<u>Firing of Auditory Nerve Fibers</u>:

~ 95% of the auditory nerve fibers (type I) are connected to the ~ 4000 inner hair cells. Each type I axon innervates only a single hair cell, but each hair cell directs it output up to ~ 10 type I auditory nerve fibers. The type I auditory nerve fibers are bipolar and are *mylenated* (*i.e.* have a nerve sheath – this protects the nerve fiber and also increases the transmission speed of action potentials along nerve fiber by up to ~ 300× over non-mylenated nerves – evolutionarily very important – for our auditory startle reflex!). ~ 5% of the auditory nerve fibers (type II) are connected to the ~ 12000 outer hair cells, are monopolar and are not mylenated.

Each auditory nerve fiber responds over a certain range of frequency and sound pressure, and has a characteristic frequency f_C at which it has maximum sensitivity. Auditory nerve fibers having high characteristic frequency have a rapid roll-off in response above their characteristic frequency f_C, however, they have a long "tail" in response below it.

A 90 *dB* sound stimulus with a single frequency, *e.g.* $f = 500$ Hz induces voltage signals on *several* adjacent nerve fibers associated with the frequency band centered on 500 Hz. The time between successive voltage signals on an auditory nerve fiber almost always corresponds to one or two or more periods $\Delta t = \tau = 1/f$ of the frequency, firing on the peak of a vibration cycle. An axon of a nerve fiber does not fire at the peak of *every* vibration cycle of the basilar membrane, but it rarely fires at any other time in the cycle. When two or more complex tones are present, things get a bit more complicated, however the pattern of electrical signals from the auditory nerves firing still carries accurate information about the frequency spectrum of the complex auditory/tonal stimulus.

A complex auditory stimulus of two pure tones C_4 (523 *Hz*) and C_5 (1046 *Hz*) – *i.e.* an octave apart – do not have much overlap in terms of auditory neural tuning curves (*i.e.* frequency response curves) as shown in the figure (a) below, because very few hair cells respond to *both* of these frequencies. However, as the interval between the two pure tones decreases, the situation changes – more and more overlap occurs, an increasing number of hair cells are stimulated by both tones, as shown in figures (b) and (c), leading to many interesting phenomena.

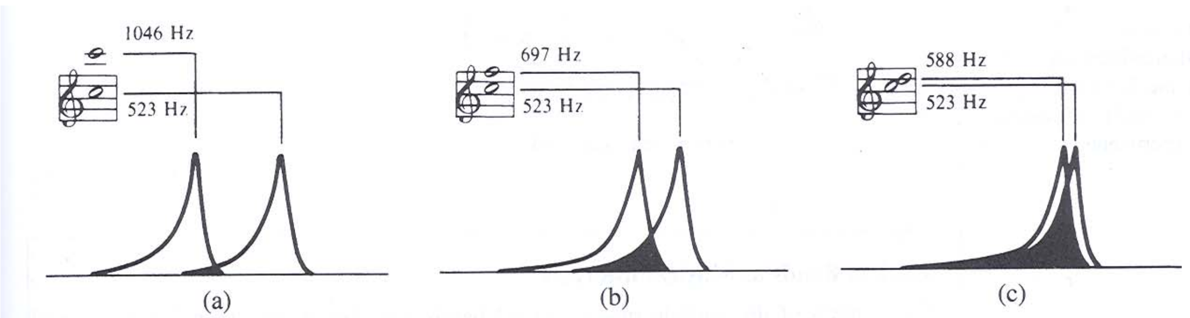

FIGURE 5.9 Frequency response curves for pairs of pure tones. As the interval between them decreases, their response curves show increasing overlap.