

Abstract

The main purpose of universal newborn hearing screening programs is to identify hearing loss in infants at the earliest stage possible, which can lead to clinical intervention at a very young age (< 3 months). Accordingly, many pre-lingual infants are fitted with hearing aids which allow them to develop communication skills. The validation of the hearing aid fitting is a key procedure, through which it is ensured that the infant is receiving an appropriate amplification, and hence, has access to speech sounds. For infants younger than 8 months, standard audiological measurements (e.g. visual reinforcement audiometry) are highly unreliable since they require active participation of the patient. Sound-field auditory steady-state responses (ASSRs), have been suggested as a potential clinical test for the objective validation of the hearing-aid fitting. This test measures the evoked potential elicited by auditory neurons, which follow the envelope of a periodically repeated stimulus presented through a loudspeaker. The loudspeaker presentation allows a clinician to validate the fitting of the hearing aid under its normal mode of operation. However, when the stimulus is presented in a sound field, its envelope and modulation could be affected due to the reverberation of the test room. This, in turn, can potentially affect the ASSR level that is highly dependent on the stimulus modulation. At the start of this project, a proper characterization of the effect of the room on sound field ASSR measurements was lacking, which is crucial for assessing the clinical viability of the test for hearing aid fitting validation.

This PhD project explored how room acoustics affects sound field ASSR measurements, and the practical implications for its potential clinical implementation. Throughout this thesis, it is shown that the room has a detrimental effect on the ASSR level. This reduction in the level leads to longer detection times and could result in lower detection rates when the testing time is limited. The assessment of 31 state-of-the-art audiometric testing rooms conducted in this project revealed a large variability of the acoustical conditions across rooms as well as between testing positions within the rooms. The effect of the room acoustics was systematically investigated in loudspeaker-based virtual acoustic environments using accurate acoustic simulation. Moreover, the inclusion of a nearby loudspeaker within the reproduction system to faithfully account for the short source to receiver distance (1 m) required for sound field ASSR measurements was validated. The results of the project showed that despite the large acoustic variability across audiometric testing rooms, sound field ASSR measurements could be generally conducted in the existing acoustic environments. However, care should be taken when selecting the room and testing positions for sound field ASSR measurements, since the detrimental effect of the room on the ASSR level can compromise, in some cases, the clinical viability of the test. It was also demonstrated that the room-induced variation

in ASSR level could be predicted using two room acoustic descriptors: the early decay time and a proposed auditory-model-inspired relative modulation power metric. Both descriptors can be measured in situ and could be used for determining whether the room is suitable for sound field ASSR. This, in the long term, could be implemented as part of a calibration protocol for sound field ASSR in the clinics.