A Filterbank Model for Echo Delay Estimation in Biosonar.

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Abstract: In a jittering-echo task, big brown bats achieve an echo-delay acuity of 10-20 ns (40 ns at echo signal-to-noise ratio of 36 dB). To understand the origin of this unusually fine acuity, a filterbank model of transduction in the bat's peripheral auditory system was developed and tested in Monte Carlo simulations to determine its delay accuracy and test its acuity in a jittering-echo paradigm at different signal-to-noise levels. Several versions of the filterbank model were tested to learn how the model's smoothing filter affected performance. When tested at an echo signal-to-noise ratio of 36 dB, the best filterbank delay-estimation method had a jitter threshold of 75 nanoseconds. To achieve 15 nanoseconds, this method required an echo signal-to-noise ratio of 50 dB and the use of a 2nd order lowpass smoothing filter with a cutoff frequency of 8 kHz. Jitter thresholds for filterbank models with either a lower cutoff frequency or a higher order were more than an order of magnitude worse than the behavioral threshold. These results predict that the smoothing filter for echolocating bats may have a higher cutoff frequency and shallower slope than typical mammalian values.

0-933957-31-9