of as the "spectrum" of $\log[X(\omega)]$; correspondingly, the time-axis for $\hat{x}[n]$ is referred to as "quefrency," and filter $l[n]$ as the "lifter." Rather than transforming to the quefrency domain, we could have directly convolved $\log[X(\omega)]$ with the Fourier transform of the lifter $l[n]$, denoted as $L(\omega)$. The three elements in the dotted lines of Figure 6.10b can then be replaced by $L(\omega)$, which can be viewed as a smoothing function:

$$\hat{Y}(\omega) = L(\omega) \circledast \log[X(\omega)] \tag{6.14}$$

which is illustrated in Figure 6.10c and where $\circledast$ denotes circular convolution.

With this spectral smoothing perspective of homomorphic filtering, one is motivated to smooth $X(\omega)$ directly rather than through its logarithm. An advantage of smoothing the logarithm, however, is that the logarithm *compresses* the spectrum, thus reducing its dynamic range (i.e., its range of values) and giving a better estimate of low-energy spectrum regions after smoothing; without this "dynamic range compression," the low-energy regions, e.g., high-frequency regions in voiced speech, may be distorted by leakage from high-energy regions, e.g., low-frequency regions in voiced speech (Figure 6.11). In a speech processing context, the low-energy resonances and harmonics can be distorted by leakage from the high-energy regions. The logarithm is simply one compressive operator. In a later section we explore spectral root ho-

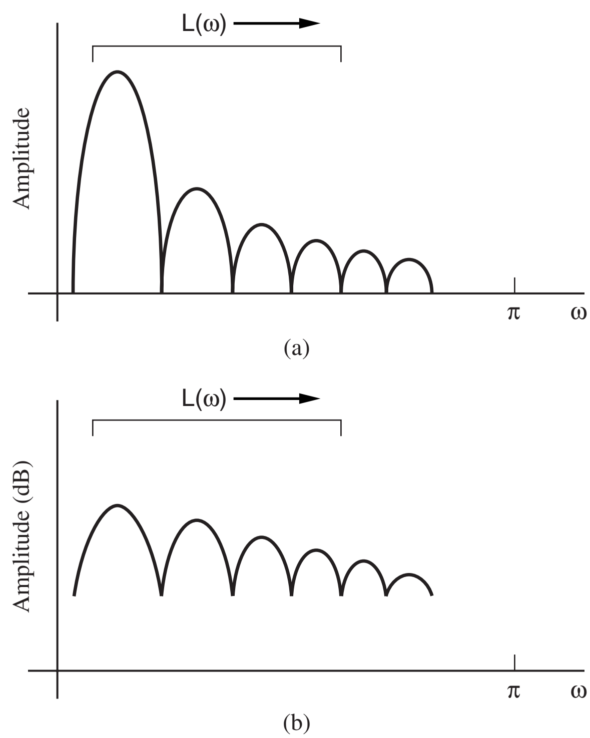

Figure 6.11 Schematic of smoothing (a) a harmonic spectrum in contrast to (b) the logarithm of a harmonic spectrum.