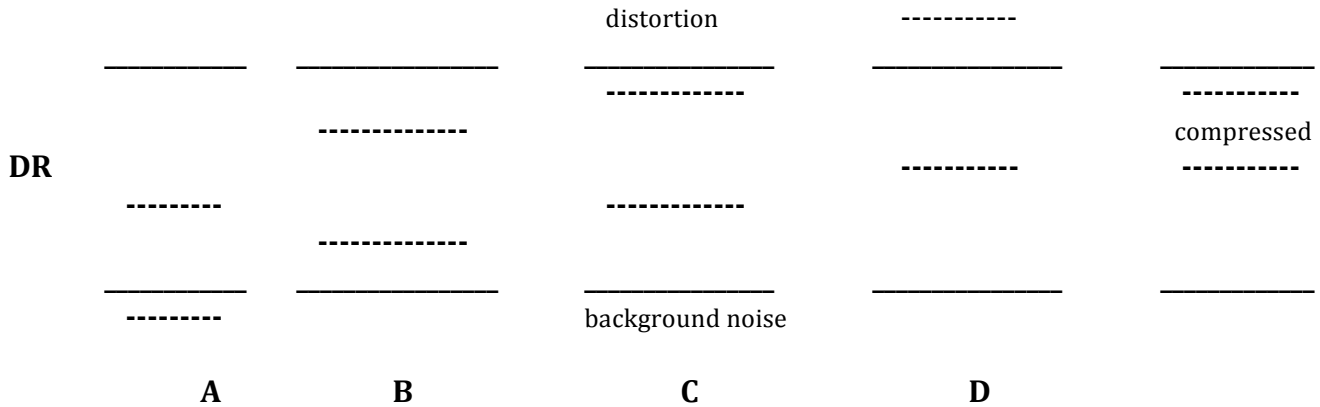# DYNAMIC RANGE AND COMPRESSION

Dynamic Range (of a sound or an audio medium) DR
- intensity levels from lowest to highest; background noise to peak levels below distortion
- does the DR of a sound "fit" into the DR of a medium
- proper record levels allow the signal-to-noise ratio (**SNR**) to be maximized without distortion by riding the signal high within the DR of the medium

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                              distortion           -----------

_____    _____    _____    _____    _____
                              ------------                   -----------
              -------------                                  compressed
DR                                           -----------     -----------
    ---------                  ------------
              -------------

_____    _____    _____    _____    _____
    ---------                background noise

        A           B               C               D
```

Higher levels of compression not only reduce the DR, but also allow the signal to be boosted in order to maximize apparent loudness.

In an analog medium, there may be "headroom" above the 0 VU level for momentary peaks; theoretically there is no such headroom in digital audio due to the means by which digital values are represented.

However, the digital medium has a larger dynamic range than analog, e.g. each binary bit adds 6 dB of DR, therefore a bit depth of 16 bits has a theoretical DR of 96 dB (but more like 90 dB in practice, since the lowest bit (0 or 1) is noise; by comparison good quality analog tape might have a DR of 60 dB; cassette tape 50 dB; optical film soundtracks maybe 30 dB; whereas the human range of hearing is around 120 dB (but auditory threshold shifts reduce what we experience at any moment).

Functions:
LIMITER: prevents peaks from exceeding maximum distortion free level (∞ : 1)
COMPRESSOR: reduces dynamic range by a ratio other than 1:1 (linear); the ratio represents the input to output ratio; gentle ratios are 2:1 to 5:1; "tight" ratios 10:1 and above
EXPANDER/GATE: reduces levels below the threshold such that the dynamic range is expanded by ratios such as 1:2 to 1:20 or more; a gate eliminates low level sounds (1: ∞)
COMPANDER: compressor plus expander

Variables:
Threshold: level above which (compression) or below which (expander) levels are affected
Attack Time: the time to bring gain control into effect
Release Time (Decay): the time to remove gain control