



# DRR-ILD Cues Weighting in Auditory Distance Perception



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## Introduction

- The estimates of auditory distance are typically dominated by the overall received stimulus intensity.
- However, distance processing can also be guided by intensity-independent cues. Specifically, the interaural level differences (ILDs) provide distance information for lateral stimuli and, in reverberant space, the direct-to-reverberant energy ratio (DRR) cue provides distance information for sources from all directions.
- In the absence of the intensity cue, listeners use these cues to estimate nearby-source distance [2].
- The question still remains, which of these cues dominates in distance perception and how it varies with different contexts and environment conditions?

## Objectives

- To study intensity-independent distance perception of broadband nearby sounds in reverberation.
- To study mechanisms of cue combination and adaptive processes used by the brain in auditory distance perception.

## Methods

- We performed a series of behavioral experiments in a virtual reverberant environment [2].
- Simulated sound sources presented at a varying distance (15-100 cm) from directly in front or to the side of the listener.
- Task was to find which of the two sounds is closer to the listener?
- To explore the listeners' weighting of the ILD & DRR cues, we manipulated the availability of the cues.
- We also examined the effect of the preceding listening experience on cue weighting.
- A model based on signal detection theory was used to evaluate the performance of the discrimination tasks. To evaluate individual subjects' performance, the sensitivity index was estimated for each subject on the basis of his/her discrimination performance [2].
- CLEAVE [3] was used for statistical analysis.

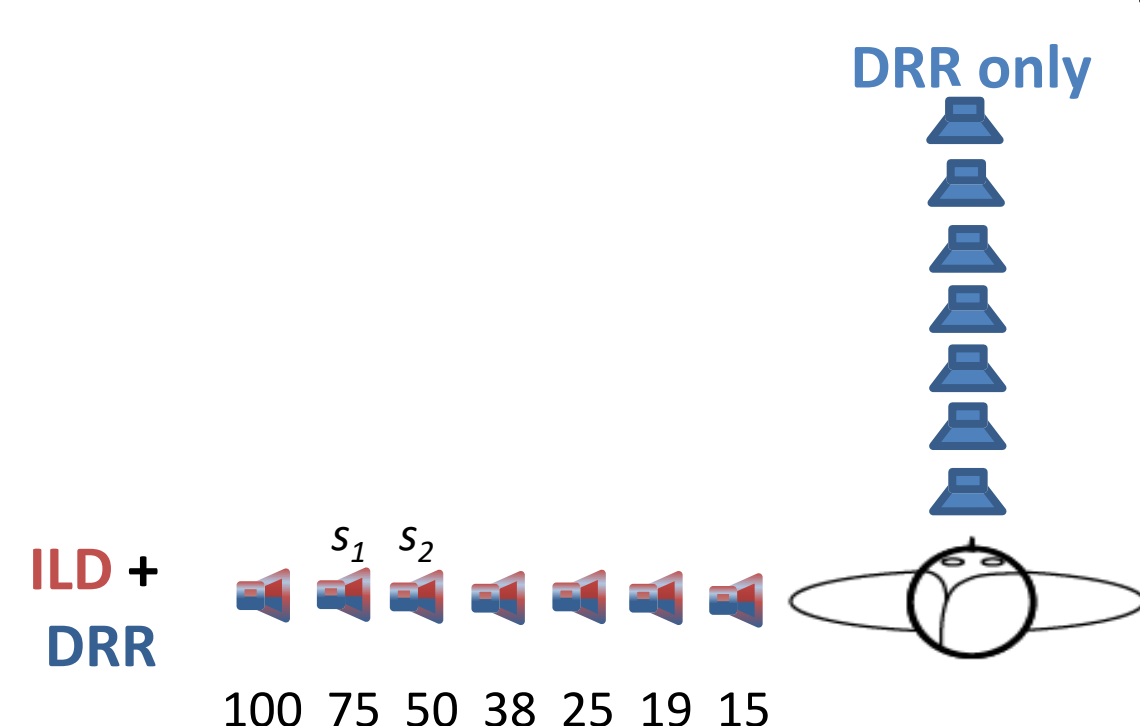


Fig. 1. Simulated distances of sound pairs (cm)

## References

- [1] Kopčo N, Shinn-Cunningham BG (2011) Effect of stimulus spectrum on distance perception for nearby sources. J Acoust Soc Am 130:1530–1541.  
[2] Norbert Kopčo, Samantha Huang, John W. Belliveau, Tommi Raji, Chinmayi Tengshe, Jyrki Ahveninen, 2012. Neuronal representations of distance in human auditory cortex. Proceedings of the National Academy of Sciences [online], 2012, vol. 109, no. 27, pp. 11019–11024 123[accessed. 31. October 2012]. ISSN 0027-8424.  
[3] <http://www.ebire.org/hcnlab/software/cleave.html>

## Results

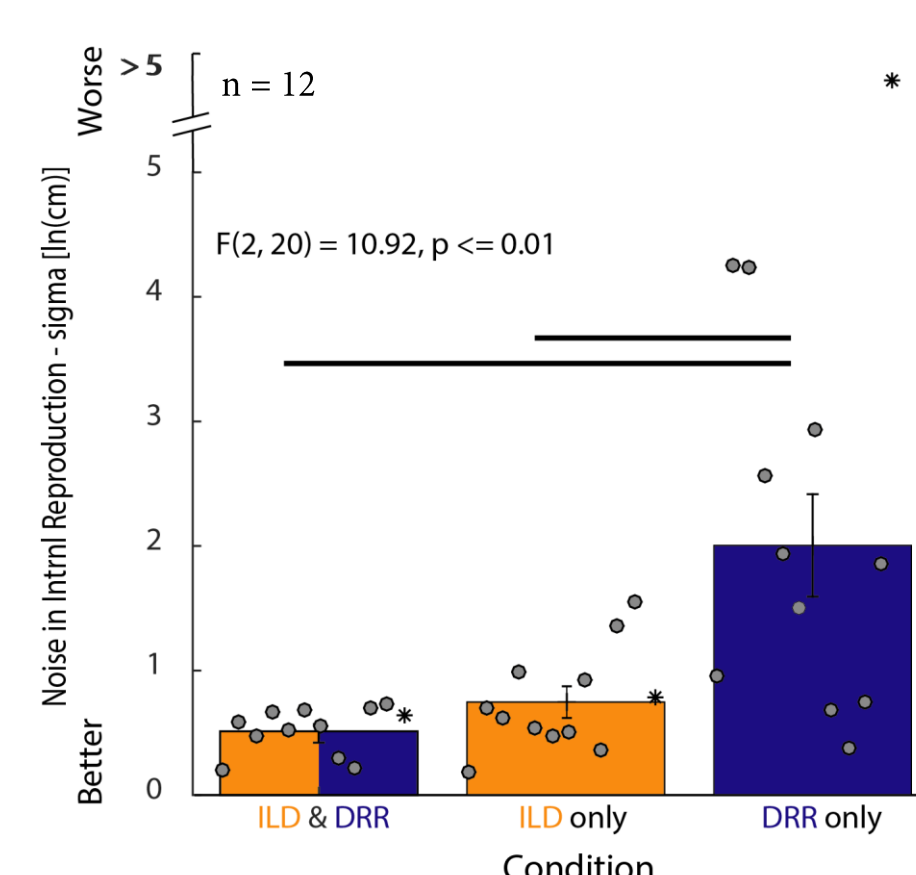


Fig. 2. Lateral ILD & DRR cue weighting

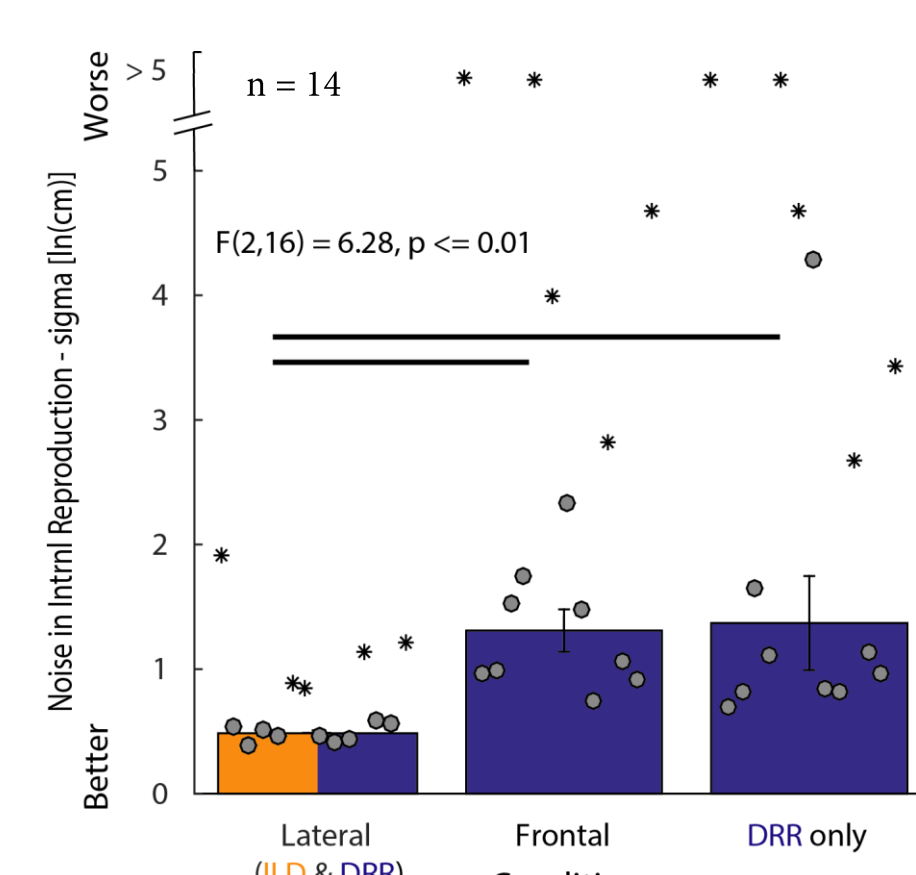


Fig. 3. Frontal and lateral cue weighting

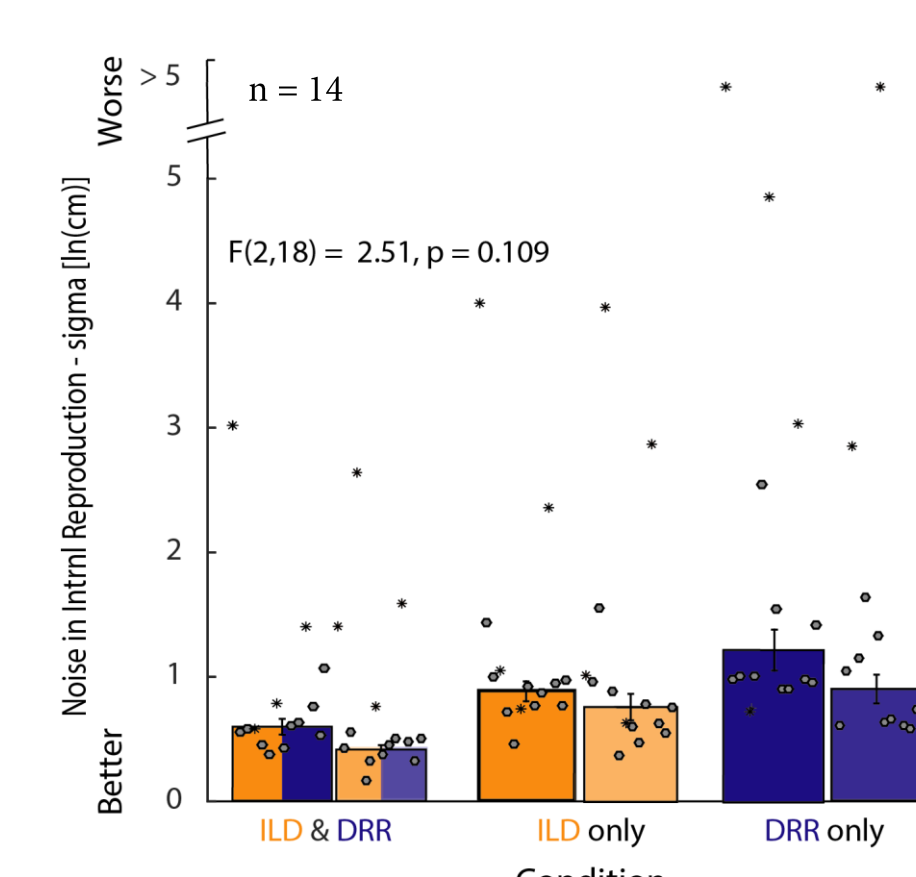


Fig. 4. Lateral ILD & DRR cue weighting with prior experience and on consecutive days

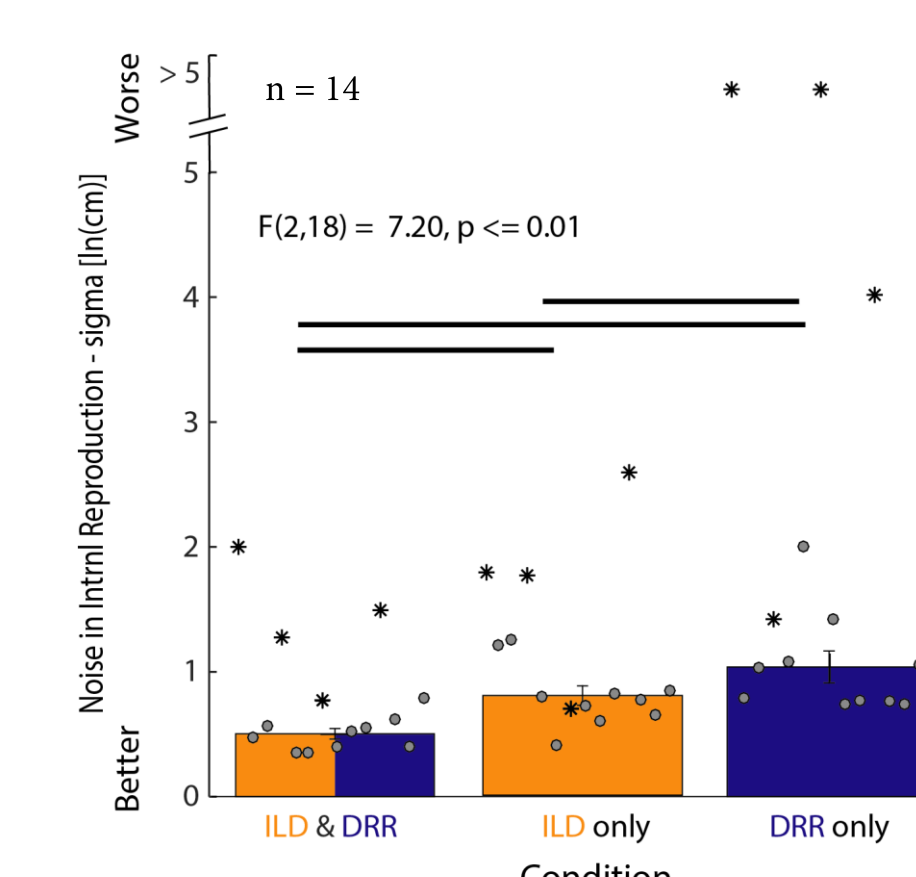


Fig. 5. Lateral ILD & DRR cue weighting with prior experience and consecutive days data merged

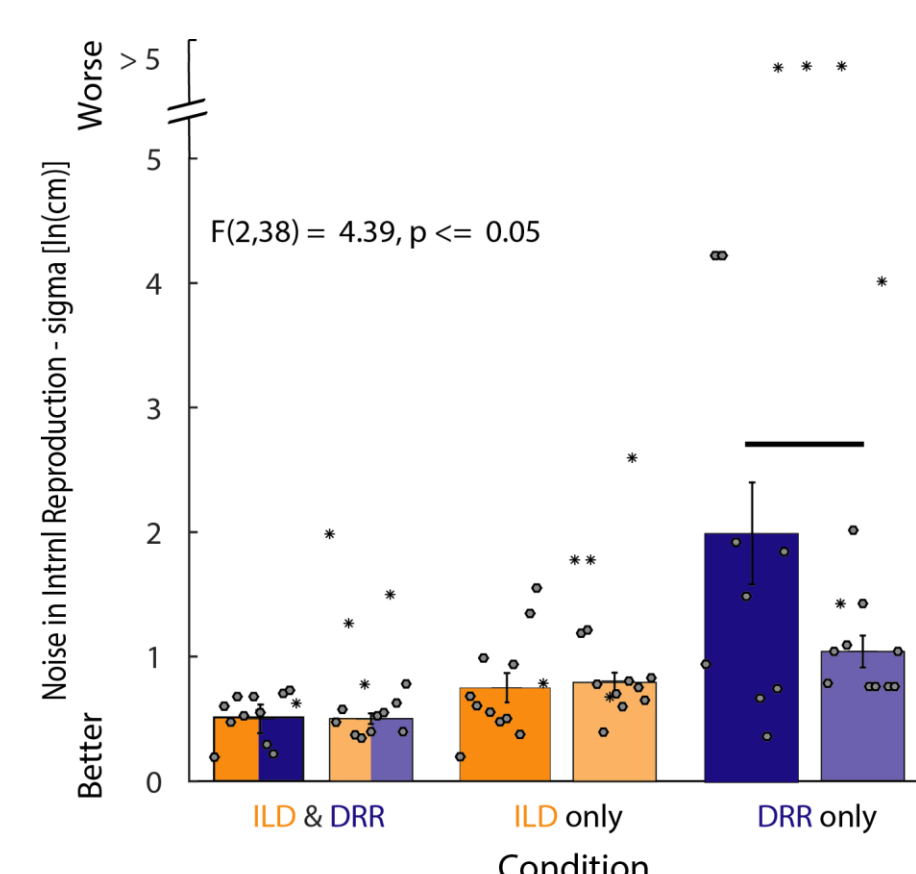


Fig. 6. Comparison between experiments in Fig.2. and Fig.5.

- Results in Fig.2. show a significantly worse lateral DRR compared to lateral congruent condition and even lateral ILD. Further we can see the lateral ILD-only condition is as good as congruent lateral one. This is not consistent with [1] where the DRR was observed as a dominant cue.
- In Fig.3. we observe lateral congruent condition is better than frontal condition. Further DRR is being weighted good enough to obtain an optimal performance. It indicates that in natural conditions, where there are both frontal and lateral sounds, listeners can use DRR. Therefore, it really seems to be a contextual effect.
- Subjects did experiment similar to Fig.2. after doing experiment as in Fig.3. on two consecutive days. The results indicate there is no significant difference between consecutive days. Hence the data was merged as shown in Fig.5.
- We observe in Fig.6. that DRR significantly re-weights more after previous natural context experience as in Fig.3.

## Conclusion

- The weighting of ILD and DRR cues in judging distance of nearby sources is strongly adaptive, depending the previous room exposure.
- This result is consistent with the hypothesis that the brain dynamically updates its model of the acoustic environment, preferring the most reliable cue combination in each room.
- Future studies will need to examine the properties of this process and the underlying neural mechanisms.

### Remember !!

- Intensity independent distance perception is possible.
- Distance perception is highly adaptive and depends on
  - availability of acoustic cues,
  - previous experience
  - And possible other factors too !!

## Contact

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