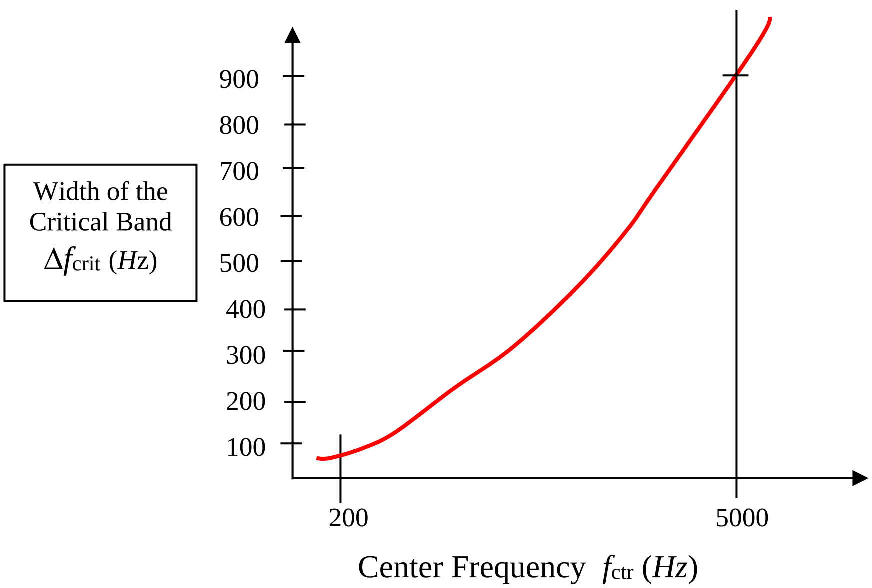
<u>The Critical Band</u>:

Two pure-tone sounds, which are slightly different in frequency f_1 and f_2 are *<u>not</u>* heard as <u>separate</u> notes by a <u>single</u> human ear if they are <u>too</u> close together in frequency.

<u>Reason</u>: The mechanical vibrational behavior of basilar membrane, and the firing & wiring of hair cells ⇒ auditory nerve has <u>finite</u> <u>bandwidth</u> associated with each…

The sound of a particular frequency produces a traveling wave - which propagates along the basilar membrane. The pressure amplitude of this wave propagating in the perilymph fluid is *<u>not</u>* a constant - it <u>peaks</u> somewhere along the basilar membrane; the position of <u>where</u> it peaks depends on <u>frequency</u> of sound wave in the perilymph fluid (see lecture notes above). The pressure amplitude of this wave is not infinitely sharply peaked at this location, the <u>disturbance</u> produced by the wave is *<u>spread out</u>* over a certain length of basilar membrane – *i.e.* it has a finite spatial extent/width along the basilar membrane.

The hair cells/nerve endings on the basilar membrane are excited over a narrow region on either side of maximum amplitude of motion of basilar membrane. The range or band of frequencies affected is known as the ***<u>critical band</u>***. At center frequencies of $f_{ctr} \le 200\ Hz$, the <u>width</u> of the critical band is ~ constant at $\Delta f_{crit} \sim 90\ Hz$ (*n.b.* $\Delta f_{crit} / f_{ctr} \sim 50\%!$), above this frequency, the width of the critical band increases ~ linearly to $\Delta f_{crit} \sim 900\ Hz$ @ $f_{ctr} \sim 5000\ Hz$, ($\Delta f_{crit} / f_{ctr} \sim 20\%$) as shown in the figure below:



n.b. The <u>width</u> of the critical band is *<u>also</u>* dependent on sound intensity.

This effect is ONLY for ONE ear – i.e. a monaural effect. It does *<u>not</u>* exist if one frequency f_1 is input to one ear, and *e.g.* another/different/nearby frequency $f_2 \sim f_1$ is input into the other ear (this doesn't happen often in nature through…). The human brain is able/capable of processing <u>binaural</u> sound information to distinguish two (or more) closely-spaced frequencies, significantly better than <u>monaural</u>-only information of the same kind/type.

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