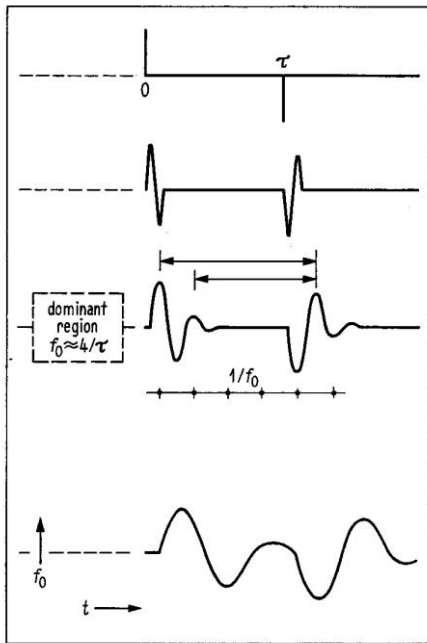


A time- and frequency-domain prediction of repetition pitch

In the upper figure (Fig.11c from Bilsen and Ritsma, *Acustica* 22, 1969/70, 63-73), impulse responses mimicking cochlear mechanics are sketched for a heterophasic pulse pair with time interval τ (upper panel) after bandpass filtering for three different center frequencies f_0 (lower panels). For each f_0 ,



itches are predicted by the reciprocal value of the time interval between prominent positive peaks (see arrows).

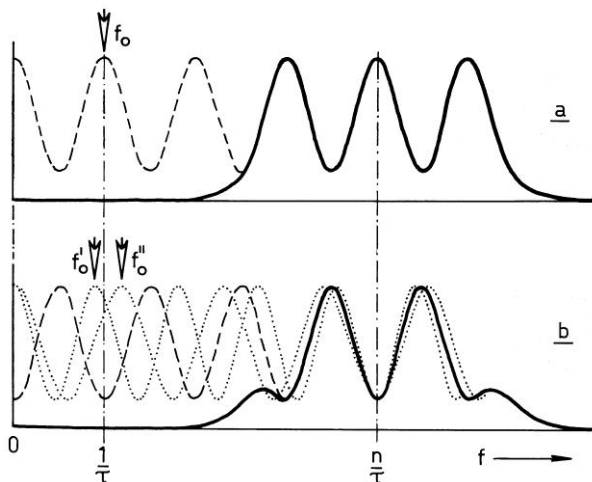
In formula:
$$RP = \frac{1}{\tau \pm \frac{1}{2f_0}}$$

Specifically, for the dominant spectral region ($f_0 \approx 4/\tau$) this simplifies to
$$RP = \frac{1}{\tau(1 \pm \frac{1}{8})}$$
 (Eq.1)

In other words: two ambiguous pitches are predicted corresponding to either $RP = \frac{0.89}{\tau}$ or $RP = \frac{1.14}{\tau}$.

These predictions were confirmed by the results of various pitch matching experiments by Bilsen, Fourcin, Yost, and others (see list of references)

Additionally and alternatively, in the lower figure (Fig.7 from Bilsen, *JASA* 61, 1977, 150-161) power spectra of a homophasic pulse pair (panel a) and a heterophasic pulse pair (panel b), filtered in the dominant region, are represented by the solid lines. In case a, a pitch RP indicated by the arrow labeled f_0 (Note that f_0 has a different meaning in the foregoing figure) is predicted. In case b, two



ambiguous pitches (f'_0 and f''_0) are predicted by the best fitting harmonic comb spectra (indicated by dotted lines). Such a spectral matching process, performed somewhere in the brain, can be summarized by the following expression (equal minima at $\frac{n}{\tau}$)

$$\left(n \pm \frac{1}{2}\right) RP = \frac{n}{\tau}$$

With $n = 4$ (dominant region) as sketched, this simplifies to
$$RP = \frac{1}{\tau(1 \pm \frac{1}{8})}$$
 (Eq.2)

In conclusion: the time-domain model (Eq.1) and frequency-domain model (Eq.2) deliver identical formulas and thus predict identical pitch matching results. Further, note that for signals like noise plus itself delayed, impulse responses can be replaced by autocorrelation functions, for which a similar reasoning applies. A choice for either model (in fact Fourier pairs) has to depend on further psychophysical or physiological data and arguments.