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Hearing screening in children using DPOAE thresholds and interactive, self-paced behavioural pure-tone thresholds (MAGIC)

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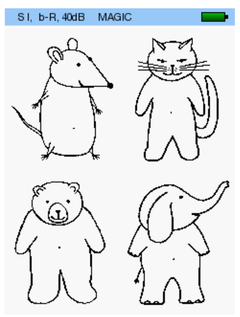
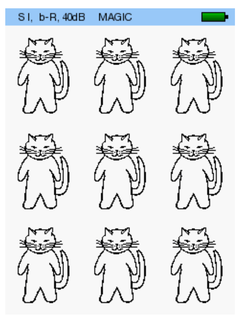
Introduction

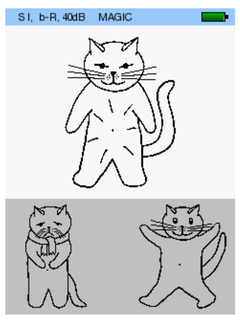
The objective of hearing screening in childhood is to identify hearing impairment that is not obvious or apparent but will cause significant handicap for the child concerned. Late identification may cause problems in communication, language acquisition and affect other areas of development. Contrary to newborn hearing screening, preschool hearing screening tests should provide more frequency-specific and quantitative information on the hearing loss. The purpose of the present study was to investigate the test-performance and the efficacy of a novel hand held device (Sentiero, Path Medical GmbH, Germany) that offers test procedures on both a psycho-acoustical (Heller, 1996; Heller and Opp-Enzinger, 2007) and a physiological base (Boege and Janssen, 2002).

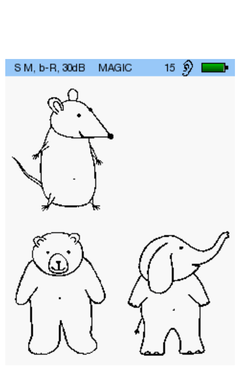
Method

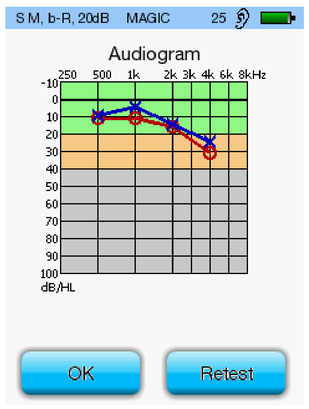
52 children between 4;5 and 10;3 years (mean 6;8 years) participated in the study. The psycho-acoustical test was based on a Multiple-Choice Auditory Graphical Interactive Check (MAGIC). Pure-tone thresholds were determined by selecting animals that “produce” sounds with different frequencies (0.5, 1, 2, 4 kHz) and sound pressure levels. The test run was controlled by the child itself via a touch-screen. After each tone, the child had to indicate if the tone was heard or not by touching either a “happy” or a “sad” animal on the screen of the hand-held device. From the “responses” (heard, not heard) the pure-tone threshold was determined. DPOAE I/O-functions were measured in (17/52) children between 5;5 and 9;3 years at primary tone frequencies f2 of 1.5, 2, 3, 4, and 6 kHz (f2 / f1 = 1.2) and levels L2 between 20 and 65 dB SPL (L1 = 0.4 L2 + 39). DPOAE data can be easily fitted by linear regression analysis in a semi-logarithmic plot (DPOAE pressure pdp over primary tone level L2). The intersection of the regression line with the primary tone level axis L2 served as an estimate of the physiological (cochlear) threshold. After converting SPL in HL, DPOAE thresholds were displayed in an audiogram form where areas of different colours indicate the degree of the hearing loss. For evaluating the reliability of the new tests, MAGIC and DPOAE thresholds were compared to the conventional behavioural pure-tone thresholds (PTA) of the children. Correlation between the measures was determined by linear regression analysis.

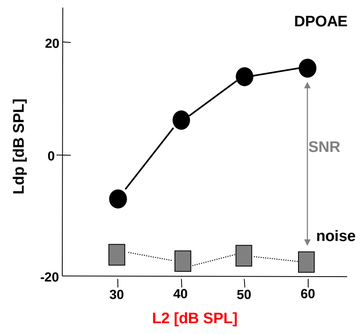


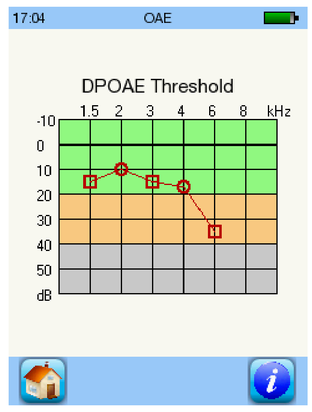


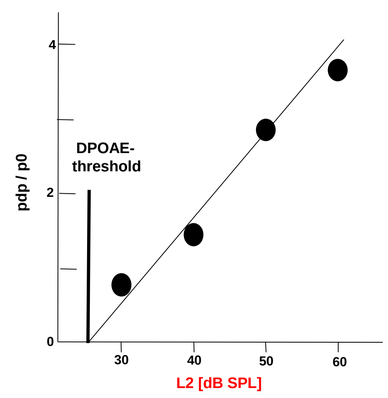




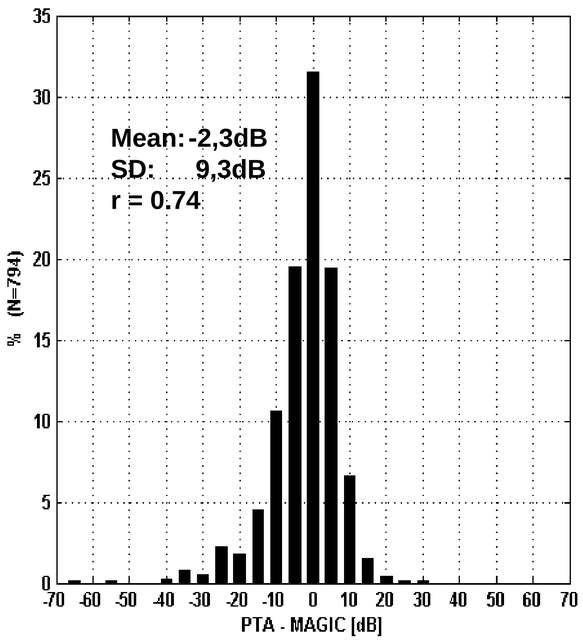








Results MAGIC

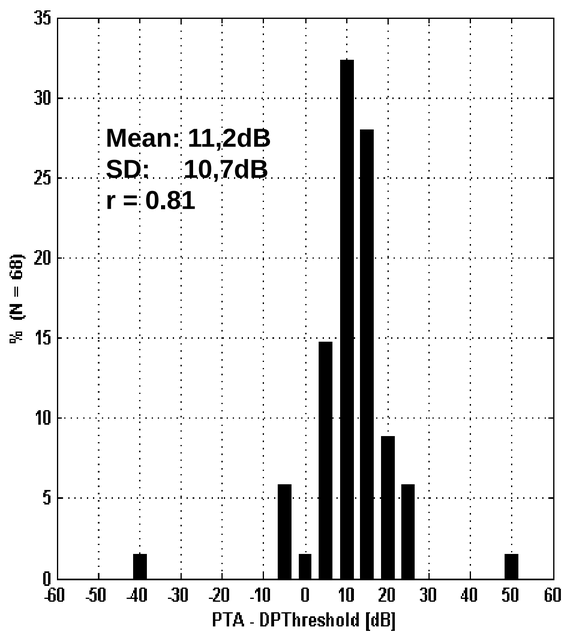


Histogram: Differences between conventional behavioural pure-tone audiometry thresholds (PTA) and MAGIC thresholds

There was a close relationship between PTA and MAGIC thresholds with a mean difference of -2.3 dB and a standard deviation of 9.3 dB. The correlation coefficient amounted to 0.74. In more than 31 % the difference was 0 dB. In almost 90 % the difference was not greater than -10 or 10 dB, respectively.

Test time for obtaining MAGIC thresholds on both ears was on average 4.5 min, which was considerably lower than that for obtaining conventional PTA thresholds.

Results DPOAE Threshold



Histogram: Differences between conventional behavioural pure-tone audiometry thresholds (PTA) and DPOAE thresholds

There was a strong correlation between behavioural und physiological thresholds with a correlation coefficient of 0.81. However, due to some outliers the standard deviation of the difference between PTA and DPOAE thresholds was relatively high being 10.7 dB. Test time per ear for obtaining a DPOAE threshold audiogram was on average 6 min.

Discussion

The close correlation between conventional PTA thresholds and MAGIC thresholds suggests that a reliable threshold estimation is feasible in young children when using a self-controlled image-based test procedure. By using appropriate images (animals) as visual amplifiers the child’s attentiveness can be considerably enhanced. The difference between DPOAE thresholds and PTA thresholds can be explained by the known discrepancy between behavioural und physiological measures in young children. Due to the higher frequency specificity, DPOAE thresholds can asses cochlear hearing loss more precisely than TEOAEs or ABRs. Both tests are easy to handle and provide frequency-specific and quantitative information on both cochlear and central sound processing within a couple of minutes. Both methods are available in a unique hand-held device.

Literature

Boege P., Janssen T. (2002) Pure-tone threshold estimation from extrapolated distortion product otoacoustic emission I/O-functions in normal and cochlear hearing loss ears. The Journal of the Acoustical Society of America 111:1810-1818.
Heller O. (1996) „Hilfen für Hörgeschädigte“, Abschlußbericht BMFT-Projekt (01 VJ 93095), Psychologisches Inst. der Univ. Würzburg, Lehrstuhl III.
Heller O., Opp-Enzinger A.H.A. (2007) Patentanmeldung, Self-paced In-Situ Audiometry, WO 2007/009287 A2, PCT/CH2006/00450.

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