The relationships between typical speech input levels and Contour data for warble tones have been derived at several frequencies for normal-hearing listeners. It is assumed that optimal amplification would restore these loudness relationships for a hearing aid wearer. The VIOLA facilitates the choice of hearing aid parameter values that will achieve this goal.

- The hearing-impaired individual's Contour data for two dispenser-chosen test frequencies (typically one low and one high) are entered into the computer program which then displays a graphical comparison of (1) soft, comfortable, and loud perception ranges (horizontal shading) and (2) the input levels of soft, average, and loud speech (vertical dotted lines).
- The dashed diagonal line depicts zero gain. A filled square indicates the target value for a given speech input level. The difference between the diagonal line and the target value gives the target gain for that speech input level at the test frequency.
- The dispencer's task is to construct input/output functions for the two frequencies that (1) approximate the goals and (2) can be realized with an available hearing instrument.

Parameters for input/output functions (low level gain, compression threshold, compression ratio, maximum output) are entered by the dispenser. Corresponding I/O functions are displayed for comparison with the target values. Up to three I/O functions can be displayed on each graph simultaneously. The hearing aid with the best-fitting I/O function is identified using trial and error methods.

### 3. Dynamic Range Assessment

A complete contour map, expressed in ear canal sound pressure levels, can serve as the underpinning for evaluation of a fitting.

- Hearing-aid processed speech is recorded in the ear canal via a probe microphone and computer-based analysis is used to assess its dynamic range. This process can be repeated under various conditions of amplitude compression.
- The short-term speech amplitudes can then be compared with the Contour map to evaluate the likely acceptability of soft, normal, and loud speech.
- Laboratory data suggest that, for comfortable listening, the 1% peaks of speech should approach, but not usually exceed, the "loud but OK" category (category 6).

Examples are shown below.
- **Dotted lines** = loudness contours.
- **Solid lines** = 1%, 40%, and 80% exceedance levels for hearing aid processed speech. (The 1% exceedance level = the level that is exceeded 1% of the time).
- **Frequency response has been shaped so that the 1% levels approach but do not exceed category 6.**

The upper figure illustrates the result of linear processing. Note that, below 1000Hz, most of the speech energy is available to this listener. However, above 1000 Hz, only the top 40% of speech is above threshold.

The lower figure shows the effect of compressing the speech using a low compression threshold (about 60dB), and a fast release time (about 250ms). Note that speech is still fully audible below 1000Hz but now considerably more of the high frequency speech information is also above threshold.