

LETTER TO THE EDITOR

Introducing a modified algorithm for enhanced operator independency in auditory steady-state responses (ASSR) testing

Presentazione di un algoritmo modificato per una maggiore indipendenza dell'operatore nei test delle risposte uditive allo steady-state (ASSR)

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Dear Editor,

Auditory steady-state responses (ASSR) are used to objectively assess the hearing thresholds of a given individual. Their value stems from reliably indicating the actual hearing levels (HLs) in four main frequencies (500 Hz, 1000 Hz, 2000 Hz, 4000 Hz), by obtaining a valid estimated audiogram through the use of statistical measures ¹. Since mathematical prerequisites should be fulfilled in order for brainstem responses to be transformed into estimated HLs, ASSR are largely considered to be operator-independent.

Nevertheless, the “extended-time” value represents an operator-dependent parameter, which may relativise the independence of ASSR testing on the basis of the operator’s experience or even wish. Indeed, the examination time is set to six minutes per examined frequency and HL in each ear. Whenever the stimulus curve reaches 100% certainty, it turns green (positive outcome) and the operator lowers the stimulus by 10 dB. If the curve remains under 100% by the end of the examination time, the outcome is negative, yet the examiner may choose to extend the test by one minute, assuming that a positive outcome is likely to occur, and perform this time-extension repeatedly. This introduces an obvious intervention to the operator-independency of the test, with potential impact on the results obtained.

We propose a standardised operator-independent protocol regarding the “extended-time” value, in which, whenever the curve of the stimulus reaches 80% certainty, the testing time is extended by one minute once, and whenever the curve of the stimulus reaches 90% certainty (or above), the testing time is extended by one minute, for as long as the curve remains above 90%, and stops, when the curve reaches 100% certainty, or drops below 90%. The proposed protocol was tested in a cohort of 47 hearing-impaired individuals ² (age-range 14-85 years old ³) in a soundproof chamber, with 40 Hz stimulus-rate CE-chirp[®] sounds given through insert phones. The correlation between pure-tone audiometry (PTA) and ASSR measurements was performed using the intra-class correlation coefficient (ICC 1,1) (Tab. I). Statistical importance was accepted at the 0.05 level of significance.

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Conflict of interest

The Authors declare no conflict of interest.

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Table I. Correlation of ASSR estimates to actual PTA measurements.

Ear	Frequency	PTA-ASSR	PTA-ASSR _{WET}	p-value
Right	500 Hz	0.922 (0.86-0.96)	0.875 (0.78-0.93)	0.075
	1000 Hz	0.901 (0.83-0.95)	0.829 (0.71-0.90)	0.021
	2000 Hz	0.904 (0.83-0.95)	0.845 (0.74-0.91)	0.049
	4000 Hz	0.917 (0.85-0.95)	0.895 (0.82-0.94)	0.384
Left	500 Hz	0.901 (0.83-0.94)	0.856 (0.75-0.92)	0.127
	1000 Hz	0.914 (0.85-0.95)	0.823 (0.70-0.90)	0.003
	2000 Hz	0.943 (0.90-0.97)	0.863 (0.77-0.92)	0.001
	4000 Hz	0.890 (0.81-0.94)	0.825 (0.70-0.90)	0.044

WET: without extended time.

* a correction factor according to the manufacturer specifications was applied in both protocols.

As shown in Table I, the ASSR results, obtained with the proposed algorithm, seem to reflect the PTA thresholds in a more accurate manner, compared to a protocol with no time-extension beyond the 6 minutes. Indeed, the correlation reliability in the proposed protocol was excellent in all frequencies of both ears, except 4000 Hz in the left ear which rated good, compared to the latter protocol, in which all frequencies had merely good correlation reliability⁴. The correlation differences between the two protocols were statistically significant in the frequencies of 1000 Hz and 2000 Hz in both ears, and 4000 Hz in the left ear. Interaural differences may be attributed to internal jittering caused by neurologic asynchronicity, and have also been described in the past^{5,6}.

Hence, not only the results obtained with the proposed algorithm demonstrate closer correlation to the PTA thresholds, they also preserve the operator-independency of ASSR testing. Maintaining operator independency is inherent to the reliability of ASSR testing, irrespective of the potential nobility of the operator's motive to intervene.

Ethical considerations

The research protocol was submitted, and received ethical

approval by the Ethics Committee of the University of Athens, prior to commencing data collection. Participants (or legal guardians) were asked to sign a consent form before being enrolled in the study.

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