

Strong modulation is observed in 2f₁-f₂ DPOAE with f₂/f₁~1.2 and stimuli >60dB SL. This is due to interference between comparable amplitude place and wave-fixed sources. Interference can also result from internal multiple reflections of the DP even in the presence of strong primary stimulation because at this wider primary spacing DP frequency specific reflector sites are not within the suppression range of the primaries.

948 Group Delays and Production Mechanisms for Tone-burst Evoked OAEs in the Guinea Pig

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In mammals, acoustically evoked otoacoustic emissions (OAEs) are thought to arise from two different mechanisms: nonlinear wave-related distortion and linear place-fixed reflection. Broader basilar-membrane excitation patterns in the guinea pig (smaller Qs than humans - see Shera et al., 2002) suggest that nonlinear distortion may play a greater role in the production of stimulus-frequency OAEs than it does in humans. Tone-burst evoked OAEs were measured in the guinea pig to determine both their group delays and the relative contribution of reflection- and distortion-sources to the total OAE. Group delays were measured using amplitude modulated tone-burst evoked OAEs by computing the envelopes of the stimulus and emission waveforms with the Hilbert transform, fitting each envelope with a sine function, and determining the time shift between the respective sinusoids. The contribution of each emission mechanism to the total OAE was determined by unmixing the two emission types using Fourier analysis and time-domain windowing. The results suggest:

i. Group delays for OAEs evoked by 18 kHz stimuli are consistent with a round-trip delay based on comparison with basilar-membrane delay measurements.

ii. A more complex interaction between the two emission mechanisms than is observed in humans, in which tone-burst evoked OAEs appear dominated by a linear reflection mechanism.

949 Multi-component Distortion Product Otoacoustic Emissions in the Leopard Frog, *Rana pipiens*

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It is currently thought that basilar membrane (BM) vibrations are boosted by an active feedback mechanism [1]. Although the absolute contribution of this mechanism to basilar membrane vibration increases with increasing stimulus intensity, its relative contribution is highest at low stimulus levels [2]. Consequently, distortion product otoacoustic emission (DPOAE) characteristics at low stimulus levels are mainly determined by the active feedback mechanism, while at high stimulus levels DPOAEs are determined by the passive mechanical properties of the BM. In frogs no cochlea is present. Instead, the inner ear holds two papillae specialised in detecting airborne sound. These papillae are not over a BM. Also, hair-cell length changes have never been shown, and are unlikely to be present in frogs. The absence of both a BM, and of hair-cell length changes as an active feedback mechanism in the frog inner ear might give rise to different DPOAE input-output curves as compared to those found in the cochlea.

Here we report on DPOAE recordings performed in the leopard frog, *Rana pipiens*. DPOAE input-output functions recorded from the amphibian papilla (AP: f₁< 1.4 kHz) as well as the basilar papilla (BP: f₁=1.5-2.5 kHz) consisted of two regions separated by a notch around

70-75 dB SPL stimulus level. As in the cochlea, high-level DPOAEs (above the notch), reflect the passive emission component, while low-level DPOAEs (below the notch) seem to be dominated by an 'active' component. A model, based on the mechano-electrical properties of hair cells [2], which seems applicable to the 'simple' BP, can not explain the phase behaviour of the DPOAE input-output curves found in this study.

Supported by NWO and the Heinsius Houbolt Foundation

[1] Gold, T (1948). Proc. R. Soc. E. B135, 492-98

[2] Lukashin, AN, Lukashina, VA, Russell, IJ (2001). JASA 111(6), 740-48

950 Do DPOAEs Require Low Stimulus Levels or Intact Cochlear Feedback to be Frequency Specific?

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It is widely held that distortion-product otoacoustic emissions at 2f₁-f₂ (DPOAE) are generated where maximum interaction occurs between stimuli, i.e., likely close to the place tuned to f₂, thus exhibiting large frequency specificity. Accordingly, impaired cochleae with well-defined transitions from normal to damaged places often exhibit DPgrams (i.e., plots of DPOAE levels against f₂) with clear-cut roll-offs showing good correlations with audiogram roll-offs. It suggests that DPgrams afford interesting mapping capabilities, but actually, it is surprising because DPOAEs are usually derived from rather high-level stimuli, which should show some degree of smearing on the basilar membrane - even more so in a damaged, poorly tuned cochlea. Thus, one would expect that the notch of a pathological DPgram would appear increasingly blurred with increasing stimulus OHC damage, owing to the resulting loss of tuning sharpness. In order to explore this issue, mice and gerbils with high-frequency cochlear dysfunction either due to genetic impairment of basal OHCs or exposure to a loud high-frequency tone, were explored with the help of cochlear potentials and DPOAEs. The levels of DPOAE-eliciting stimuli were increased stepwise from 40 to 80 dB SPL and the limit frequencies separating normal from decreased DPOAE or cochlear potential responses were compared: they were similar regardless of stimulus level. The next step consisted of administering furosemide or inducing ischemia in the already impaired animals so as to decrease their endocochlear potential, thereby turning off the OHC-based cochlear loop ensuring the gain and frequency selectivity of basilar membrane movements. As expected, DPOAEs elicited by stimuli below 60 dB SPL vanished at all frequencies instead of remaining present at low frequencies. Yet, the boundary between the interval with initially impaired OHCs and the lower-frequency one not only reappeared, but also looked sharper with increasing stimulus level from 65 dB SPL on up. However, it could shift downward by about 1 kHz. It suggests that instead of relying upon the existence of an intact cochlear feedback loop, the frequency-specific presence of DPOAEs is ensured by the integrity of a nonlinear element in OHCs, this element showing both tuning and lack of sensitivity to furosemide (stereocilia would be good candidates).

951 Post-mortem Distortion Product Otoacoustic Emission in the Leopard Frog

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Distortion product otoacoustic emission measurements were performed in the leopard frog, *Rana pipiens*. Animals were sacrificed by destruction of the CNS (double-pith procedure) or by cardioectomy. The time course of emission decay was monitored by measuring DPOAE input-output functions for stimulus frequencies in the amphibian papilla frequency range (f₁=1011 Hz, f₂/f₁=1.1), and in the basilar papilla frequency range (f₁=2011 Hz, f₂/f₁=1.1). Input-output curves consisted of two parts, separated by a knee point near 70 dB SPL input level.