817	,382	-,319	13	,755	-7,35714	23,04239	-57,13720	42,42291
	No se asumen varianzas iguales			-,317	12,296	,756	-7,35714	23,20194	-57,77530	43,06101

Correlations

<div align="center">**Correlaciones**</div>

			P1V	P1E	P2V	P2E	P3	P4	Umbral _OD	Umbral _OE	Lin_O D	Lin_O E	Ambli au	Binau ral	Orient	Llengu atge
Rho de Spearman	P1V	Coeficiente de correlación	1,000	-,025	,464*	-,174	-,339	-,278	,202	,101	,475*	,287	,230	,284	,201	,240
		Sig. (bilateral)	.	,906	,026	,416	,105	,189	,344	,637	,019	,173	,279	,178	,345	,259
		N	24	24	23	24	24	24	24	24	24	24	24	24	24	24
	P1E	Coeficiente de correlación	-,025	1,000	-,222	,427*	,414*	,362	-,303	-,345	-,149	-,225	,146	-,443*	,199	-,031
		Sig. (bilateral)	,906	.	,309	,037	,045	,083	,151	,099	,486	,291	,496	,030	,352	,885
		N	24	24	23	24	24	24	24	24	24	24	24	24	24	24
	P2V	Coeficiente de correlación	,464*	-,222	1,000	-,232	-,077	-,399	-,023	,048	,212	,204	-,110	,167	-,014	-,206
		Sig. (bilateral)	,026	,309	.	,287	,726	,059	,918	,828	,331	,350	,616	,445	,951	,346
		N	23	23	23	23	23	23	23	23	23	23	23	23	23	23
	P2E	Coeficiente de correlación	-,174	,427*	-,232	1,000	,373	,499*	-,666**	-,671**	-,542**	-,564**	,236	-,655**	,108	,199
		Sig. (bilateral)	,416	,037	,287	.	,072	,013	,000	,000	,006	,004	,266	,001	,614	,351
		N	24	24	23	24	24	24	24	24	24	24	24	24	24	24
	P3	Coeficiente de correlación	-,339	,414*	-,077	,373	1,000	,719**	-,523**	-,502*	-,524**	-,693**	,111	-,701**	,088	,076
		Sig. (bilateral)	,105	,045	,726	,072	.	,000	,009	,012	,009	,000	,604	,000	,682	,723
		N	24	24	23	24	24	24	24	24	24	24	24	24	24	24
	P4	Coeficiente de correlación	-,278	,362	-,399	,499*	,719**	1,000	-,279	-,389	-,562**	-,739**	,220	-,635**	,157	,228
		Sig. (bilateral)	,189	,083	,059	,013	,000	.	,187	,060	,004	,000	,302	,001	,463	,284
		N	24	24	23	24	24	24	24	24	24	24	24	24	24	24
	Umbral _OD	Coeficiente de correlación	,202	-,303	-,023	-,666**	-,523**	-,279	1,000	,830**	,502*	,473*	-,076	,661**	-,072	-,052
		Sig. (bilateral)	,344	,151	,918	,000	,009	,187	.	,000	,012	,020	,724	,000	,737	,810
		N	24	24	23	24	24	24	24	24	24	24	24	24	24	24

Umbral_OE	Coeficiente de correlación	,101	-,345	,048	-,671**	-,502*	-,389	,830**	1,000	,479*	,664**	-,569**	,794**	-,546**	-,514*
	Sig. (bilateral)	,637	,099	,828	,000	,012	,060	,000	.	,018	,000	,004	,000	,006	,010
	N	24	24	23	24	24	24	24	24	24	24	24	24	24	24
Lin_OD	Coeficiente de correlación	,475*	-,149	,212	-,542**	-,524**	-,562**	,502*	,479*	1,000	,699**	-,071	,693**	,015	-,076
	Sig. (bilateral)	,019	,486	,331	,006	,009	,004	,012	,018	.	,000	,743	,000	,945	,724
	N	24	24	23	24	24	24	24	24	24	24	24	24	24	24
Lin_OE	Coeficiente de correlación	,287	-,225	,204	-,564**	-,693**	-,739**	,473*	,664**	,699**	1,000	-,411*	,854**	-,367	-,393
	Sig. (bilateral)	,173	,291	,350	,004	,000	,000	,020	,000	,000	.	,046	,000	,078	,058
	N	24	24	23	24	24	24	24	24	24	24	24	24	24	24
Ambliau	Coeficiente de correlación	,230	,146	-,110	,236	,111	,220	-,076	-,569**	-,071	-,411*	1,000	-,390	,902**	,923**
	Sig. (bilateral)	,279	,496	,616	,266	,604	,302	,724	,004	,743	,046	.	,060	,000	,000
	N	24	24	23	24	24	24	24	24	24	24	24	24	24	24
Binaural	Coeficiente de correlación	,284	-,443*	,167	-,655**	-,701**	-,635**	,661**	,794**	,693**	,854**	-,390	1,000	-,415*	-,329
	Sig. (bilateral)	,178	,030	,445	,001	,000	,001	,000	,000	,000	,000	,060	.	,044	,117
	N	24	24	23	24	24	24	24	24	24	24	24	24	24	24
Orient	Coeficiente de correlación	,201	,199	-,014	,108	,088	,157	-,072	-,546**	,015	-,367	,902**	-,415*	1,000	,735**
	Sig. (bilateral)	,345	,352	,951	,614	,682	,463	,737	,006	,945	,078	,000	,044	.	,000
	N	24	24	23	24	24	24	24	24	24	24	24	24	24	24
Llenguatge	Coeficiente de correlación	,240	-,031	-,206	,199	,076	,228	-,052	-,514*	-,076	-,393	,923**	-,329	,735**	1,000
	Sig. (bilateral)	,259	,885	,346	,351	,723	,284	,810	,010	,724	,058	,000	,117	,000	.
	N	24	24	23	24	24	24	24	24	24	24	24	24	24	24

*. La correlación es significativa en el nivel 0,05 (bilateral).
**. La correlación es significativa en el nivel 0,01 (bilateral).

P1 V - Letter's Name Speed
P1 E - Letter's Name Right Answers
P2 V - Pseudoword Reading Speed
P2 E - Pseudoword Right Answers
P3 - Grammar structures Right Answers
P4 - Text Comprehension

Threshold Right Ear
Threshold Left Ear
Linearity Right Ear
Linearity Left Ear
Amblyaudia
Binaural Fusion
Spatial Orientation
Language

Participants' perception questionnaires

Estimats alumnes,

Volem conèixer la vostra opinió i com us heu sentit participant en la recerca sobre l'audició i la lectura. No hi ha respostes correctes o incorrectes perquè ens importa la vostra valoració, per tant, contesteu el més sincerament possible, si us plau. A més a més, l'enquesta és anònima i s'utilitzarà únicament per la recerca.

L'enquesta només t'ocuparà 5 minuts. A continuació, trobareu les instruccions. Moltes gràcies per avançat.

Encercla la opció que més defineixi el que penses sabent que 😊 és que estàs totalment d'acord, 😐 que estàs d'acord i que 🙁 vol dir que no estàs gens d'acord.

1.- T'han informat de forma clara i entenedora sobre l'objectiu de la recerca.

😊	😐	🙁

2.- T'has sentit còmode i amb confiança amb l'investigador durant el desenvolupament de les activitats.

😊	😐	🙁

3.- Has entès les explicacions de les tasques.

😊	😐	🙁

4.- T'ha semblat fàcil de fer totes les activitats.

5.- T'ha agradat participar en la recerca.

6.- Participaries en activitats semblants.

7.- Comentaris:

Moltes gràcies per la teva participació.

STATE SCHOOL						
Nom	Informació	Comoditat	Comprensió	Facilitat	Interès	Participació	Comentaris
J1	10	10	5	10	10	5	Res
J2	10	10	5	10	10	10	Res
J3	10	10	10	10	10	10	Molt bé
J4	10	10	10	0	10	10	És molt difícil llegir
J5	10	10	10	10	10	10	Res
J6	10	10	10	10	10	10	M'ho he passat molt bé
J7	5	10	5	5	10	5	No ho he entès, però la Judit molt bé
J8	10	10	5	10	5	10	No
J9	10	10	5	5	10	5	He llegit molt
J10	10	10	10	10	10	10	M'ha agradat molt
J11	10	10	10	10	5	10	Molt bé
J12	10	10	5	5	10	10	Res

	MOLT (10)	NORMAL (5)	POC (0)
Informació	11	1	0
Comoditat	12	0	0
Comprensió	6	5	0
Dificultat	8	3	1
Interès	10	2	0
Participació	9	3	0

PRIVATE SCHOOL							
Nom	Informació	Comoditat	Comprensió	Facilitat	Interès	Participació	Comentaris
M1	10	5	5	10	10	5	Res
M2	10	10	10	10	5	10	Res
M3	10	10	10	10	10	10	Res
M4	10	10	5	0	10	10	Avorrit
M5	10	5	10	10	10	10	Res
M6	10	10	10	5	10	10	Res
M7	5	10	5	10	10	5	Està bé
M8	10	5	10	10	0	10	
M9	10	10	5	5	10	5	Una mica llarg
M10	10	10	10	10	10	10	M'ha agradat molt
M11	5	10	10	10	10	10	Divertit
M12	10	10	5	10	10	5	Res

	MOLT (10)	NORMAL (5)	POC (0)
Informació	10	2	0
Comoditat	9	3	0
Comprensió	6	5	1
Dificultat	9	2	1
Interès	10	1	1
Participació	8	4	0

STATE SCHOOL

	Molt	Normal	Poc

PRIVATE SCHOOL

	Molt	Normal	Poc
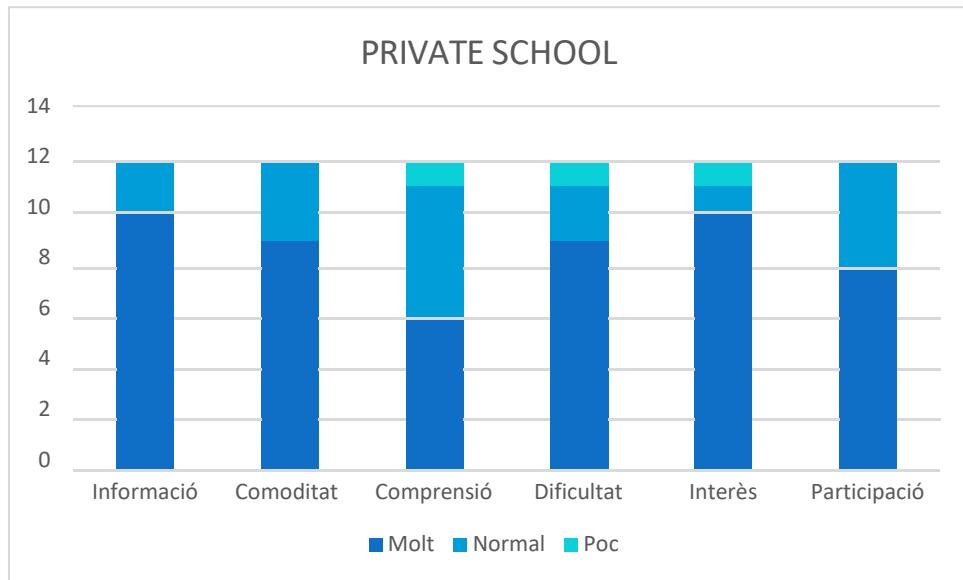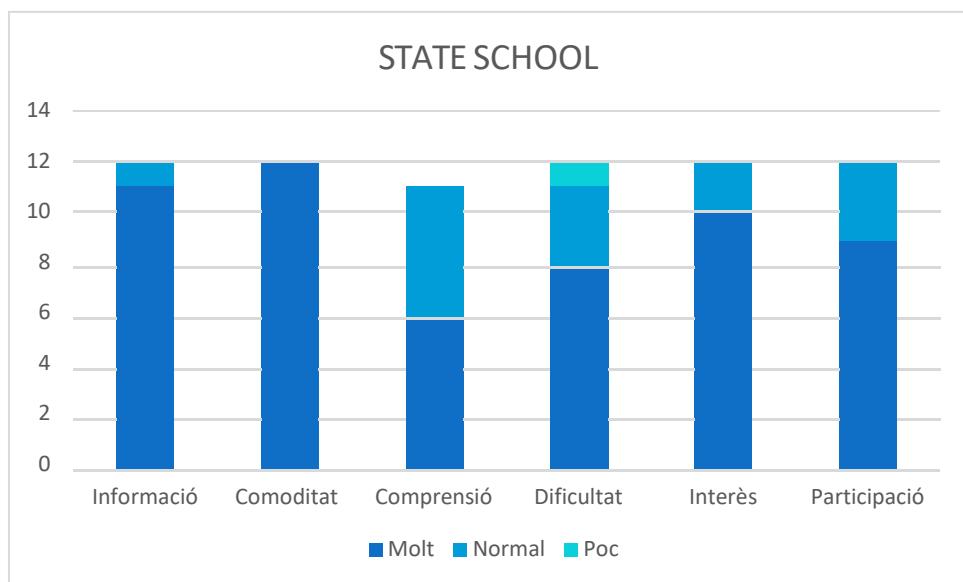
Teachers' perception questionnaires

Benvolguts professors i professores,

Per mitjà d'aquesta enquesta de satisfacció que els hi presentem, volem conèixer la seva opinió i valoració respecte a la recerca realitzada amb la participació dels seus alumnes per a relacionar la qualitat de l'audició amb la velocitat i comprensió lectora.

L'enquesta és anònima i la informació facilitada serà utilitzada per l'objecte pel qual s'ha dissenyat. La durada aproximada per a completar-la és d'entre 5 i 10 minuts. Moltes gràcies per avançat.

Contestin, si us plau, el més sincerament possible. Puntuïn de l'1 al 5, essent 1- Gens i 5- Molt, les següents afirmacions.

1.- La informació facilitada per els investigadors ha estat adequada i s'ha ajustat als criteris ètics dels docents?

1	2	3	4	5

2.- La organització de les diferents activitats ha estat correcta i s'ha ajustat a les necessitats dels alumnes.

1	2	3	4	5

3.- S'ha creat un clima adequat entre l'investigador i els alumnes que ha facilitat el desenvolupament de la recerca.

1	2	3	4	5

4.- La recerca realitzada beneficia la seva tasca com a docent.

1	2	3	4	5

5.- Agrairia rebre més informació i formació sobre el tema de la recerca.

1	2	3	4	5

6.- Comentaris:

Gràcies per la seva col·laboració.

	J1	J2	J3	J4	M1	M2	M3	M4
Informació	5	4	5	5	4	5	5	5
Organització	4	3	4	5	4	4	3	4
Clima	5	5	5	5	4	5	4	5
Beneficis investigació	4	4	5	5	5	5	4	5
Formació	5	4	5	5	5	4	5	5

Comentaris:

J1: Com seguir, proposar després.

J2: Incloure més participants.

J3: Sorprenent, vol llegir el treball.

J4: Valorar els alumnes en general.

M1: Sorprenent el tema de l'audició.

M2: Investigar més.

M3: Conèixer els resultats dels alumnes.

M4: Incloure més participants.

Teachers' perception questionnaires