Accuracy of Automated Hearing Assessment in the Presence of Background Noise

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What is KUDUwave?

KUDUwave:

- Is a fully functioning portable audiometer (air, bone, speech)
- Does not require a sound booth
- Can be manual or fully automated

How does it work?

1. Foam insert earphones are placed inside the ear canal
2. Circumaural noise-attenuating headphones are placed over the top of the ear
3. KUDUwave monitors ambient noise level with external and internal SPL sound meters
4. Only tests when noise levels are low
5. In manual mode, it notifies the tester when noise levels are too high
6. Specifications state KUDUwave can test accurately to -10 dBHL in 50 dBA of ambient noise

Why KUDUwave?

A Kudu is a type of African antelope that is known for its large ears and excellent hearing.

Disclosure: There is no financial relationship between any of the researchers and GeoAxon, the Manufacturer of the KUDUwave

Background

The Problem:

1. 275 Million people worldwide suffer from moderate to profound hearing loss.
2. 80% of those live in countries where only 3% are treated. (WHO 2012)
3. Untreated hearing loss can cause communication difficulties, isolation, and depression.

Tele-Audiology

Tele-audiology enables a person in one location to treat a patient at another location. However, a sound booth and audiometer are required at the test site.

Potential solution: KUDUwave

Previous research has found the KUDUwave to be accurate when using it for remote testing via the internet (Swanepoel, Mngemane, Molemong, Mkwanazi &Tutshini, 2010) and when using it in its automated setting (Swanepoel, Koekemoer & Clark, 2010).

Purpose

Previous research was done in a quiet sound booth. However, KUDUwave was designed to be accurate in noise.

The purpose of this study was to determine the accuracy of the KUDUwave unit for obtaining air conduction thresholds in the presences of low level background noise as compared to a clinical audiometer.

Methods

Participants

31 adults and adolescents 13 years or older
21 with normal hearing
10 with hearing loss

Hearing loss was defined as thresholds worse than 25 dB at 2 or more frequencies in one ear. Hearing loss ranged from mild to profound as defined by a participant's worst threshold.

Measures

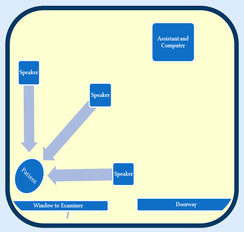
Air-conduction thresholds were obtained in 3 conditions:

1. With a GSI Clinical Audiometer in an ANSI certified sound treated booth
2. With the KUDUwave in a quiet sound booth using the automated mode
3. With the KUDUwave inside a sound booth with 40 dBA of background noise directed through 3 sound field speakers.

Measures were equally counterbalanced to eliminate the order effect

Thresholds were compared to assess the accuracy of the two KUDUwave conditions.

Test Set-Up



3 Speakers at 0 and 45 degrees azumuth.

40 dBA of 12-talker babble

Results

Thresholds obtained using the KUDUwave were compared with those obtained using a clinical audiometer. Thresholds within ± 5 dB were considered to be accurate. The mean difference was calculated by subtracting the KUDUwave threshold from the clinical audiometer. Thus negative differences indicate the KUDUwave produced higher (poorer) thresholds.

% Accurate Thresholds and Mean Differences

	N	% Thresholds within 5 dB	M Difference in dB	SD
Quiet Condition	62	88.54	-2.20	8.00
Noise Condition	62	91.77	-1.08	3.73

Note. Negative values indicate the KUDUwave had higher (poorer) thresholds.

Analysis of accuracy by frequency indicated better accuracy from 500 to 6000 Hz.

% Accurate Thresholds, Mean Differences and Correlations by Frequency (N = 62)

Hz	250	500	750	1000	1500	2000	3000	4000	6000	8000
Quiet Condition										
Accurate Thresholds	85.7	90.3	85.7	88.7	90.3	88.7	90.3	91.9	88.7	75.8
M Difference in dB (SD)	-1.21 (6.63)	-1.13 (4.65)	-0.97 6.33	-2.34 (7.88)	-2.10 (6.87	-2.90 (9.56)	-2.85 (8.41)	-0.65 (8.32)	-1.37 (9.67)	-3.47 (11.44)
Correlations	0.84	0.91	0.92	0.94	0.96	0.91	0.94	0.94	0.93	0.90
Noise Condition										
Accurate Thresholds	88.7	95.1	91.9	93.5	95.1	93.5	95.1	96.8	91.9	75.8
M Difference in dB (SD)	-1.21 (6.63)	-1.13 (4.65)	-0.97 (6.33)	-1.37 (4.45)	-1.69 (5.58)	-1.37 (4.26)	-1.05 (4.35)	0.40 (5.06)	-0.08 8.32	-2.34 (8.90)
Correlation	0.93	0.97	0.95	0.98	0.97	0.98	0.98	0.98	0.95	0.94

Note: Correlations are between the KUDUwave thresholds for each condition and clinical audiometer thresholds.

Future Research

Further Research is needed to investigate accuracy of:

- Higher Ambient Noise Levels
- Pediatric Testing
- Other Battery Components (bone conduction and speech)

References

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