Tablet-Based Central Auditory Processing

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Objective

Determine the feasibility of administering portable, mobile central auditory testing in English and Spanish-speaking children using self-led, tablet-based training. By developing a device that does not require a trained audiologist to administer auditory testing, we aim to implement this method in communities at high risk for central auditory processing deficits where access to healthcare resources is lacking.

Introduction

Hearing loss is prevalent in children living and working in mining communities due to high levels of heavy metal toxins such as lead, arsenic, and mercury. In areas of the world where industry regulations on metal exposure are lacking, children and adults are most at risk. Preliminary studies using central auditory processing (CAP) tests suggest that exposure to heavy metals may affect the central nervous system leading to impairments in auditory processing [1-3].

Many of these mining towns are in areas of the world where access to a trained audiologist is rare or non-existent. To identify hearing loss in children living in these communities, CAP testing needs to be accessible without the need for an audiologist to administer auditory exams. Through the development of a self-led, tablet-based training system, children can complete CAP testing without the need for an audiologist to be present at the time of testing.

Procedure

A novel, tablet-based system for assessing central auditory processing in children was developed for this study. English speaking children and adolescents, ages 6-18 years old, were recruited from local schools in the Upper Valley Community and included in this pilot study (Table 1). Exclusion criteria for this analysis included children <6 years of age, active ear infections or middle ear pathology, congenital cognitive impairment, severe to profound hearing loss, and other health conditions prohibiting the completion of the CAP test battery. Pure tone audiometry and mCAPE testing was performed with the Creare headset (WiScreener) and tablet-based system (Tabsint) and uploaded to a GitLab repository via an mHealth network (Images 1 and 2). Central auditory testing results (Gap Detection, Augmented Frequency Threshold Test, Masking Level Difference, Hearing and Noise Test (HINT), Dichotic Digits, and Frequency Pattern Detection Test) through the WiScreener/Tabsint delivery platform (Table 2) were compared with standard values.

Demographics		
Subject	Age	Gender
1	11	F
2	10	F
3	9	M
4	12	M
5	16	M
6	16	F
7	9	M

Table 1. Demographic Characteristics

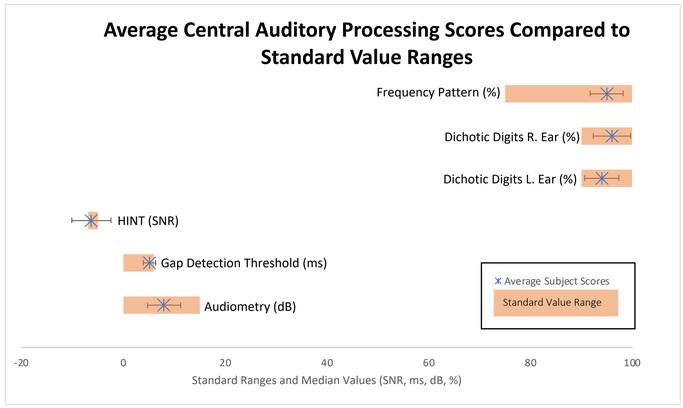
Images 1 & 2. Use of training videos to provide instruction for central auditory processing tests (left) and implementation of tests using the Creare headset and tablet-based system (right)

Battery of Test Descriptions	
Audiometry Pure Tone	A behavioral test to assess subject hearing sensitivity.
Gap Detection Threshold	Assesses ability to detect short gaps in continuous noise. Thresholds are determined by shortest detected gap length.
Hearing and Noise Test	Assesses ability of subjects to correctly recall 5 word sentences overlayed with white noise.
Dichotic Digits	Subjects are presented with 2 sets of 2 numbers presented simultaneously in each ear and are assessed for correct recall of numbers
Frequency Pattern	Two tones are presented in sequence, and subjects are asked to recall the order of the tones.

Table 2. Battery of Test Descriptions

Results

Of the 7 children and adolescents included in this study thus far, all subjects were successfully able to complete central auditory processing using the table-based training videos created for this study. Compared to standard value ranges, the average subject scores for Audiometry Pure Tone, Gap Detection Threshold, Hearing and Noise Test, Dichotic Digits, and Frequency Pattern were within normal limits (Graph 1). Variability of responses for the HINT was greater than expected range. Average time to complete the full battery of tests was 52 minutes and 44 seconds, which was within the 1 hour of expected time for testing.



Graph 1. Composite representation of average subject scores for individual battery of tests compared to standard value ranges

Conclusions

Completion of central auditory testing using self-led, tablet-based training videos verifies its utility for future clinical investigations where a trained audiologist is not readily accessible. In this small pilot cohort, all results were within normal limits, indicating that comprehension of the training was adequate to appropriately complete the tests. In addition, the battery of tests was completed well within the allotted time. This implies that using tablet-based training videos may allow for a more streamlined and efficient approach to completing the battery of tests.

Future Directions

We plan to continue evaluating this protocol in a larger cohort (n=40). This will allow for further investigation of the variability in the HINT results. The initial success of this verification study shows promise for use of the Creare headset and tablet-based system for central auditory processing to be completed in Nicaraguan mining communities without the need for a trained audiologist for data collection. To further investigate this, we plan to replicate this verification study in Spanish-speaking children using a Spanish version of the testing protocol. This protocol is close to finalization.

Once validated, the headset and training videos will be used in Nicaragua to investigate the prevalence of hearing loss in children living in mining communities, which may be attributed to heavy metal exposure causing central auditory processing deficits.

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