

Auditory Distance Perception with Congruent & Incongruent Cues

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Distance perception: Main cues

- Multiple cues (for a review, see Zahorik et al., 2005)
- **Intensity cue** - familiarity (Warren, 1999)

Main intensity-independent cues (Kopčo et al., 2012)

Interaural Level Differences

- Binaural
- Anechoic (& reverberant?) space (Brungart, 1999)

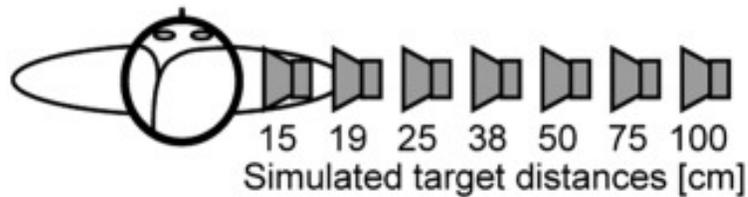
Direct-to-Reverberant Ratio

- Binaural or monaural ? (Larsen et al., 2008)
- Reverberant space (Kopčo et al., 2012)

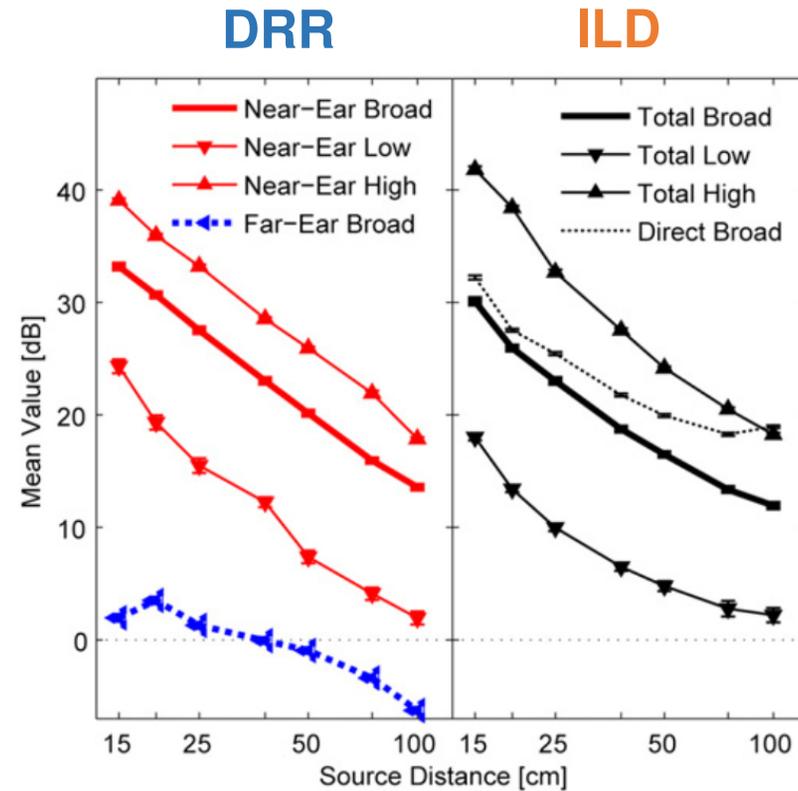
Adaptation to rooms (Shinn-Cunningham, 2000)

Which cue is more important in reverberation?

Previous evidence: Acoustic analyses



The main cue:
monaural near-ear **DRR**
Kopčo & Shinn-Cunningham (2011)

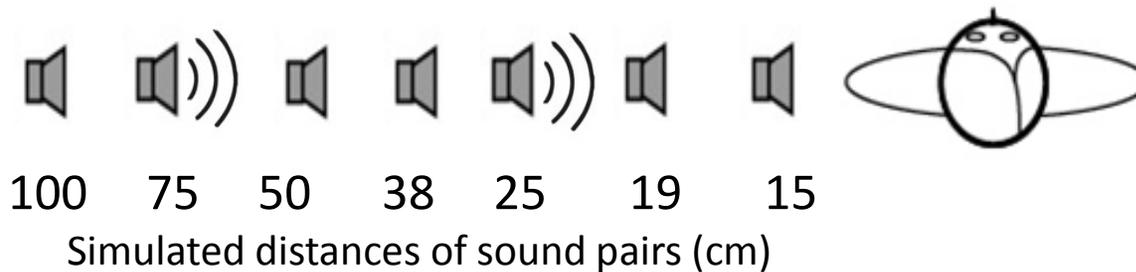


Current study

- Study intensity-independent distance perception of broadband nearby sounds in reverberation
- **Cue weighting: ILD vs DRR**
- **Stimulus presentation:** monaural - binaural - diotic
- **Context & *a priori*** experience
- **Incongruency** effect

Distance discrimination task

- virtual reverberant environment
- nonindividualized BRIRs recorded in a small classroom (Shinn-Cunningham et al., 2005)
- 2 consecutive sounds presented at varying distance



Sounds:
Broadband noise bursts
ISI = 1s

- **Task:** Which of the sounds is closer to the listener?
Ignore how loud the sound is.

Task conditions

Stimulus direction:

- lateral or frontal
- for lateral, presentation: binaural, monaural, diotic

Intensity cue elimination:

- overall level normalization + 6-dB rove

Distance cue manipulation:

- **ILD** or **DRR** cue removed
- **ILD** & **DRR** presented incongruently

ILD
+
DRR



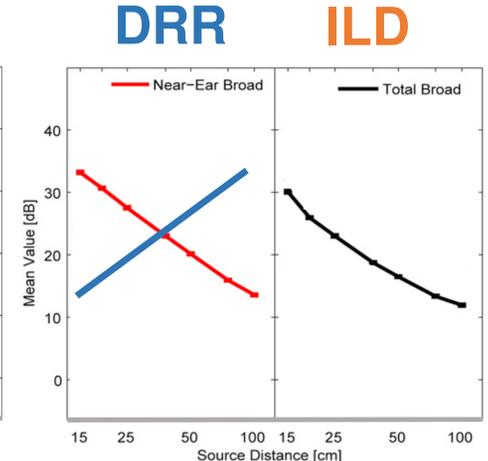
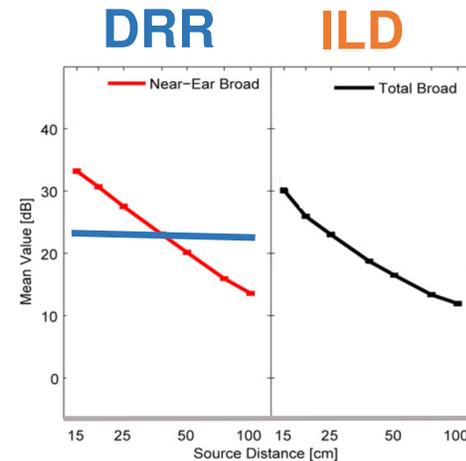
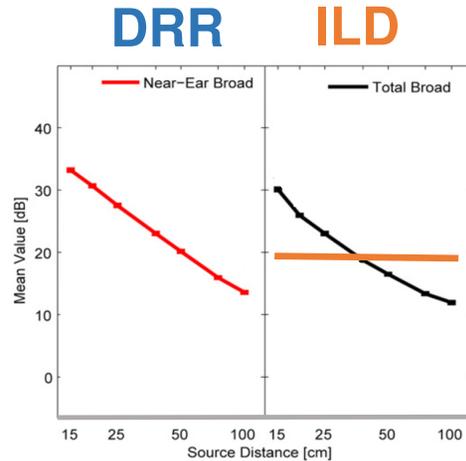
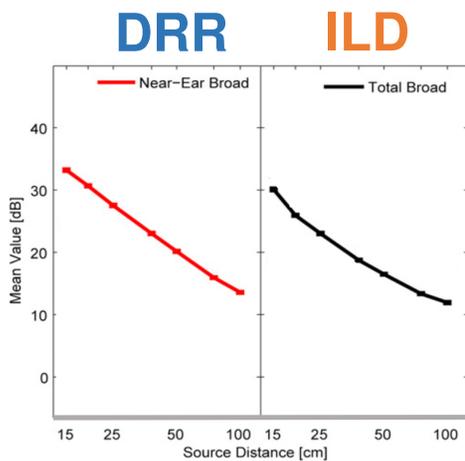
DRR



Cue manipulation

Availability

Congruency



Congruent condition

DRR-only condition

ILD-only condition

Incongruent condition

Performance evaluation

Signal detection theory model

σ [ln (cm)] sigma estimation
listener's sensitivity to distance changes
smaller sigmas = better performance

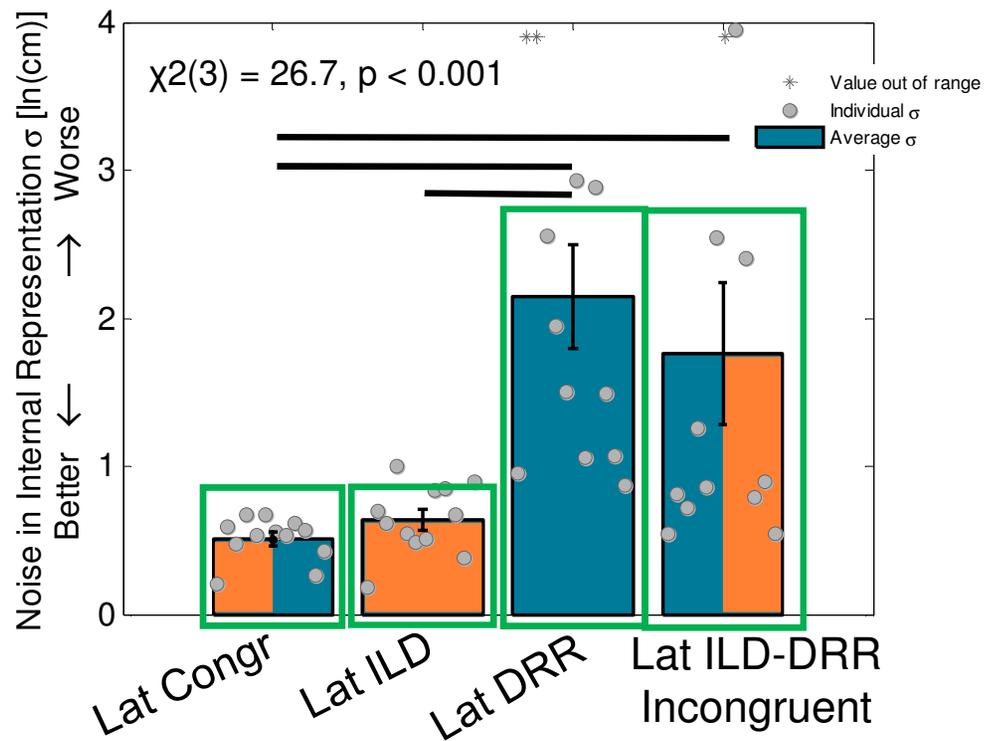
ILD
+
DRR



DRR



Exp 1: **ILD** & **DRR** Cue Weighting



Only LATERAL source

Cue availability balanced between ILD & DRR

Distance perception:

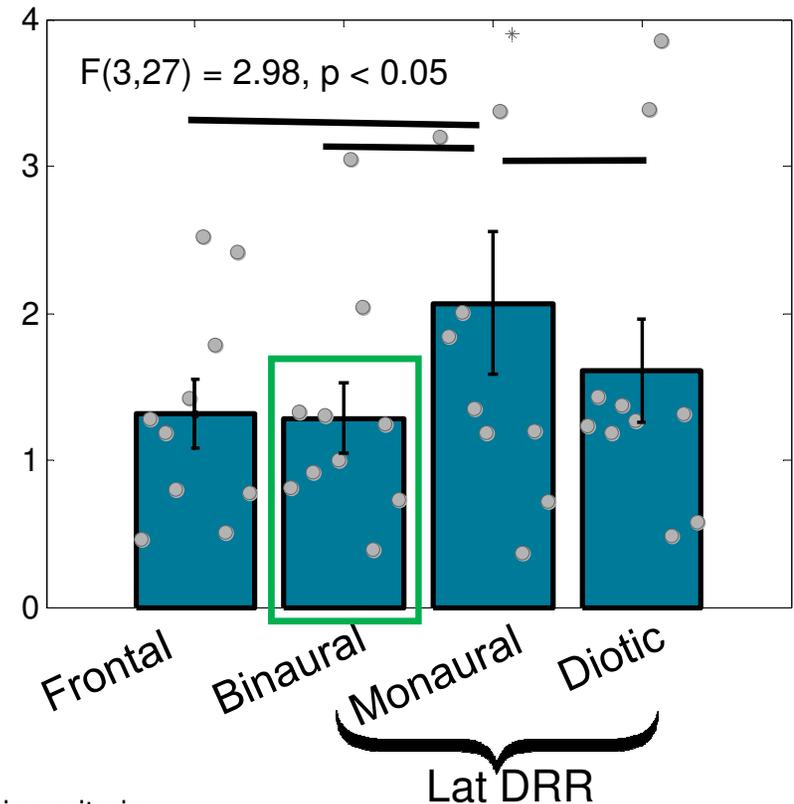
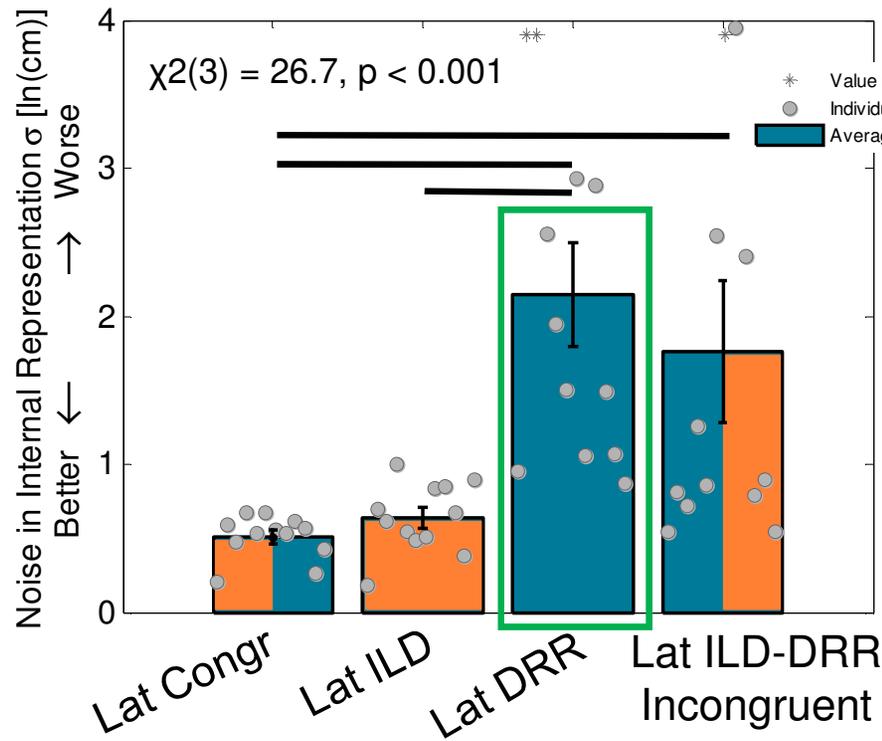
- worse with incongruent cues
- better in ILD-only than in DRR-only condition
- not consistent with Kopčo & Shinn-Cunningham (2011)

Contextual effect?

Exclusion criteria: Lat $\sigma \geq 1$ ln(cm); % correct < 55%

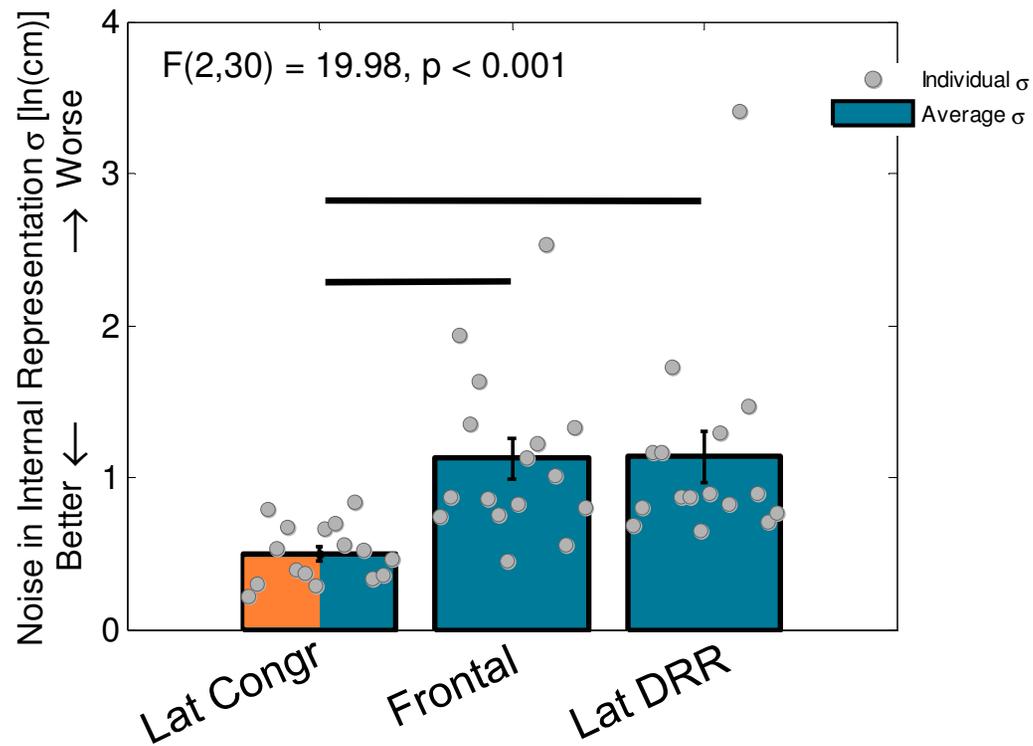
Exp 1:

Exp 2: DRR cue



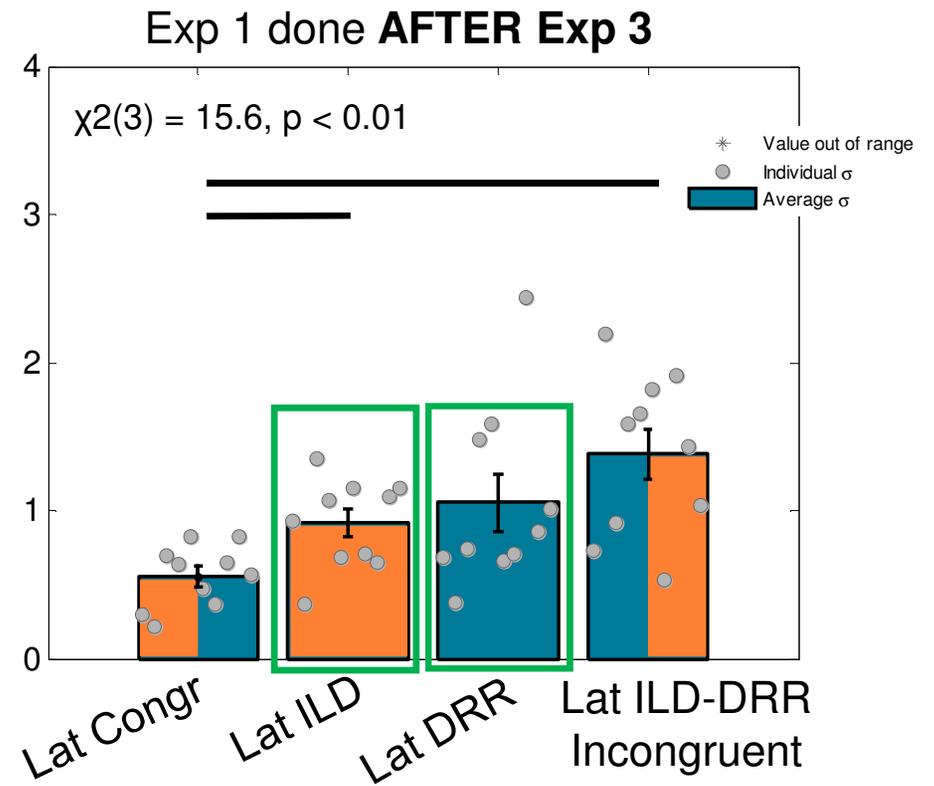
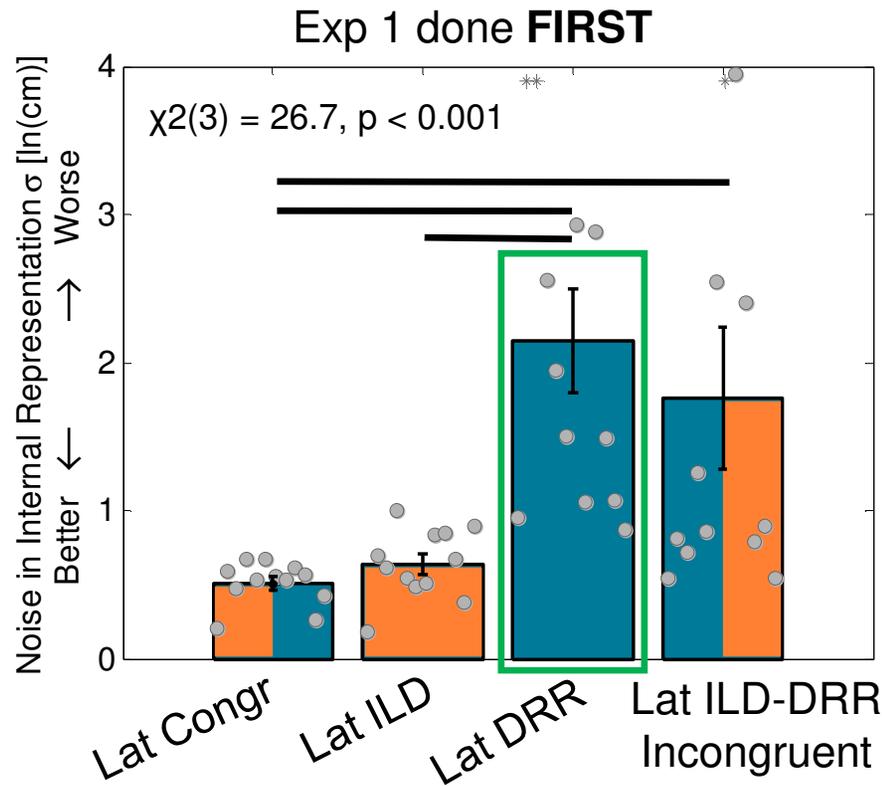
Exclusion criteria:
 Front $\sigma \geq 3$ ln(cm); % correct < 55%

Exp 3: Frontal & Lateral



Exclusion criteria: Lat $\sigma \geq 1$ ln(cm); % correct < 55%

Exp 1 & Exp 1B: *A priori* experience



Exclusion criteria: Lat $\sigma \geq 1$ ln(cm); % correct < 55%

Summary

- When **ILD** & **DRR** equally available, performance based mostly on **ILD** (balanced lateral conditions, Exp 1)
- When only **DRR** available, performance based on **DRR** improves (DRR-only performance in Exp 2 better than in Exp 1)
- When **ILD** & **DRR** are available & presented naturally (with ILD available in 1 of 3 conditions), **DRR** weighting is still good (Exp 3)
- When listeners learn to use **DRR** in a natural condition, they retain high **DRR** weighting (ILD- and DRR-based performance equally good in Exp 1 after Exp 3)

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- Cue weighting critically depends on the context & previous experience
 - When direction of stimuli varies, DRR is a reliable cue
 - When direction is fixed to lateral, ILD is the main cue unless previous experience leads the listener to focus on DRR

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