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Case Report

Auditory Training with Computerized Software in Children with Auditory Processing Disorder by a Pediatrician: Description of Two Cases

Çocuk Hekimi Tarafından İşitsel İşlemleme Bozukluğu Olan Çocuklarda Bilgisayarlı Yazılımla İşitsel Eğitim: İki Olgu Sunumu

Vanessa Pacini Inaba Fernandes

Sumare City Hall, Primary Care Unit, Sumare, Brazil

ABSTRACT

Auditory processing disorder (APD) is a condition in which what is heard is not completely understood, even with adequate peripheral hearing. Treatment for APD can be providede with auditory training, but it is not included in public health insurance. This study describes two cases of low-income children with learning disabilities and APD, treated with the computerized auditory software "Tuning the Brain" provided by a pediatrician.

Case 1 is a ten-year-old girl with learning disability, family history of learning disability and recent death of a parent. After performing games for 17.3 hours over 14.2 months she showed improvement in dichotic digit Binaural integrationand separation, in Musiek temporal ordering (nominating and inversion), in Staggered Spondaic Word binaural integration, but worsened Masking Level Difference binaural integration. Case 2 is a ten year-old boy with personal and family history of learning disabilities. After performing games for 7.5 hours during 17.6 months he improved his figure-background Synthetic Sentence identification, dichotic digit Binaural integration and right ear dichotic digit Binaural separation, Musiek temporal ordination, nominating and inversions, Staggered Spondaic Word binaural integration and worsened left ear dichotic digit Binaural separation. After auditory training, patient 1 had three normalized skills (dichotic digit Binaural integration and separation and Staggered Spondaic Word binaural integration) and patient 2 had one (Synthetic sentence identification figure-background).

Computerized auditory training is a relevant tool for treatment of APD. More studies with greater samples and reduced training periods are needed to endorse this finding.

Keywords: *Children, auditory processing disorder, auditory training, Tuning the brain software, learning disabilities*

ÖZET

İşitsel işlemleme bozukluğu (APD), periferik işitme yeterli olmasına rağmen duyulanların tam olarak anlaşılamadığı bir durumdur. APD tedavisi işitsel eğitim ile sağlanabilmekte, ancak bu tedavi kamu sağlık sigortası kapsamında yer almamaktadır. Bu çalışma, çocuk doktoru tarafından sağlanan "Tuning the Brain" adlı bilgisayarlı işitsel eğitim yazılımı ile tedavi edilen, öğrenme güçlüğü ve APD tanısı bulunan düşük gelirli iki çocuğu tanımlamaktadır.

Olgu 1, öğrenme güçlüğü, ailede öğrenme güçlüğü öyküsü ve yakın zamanda ebeveyn kaybı bulunan on yaşında bir kız çocuğudur. Toplam 14,2 ay boyunca 17,3 saat oyun uygulamasının ardından; dikotik sayı testinde binaural bütünleme ve ayırma, Musiek temporal

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Correspondence / Yazışma: Vanessa Pacini Inaba Fernandes · Sumare City Hall, Primary Care Unit, Sumare, Brazil · vpinaba@terra.com.br

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sıralama testinde (isimlendirme ve tersine çevirme) ve Staggered Spondaic Word testinde binaural bütünleme becerilerinde iyileşme görülmüş, ancak Masking Level Difference binaural bütünleme becerisinde kötüleşme saptanmıştır. Olgu 2 ise kişisel ve ailesel öğrenme güçlüğü öyküsü bulunan on yaşında bir erkek çocuğudur. Toplam 17,6 ay boyunca 7,5 saat oyun uygulamasının ardından; figure-background Synthetic Sentence Identification testi, dikotik sayı binaural bütünleme ve sağ kulakta dikotik sayı binaural ayırma, Musiek temporal sıralama testi (isimlendirme ve tersine çevirme) ile Staggered Spondaic Word binaural bütünleme becerilerinde iyileşme görülmüş, ancak sol kulakta dikotik sayı binaural ayırma becerisinde kötüleşme saptanmıştır. İşitsel eğitim sonrasında birinci hastada üç beceri (dikotik sayı binaural bütünleme ve ayırma ile Staggered Spondaic Word binaural bütünleme), ikinci hastada ise bir beceri (Synthetic Sentence Identification figure-background) normalleşmiştir.

Bilgisayarlı işitsel eğitim, APD tedavisinde önemli bir araçtır. Bu bulguyu desteklemek için daha geniş örneklemli ve daha kısa eğitim sürelerini içeren çalışmalara ihtiyaç vardır.

Keywords: *Çocuklar, işitsel işlemleme bozukluğu, işitsel eğitim, Tuning the Brain yazılımı, öğrenme güçlükleri*

INTRODUCTION

Auditory processing disorder (APD) occurs when at least one of the hearing skills of central auditory processing is underdeveloped (1, 2). Treatment for APD can include auditory training, that is typically conducted by a speech-language pathologist or audiologist, with or without computerized auditory software, however it is not covered by the Brazilian public health insurance (Sistema Unico de Saude, SUS) (3, 4).

Therefore, we decided to investigate if the use of the Brazilian Computerized Auditory Software "Tuning the Brain" in children evaluated for learning disabilities with APD provided by a pediatrician without dedicated speech-language pathologist or audiologist intervention, would help improve their underdeveloped skills in a population in a low-income resources without access to a specific professional intervention.

MATERIALS AND METHOD

This study was derived from the previous "Pediatrician's role on patients with learning disabilities: a pilot study"(5). From the fifteen patients with learning disabilities evaluated between 2022 and 2023, ten underwent auditory processing with APD diagnosis.

The skills tested in the auditory processing test were: to identify nonsense sentences in correspondence with a sentence or picture, with competitive sound (Synthetic sentence identification,SSI, and Masking Level Difference, MLD); to evaluate binaural interaction and separation by presenting numbers or sounds to each ear simultaneously and asking to select information of a specific ear or integrate information from both ears; this test can also access hemisphere dominance (Selective and free attention Digit Dichotic test and Staggered Spondaic Word, SSW); to evaluate temporal resolution, by the perception of two sound intervals in the smallest difference in time presented (Randon Gap Detection Test, RGDT test); to evaluate temporal ordering by the perception of difference in intensity of sounds (low and high tones) in sequences (Frequency pattern test, Musiek test).

All patients were offered to perform 32 games to develop these skills with "Tuning the brain" software (activities shown in Table 1). There was a total of 113 levels to perform with at least 80 points needed to skip from one level to the next. To gauge the time to perform the test, the author VPIF performed all these levels in 7.6 hours. Patients who completed more than 60% of the levels proposed should perform another auditory processing test.

Unfortunately, only seven patients managed to perform the exercises (mean 4.8 hours; from 3 minutes to 17.3 hours) for a period of time (mean 7.4 months; from 1 day to 17.6 months). The causes for not doing the exercises were: lack of material (mobile phone or computer), lack of parent´s help, lack of interest and exercises too difficult to perform. As most of the patients had very little effort in performing the auditory training, they couldn't achieve the proposed goal to justify another auditory processing test, as it is afforded by public health expenses. From that cohort, we decided to describe the only two patients who were more engaged and had more parental support to perform the exercises and were submitted to a second auditory processing test. Both parents and children gave consent for this case description.

Case description

Case one

The first patient is a ten-year-old girl in fifth grade with learning disability. Her father had only elementary schooling and died during the Covid-19 pandemic. Her mother and brother did not have learning disabilities. She was a literate girl with difficulty in reading, writing and mathematics skills. The patient had left hemispheric dominance and difficulty in the following skills: SSI figure-background (right ear, RE, 50% and left ear, LE 50%; normal value 60%), dichotic digit Binaural integration (LE 82%, normal value 90%); dichotic digit Binaural separation (LE 60%; normal value 85%); couldn´t perform RGDT temporal resolution and nominating and inversions of temporal ordination and SSW binaural integration (competitive right, CR, 87.5% and competitive left, CL, 67.5%; normal value 90%). This information is shown on Table 2. She performed 76 levels (> 80 points in 67.2% of the levels) of the 32 games for 17.3 hours during 14.2 months. After this time, she underwent another auditory processing test, there was improvement in dichotic digitBinaural integration (LE 95%, increase of 15.8%); improvement in dichotic digit Binaural separation (LE 95%, increase of 58.3%); improvement in Musiek temporal ordination in nominating (16.6%) and inversions (20%); improved SSW binaural integration (CR 90%, increase of 2.8% and CL, 87.5%, increase of 29.6%); and worsened MLD binaural integration for both ears (RE and LE 8 dB, decrease of 20%). After auditory training, dichotic digit Binaural integration LE, dichotic digit Binaural separation LE and SSW binaural integration both ears improved to normal values.

Case two

The second patient was a ten-year-old boy in fifth grade with learning disability. His father had learning disabilities but finished high school. His brother has anxiety disorder and his mother works as a teacher. He was a literate boy with difficulty in reading, writing and mathematics skills. Patient had left hemispheric dominance and difficulty in the following skills: SSI figure-background (RE 40% LE 40%; normal value 60%), dichotic digit Binaural integration (LE 85%, normal value 90%); dichotic digit Binaural separation (LE and RE 80%; normal value 85%); nominating (50%) and inversions (20%) of temporal ordination (normal value 65%) and SSW binaural integration (CR 82.5% CL 67.5%; normal value 90%). This information is shown on Table 3. He performed 60 levels (> 80 points in 53% of the levels) of 25 games for 7.5 hours during 17.6 months. After this time, he performed another auditory processing test, with improvement in figure-background SSI (both ears 60%, increase of 50%); improvement in dichotic digit Binaural integration (LE 87.5%, increase of 2.9%); improvement in RE (RE 85%, increase of 6.2%) and worsened LE (LE 70%, decreased 12.5%) in dichotic digit Binaural separation; improvement Musiek temporal ordination in nominating (53.3%, increase of 6.6%) and decrease in inversions (13.3%, decrease of 33.5%); and improvement in SSW binaural integration (CR 87.5%, increase of 6% and CL 77.5%, increase of 14.8%). Despite increases in many tests, only the SSI figure-background returned tonormal values.

DISCUSSION

Auditory training software is an effective tool for treating APD(6), however most of them are for English speakers and only two are available for Portuguese speakers, "Tuning the brain"(7-11) and Sena Method(12), with the former having more scientific evidence.

A study with 34 children (8- to 14-year-old) with (study group) or without (control group) documented history of otitis media with effusion and bilateral tympanostomy tube placement submitted to a 45-minute weekly session for eight weeks of auditory training with "Tuning the brain" software found in study group improvement in resolution and ordination skills, which can be altered by otitis media(7). A masters thesis evaluated 12 children (8 to 12 years-old) with APD and learning disabilities (study group 1), without APD and learning disabilities (control group) and without APD and learning disabilities (study group 2). Study group one and two were submitted to an 8-group weekly session in school with "Tuning the brain" software, while control group didn't have any intervention. After training, besides improvement in all skills, 3 of 4 patients normalized their auditory processing test. Auditory processing test remained normal in control group, however in study group 2, patients improved temporal ordination, binaural integration and figure-ground skills(8). A congress study presentation of 13 students (7 to 11 years-old) with learning disabilities, submitted to a twelve weekly sessions with "Tuning the brain" software, with or without acoustic booth revealed that all students had

normalization of the skills hearing localization, dichotic digit test, non-verbal dichotic test, logo audiometry test, speech in noise test, temporal resolution (RGDT test) and frequency pattern test and improvement in Staggered Spondaic Word (SSW)(9). Finally, a case report of two male patients 8 and 9 years-old with developmental stuttering with APD diagnosis, after a fifty minutes eight weekly sessions with a speech therapist and a daily use of "Tuning the brain" in their home, both patients had improvement of some skills in auditory processing, but not total normalization, and also didn't improve fluency of speech of both children(10).

In our patients, there was improvement of at least two skills and normalization of at least one skill on auditory processing test after intervention with "Tuning the brain" software auditory training. Auditory training is typically conducted by speech-language pathologist or audiologist, but the lack of this treatment in public health is a challenge for low-income children. This study was an effort to try to give an opportunity for these children, on a legal basis, as "Tuning the brain" software is an open platform for both professionals and general public. What was found was that when you don't have a weekly basis appointment, for a regular period of time, the interest of patient and parents decreases, and only patients with more engaged families can overcome this task, even if the amount of time greatly exceeds what was scheduled.

CONCLUSION

Auditory training software are relevant tools for training auditory skills and overcoming APD. Auditory training is typically conducted by a speech-language pathologist or audiologist, but in the absence of these professionals as seen in public healthy care, pediatrician can play a role in guidance of child with APD with "Tuning the Brain" software to help them improve decreased skills in auditory processing test, even though with a remarkable amount of time. Other studies are necessary with more patients and with a reduced time schedule to confirm this finding.

Patient Consent Form / Hasta Onam Formu

The parents' of this patient consent was obtained for this study.

Conflict of Interest / Çıkar Çatışması

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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Author Contributions / Yazar Katkıları

All stages of the study, including concept, design, supervision, materials, data collection and/or processing, analysis and interpretation, literature review, manuscript writing, and critical review, were performed by the author. The author approved the final version of the manuscript.

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