Monaural and dichotic effects of real-room reverberation on loudness perception

Andrew P Raimond | Anthony J Watkins

Background

Stecker & Hafter (2000) found that short sinusoids shaped with fast-onset and slow-off temporal envelopes, "FS sounds", are judged to be less loud than their time-reversed counterparts, "SF sounds". The excitation-pattern model of Glasberg & Moore (2002) accounts for this loudness difference. However, the loudness difference is more apparent when the sounds to be judged are each preceded by FS sounds than when they are preceded by SF sounds. This "context effect" might be due to the resemblance of these sounds' offsets to the decaying 'tails' caused by the reflected sound in everyday listening environments (Stecker & Hafter, 2000). The idea is that when successive sounds have similarly long tails, a 'perceptual constancy for room listening' is more apparent when these sounds' offsets to the decaying 'tails' caused by the reflected sound in everyday listening environments. Energy in a decaying tail might thereby be discounted from loudness assessments if listeners judge only the source.

Previously, we have found a similar context effect with dichotic sounds that have tails from real-room reflections. These tails are relatively long in duration, and they are de-correlated at the two ears. This result confirms the idea that a perceptual constancy for room listening-conditions is likely to be responsible for the loudness context effect.

Certain-room reflection 'tail effects' that have been found in speech perception experiments are increased in monaural conditions (Watkins, 2005). Here we ask whether the loudness context effect is also increased when sounds are presented in monaural-room reverberation.

FS and SF pairings

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Experiment

On a trial, listeners seated in a soundproof chamber were presented with a two-interval relative-loudness judgment (2IC). The BRIRs were convolved with function gated stimuli in such a way that the time-direction of the function-gated tail was the opposite of the BRIR's tail. Hence, SF stimuli were convolved with forwards BRIRs, and FS stimuli were convolved with reversed BRIRs. The three factors were:

- Real-room FS with SF pairings
- Real-room SF with SF pairings
- Real-room FS with FS pairings

The excitation pattern is that of Subjective Equality. The loudness function for the real-room FS with SF pairings over headphones, to which they responded with a loudness judgment (2IC).

Preparation Test Identifying room loudness

Figure 4. BRIR recorded in a real-semitone-room with a distance of 2.5 m between source and listener, giving a ratio of early (50 ms) to late energy of 9.7 (dB). (C4, left ear, A-weighted).

Figure 3. BRIRs were convolved with function gated stimuli in such a way that the time-direction of the function-gated tail was the opposite of the BRIR's tail. Hence, SF stimuli were convolved with forwards BRIRs, and FS stimuli were convolved with reversed BRIRs. The three factors were:

- Real-room FS with SF pairings
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The excitation pattern is that of Subjective Equality. The loudness function for the real-room FS with SF pairings over headphones, to which they responded with a loudness judgment (2IC). The loudness context effect is obtained with the real-room FS with SF pairings for all presentation configurations. This context effect is substantially increased in the monaural conditions.

Conclusions

Effects of the real-room tails successfully oppose effects of the function-gated tails, as there was a substantial context effect that depended on the direction of the real-room tail. As with "tail effects" in speech, this context effect is found in both monaural and dichotic conditions, but is less prominent in dichotic conditions. There appears to be a "dereverberation" in dichotic conditions that may be due to the de-correlation between the two ears' signals with the real-room BRIRs.

References


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