Psychoacoustic Examination in Germany on Adequate Sound Levels of Possible Warning Sounds for Quiet Vehicles

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Background of the study

- For the discussion on the AVAS or something like systems,
- It is very important to understand the relationship between hearing impression and acoustic properties of vehicles' sounds.
- We have conducting some pychoacoustic investigations.

hearing impression

awareness

annoyance

approaching/distancing

acceleration/deceleration

...

acoustic properties

sound level

pitch/frequency

timbre(tone color)

temporal pattern

...

◆ HV車／EV車の小さなエンジン音にオススメ！

国土交通省は2010年1月、「ハイブリッド車等の静音性に関する対策のガイドライン」を設け、一定の要件を満たした装置を任意で装備できるよう自動車メーカー等に周知しています。G-TECH「DriveAlarm」「DriveTone」はガイドラインをクリアした車輌接近警報装置、歩行者にやさしく車の接近を音声で知らせる新しいクラクションで歩行者の安全を守ります。

Suitable for quiet engine vehicle

Beep beeep!
“Excuse me. Car is comming!!”

Disney Melody version
also available!!

This product is conforming to
the guideline form MLIT/jp

Trade-off problem

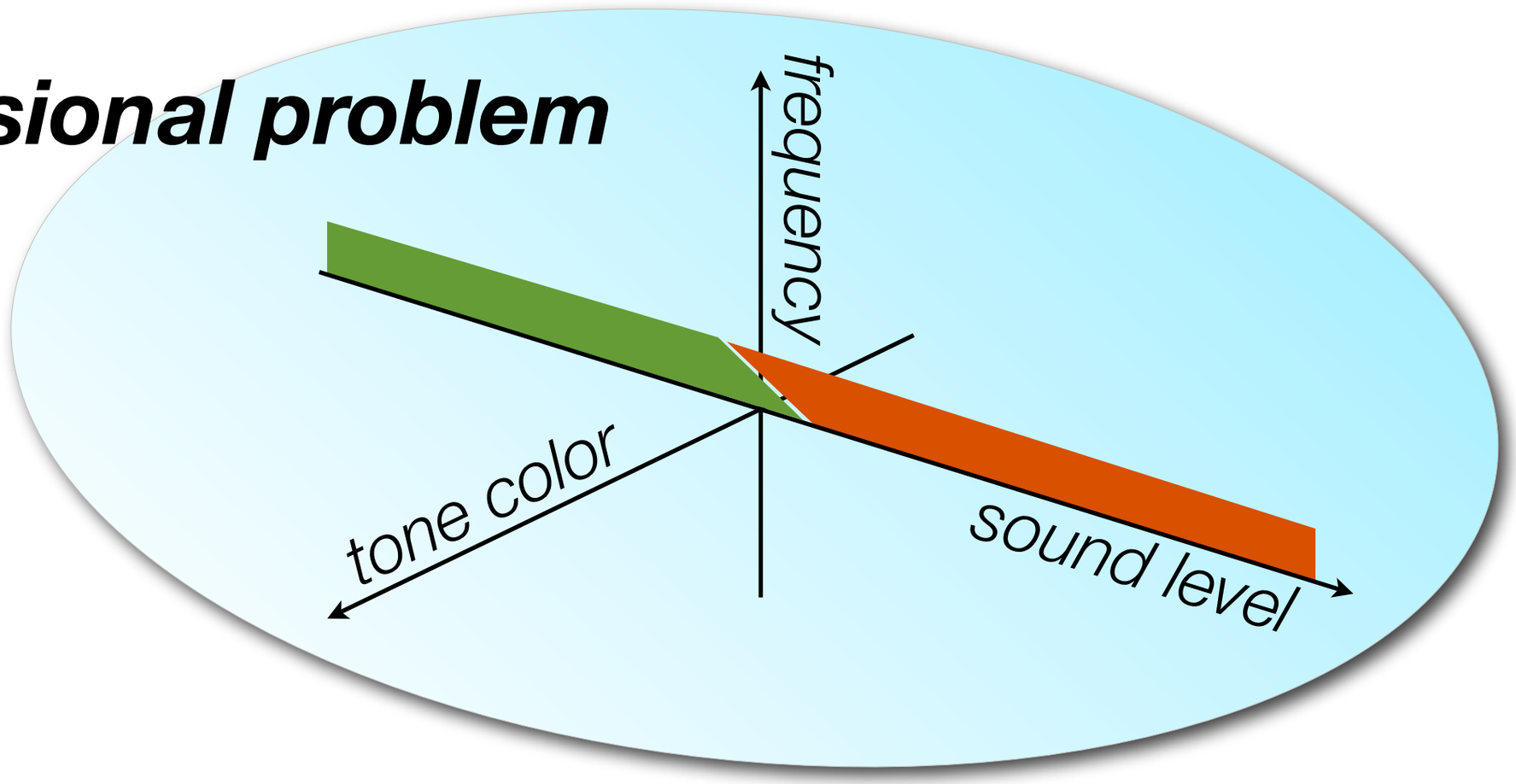
Recommendation

for industry how to design the sound

to manage total sound environment

Limitation

Multi-dimensional problem



Examination in Japan

- An psychoacoustic experiment to examine the **adequate sound levels** of the warning sounds in Japan.
  (*informal document, QRTV-04-05*)
  - The adequate and the lowest sound levels were differed among the background conditions.
  - The adequate level for a quieter environment (60.8 dB) was perhaps too small to be audible in a louder environment (73.2 dB).
  - Measurement precision was not excellent.

Examination in Germany 

Is the sound level evaluation depend on cultures?

More reliable result is required.

- Similar examination has done in Germany.
- The input device and the layout of the test procedure were improved.
- The fluctuation of the sound level adjustment within each participant was examined.

Background Stimuli (urban environmental sounds)

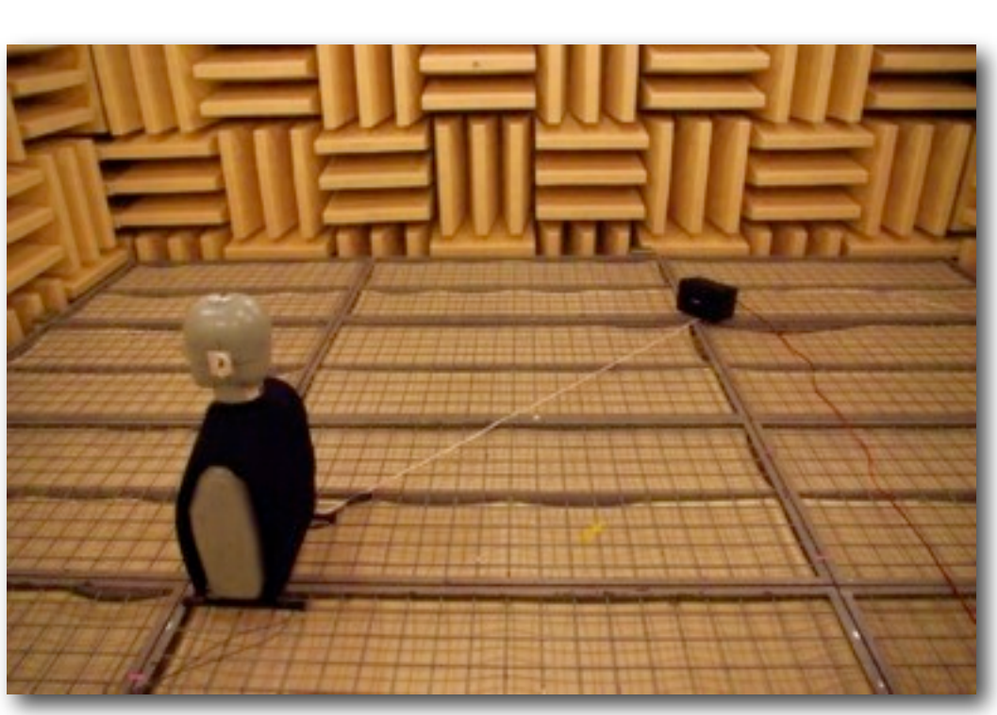
	Env.1	Env.2	Env.3	Env.4
				
	Downtown	Residential	Heavy traffic	Shopping str.
L_{Aeq} (5min.)	65.9 dB	67.8 dB	73.2 dB	60.4 dB

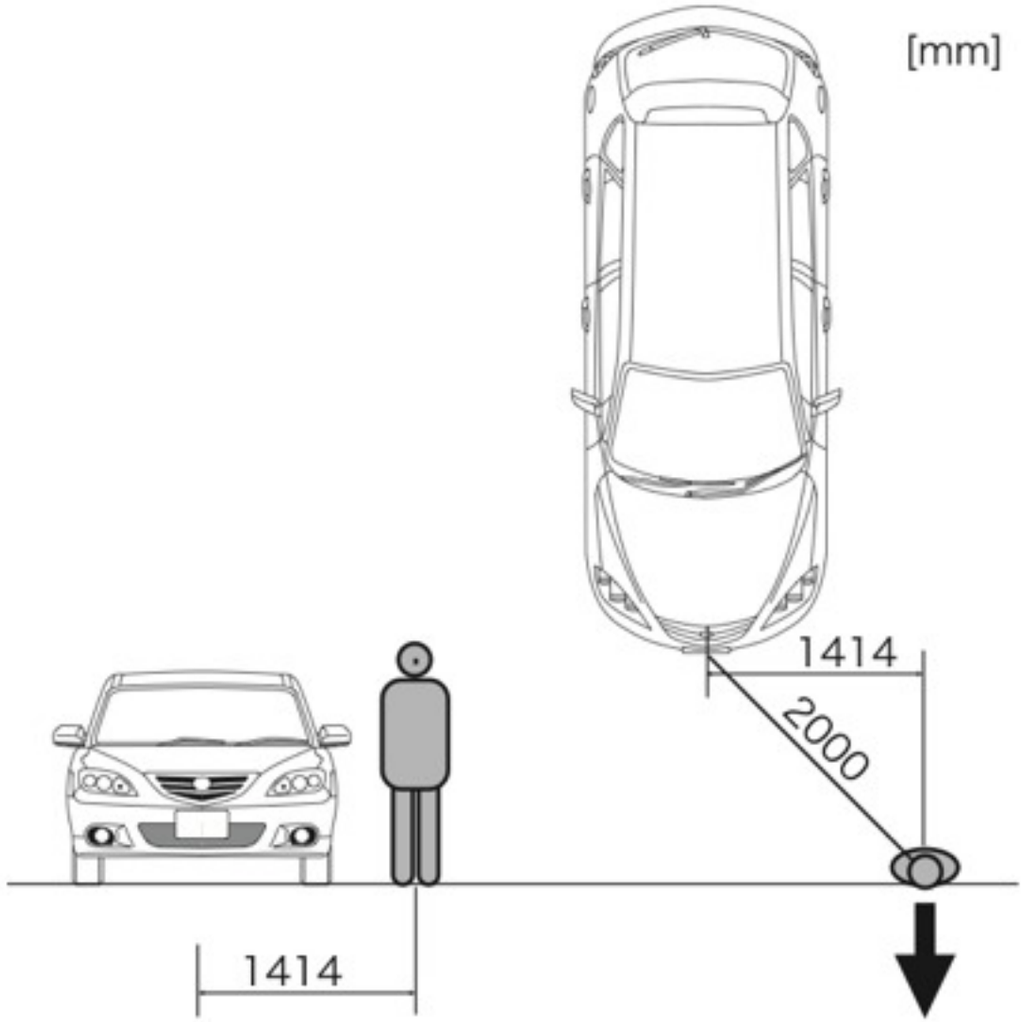
- Recorded on sidewalk of the road in Fukuoka, Japan.
- Binaural Recording (with Head and Torso Simulator/HATS)

Target stimuli (possible warning sounds)

(A) Horn	(B) Engine sound	(C) Broadband noise

- Played back in anechoic room and recorded with HATS positioned diagonally forward left 2m from the loudspeaker.



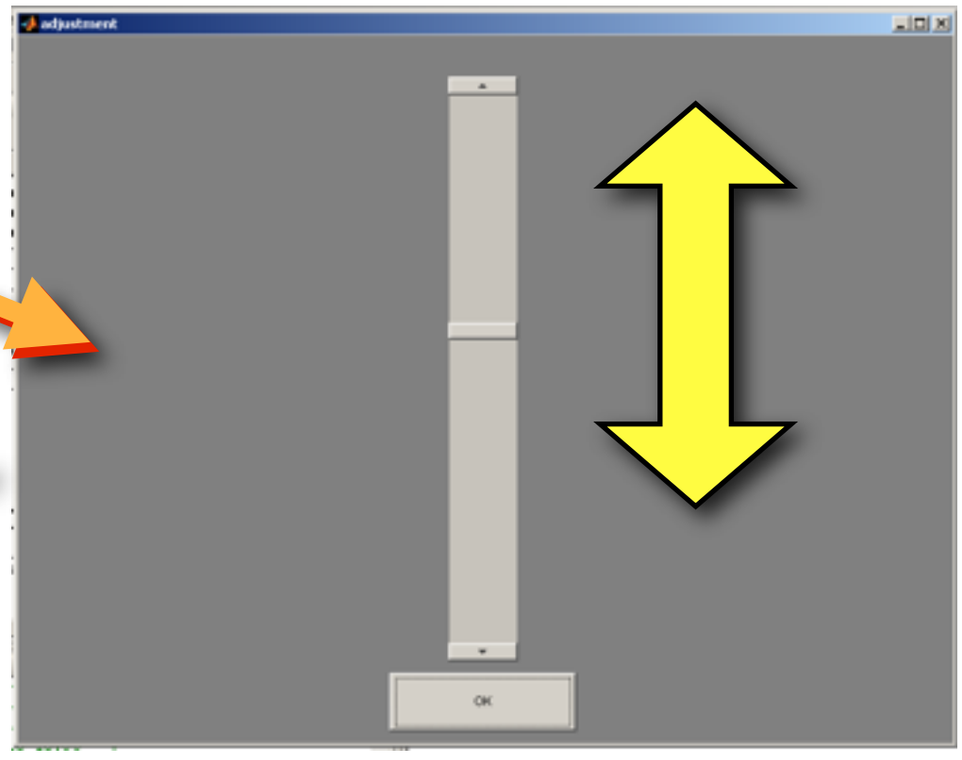


Procedure

- The background was presented via headphones.
- About 10 s later, the target was also presented.

Environmental Sound (background)	External Acoustic Sign (target)
fixed sound level	changeable sound level by the participant

adjust to “adequate level” and “lowest level”



Participants

- The tests took place in the sound proof chamber of the institute for Mensch–Maschine–Kommunikation at the TU München.
- 11 male and 4 female
  - Living in Munich.
  - Age: 26 to 49 (31.3 in average)
  - Length living in Germany/Austria: 26 to 33 years (29.1 in average)
  - Nine of the them drive their own car (not EV/HEV) more than once a week.
  - None of them has ever detected their hearing abnormalities by their routine physical examination.

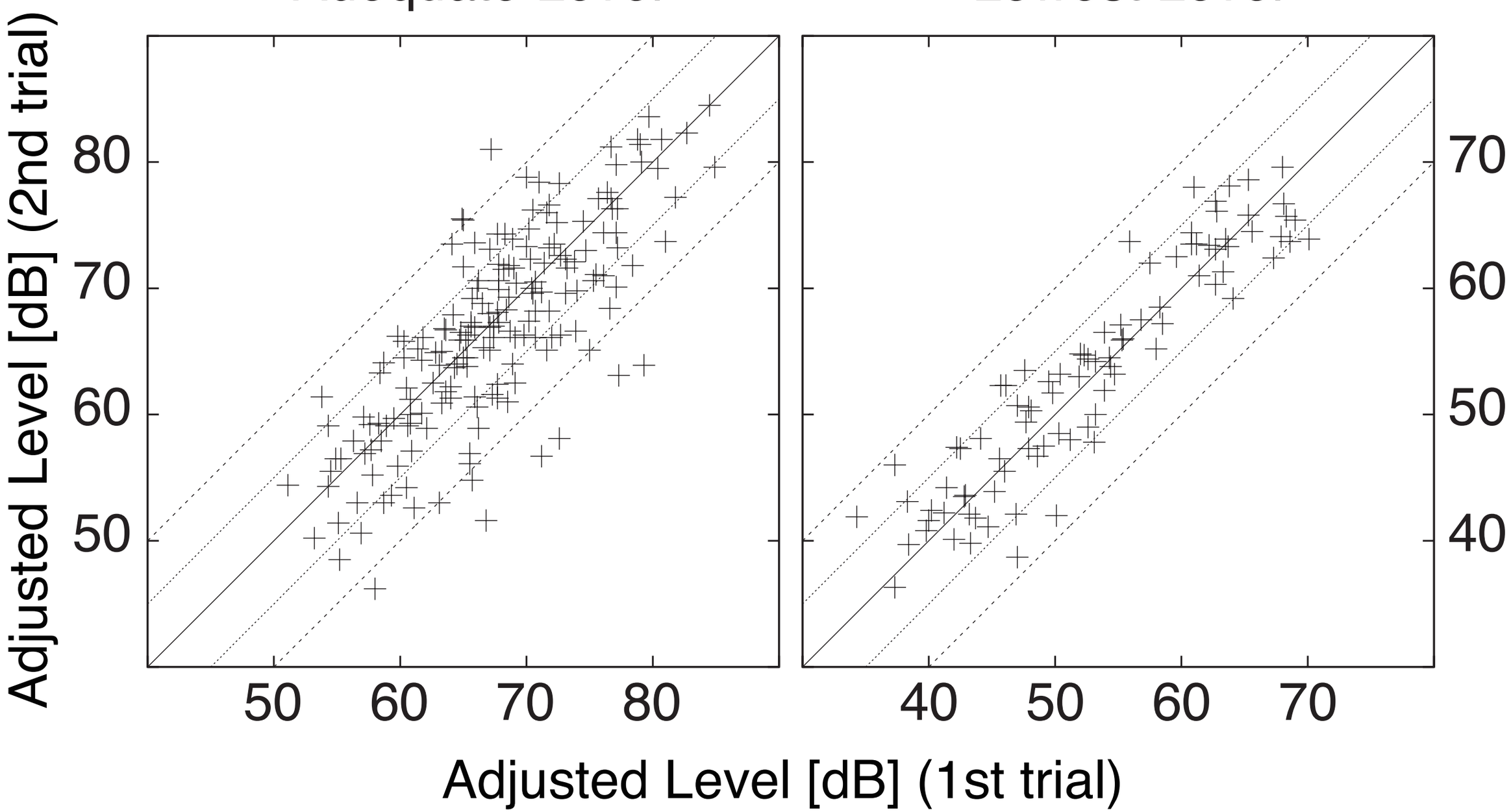


Fig.1 *– Scattergram of adjusted levels between two trials.*

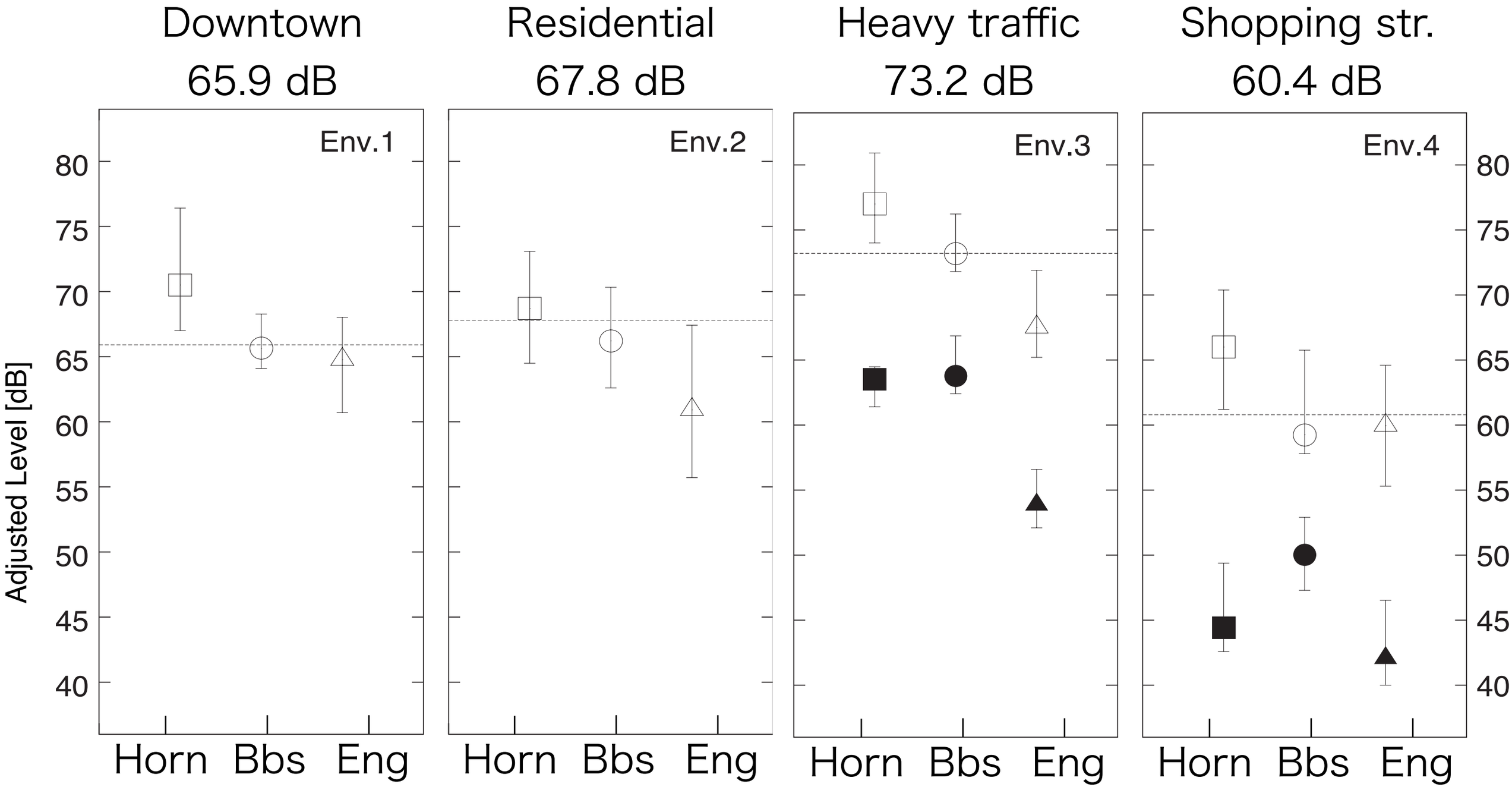
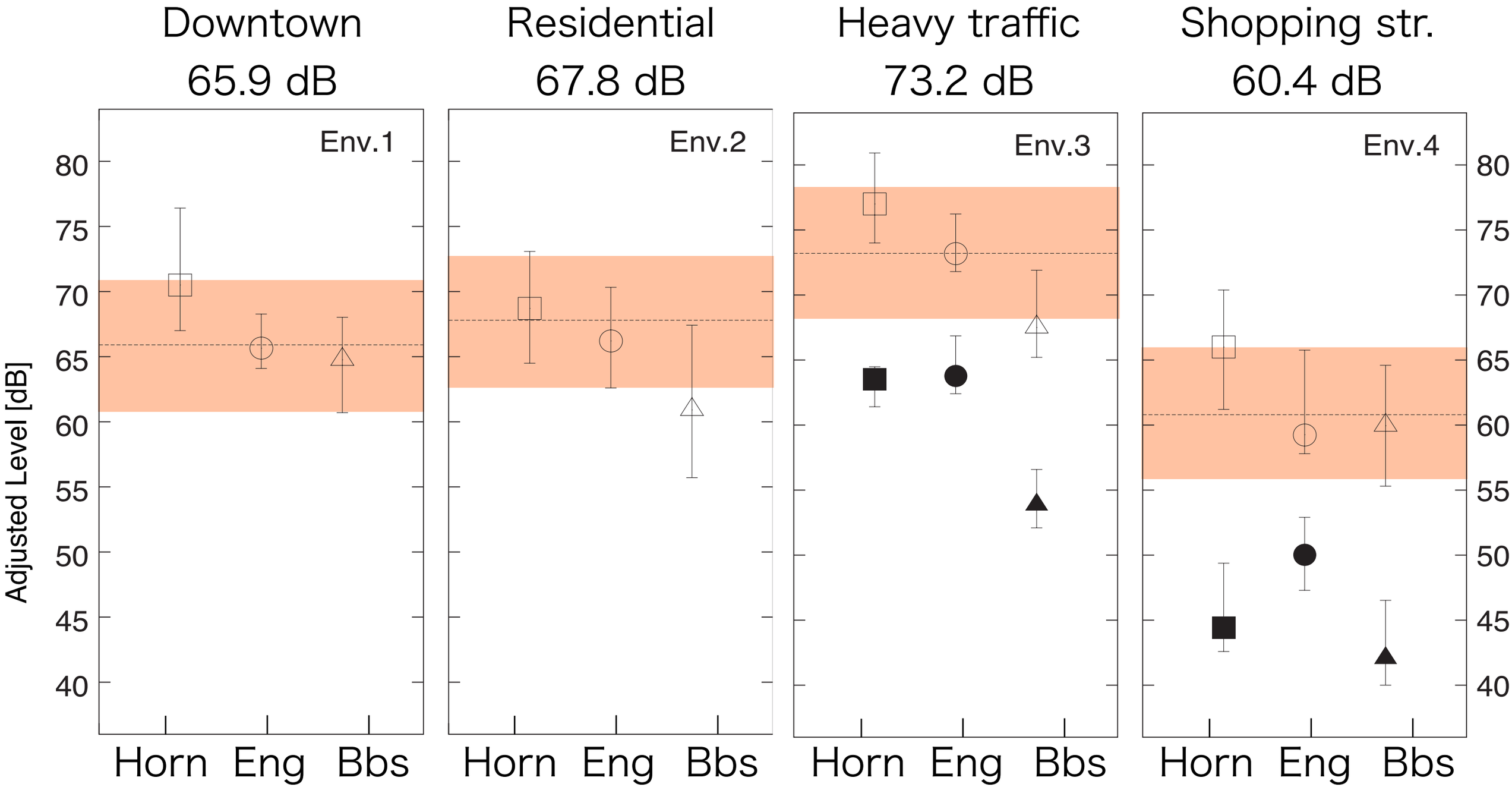


Fig.2 *– Medians and interquartile ranges of the adequate levels (opened markers) and the lowest levels (filled markers). The horizontal dashed line indicates the noise level (L_{Aeq}) for each background*



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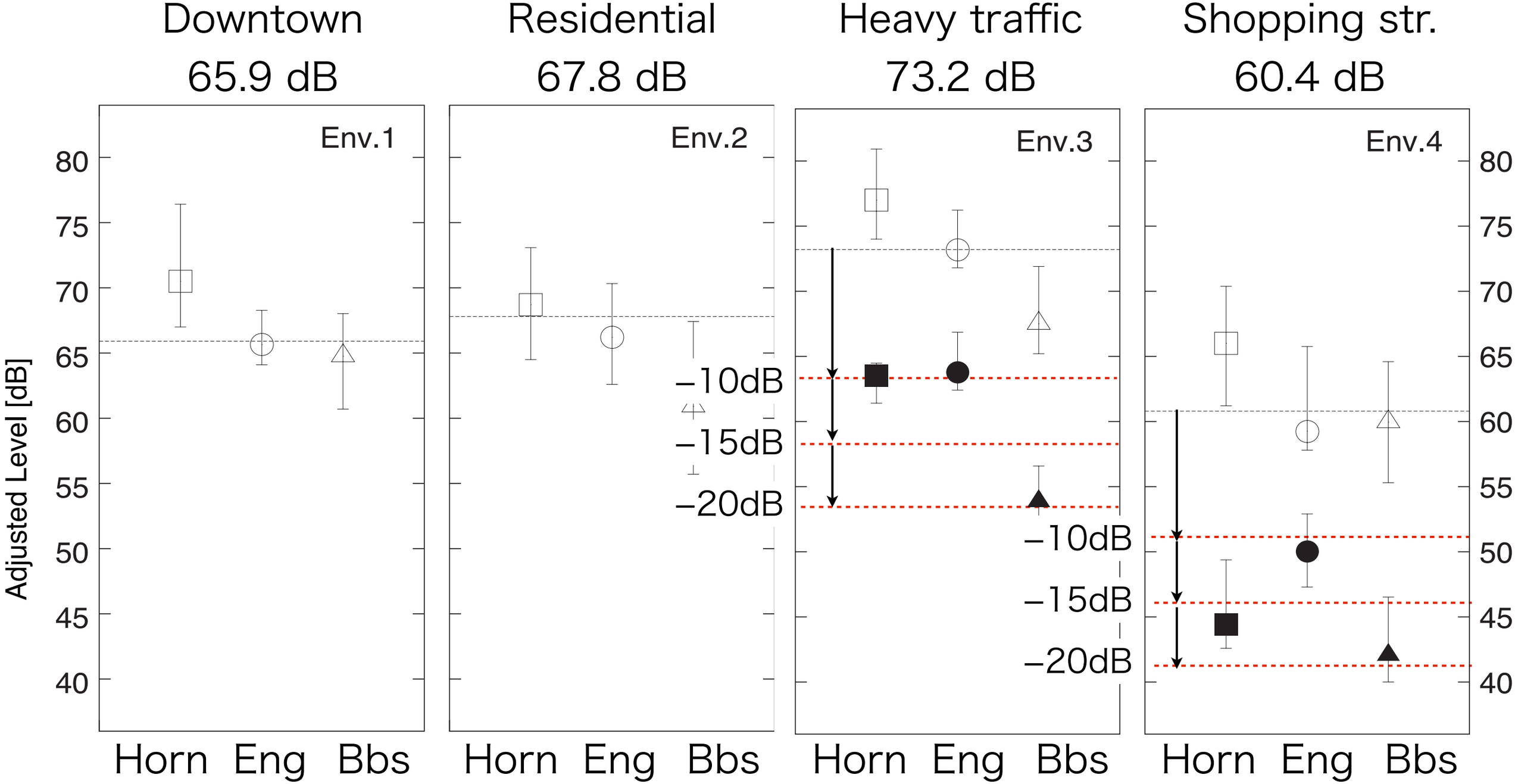

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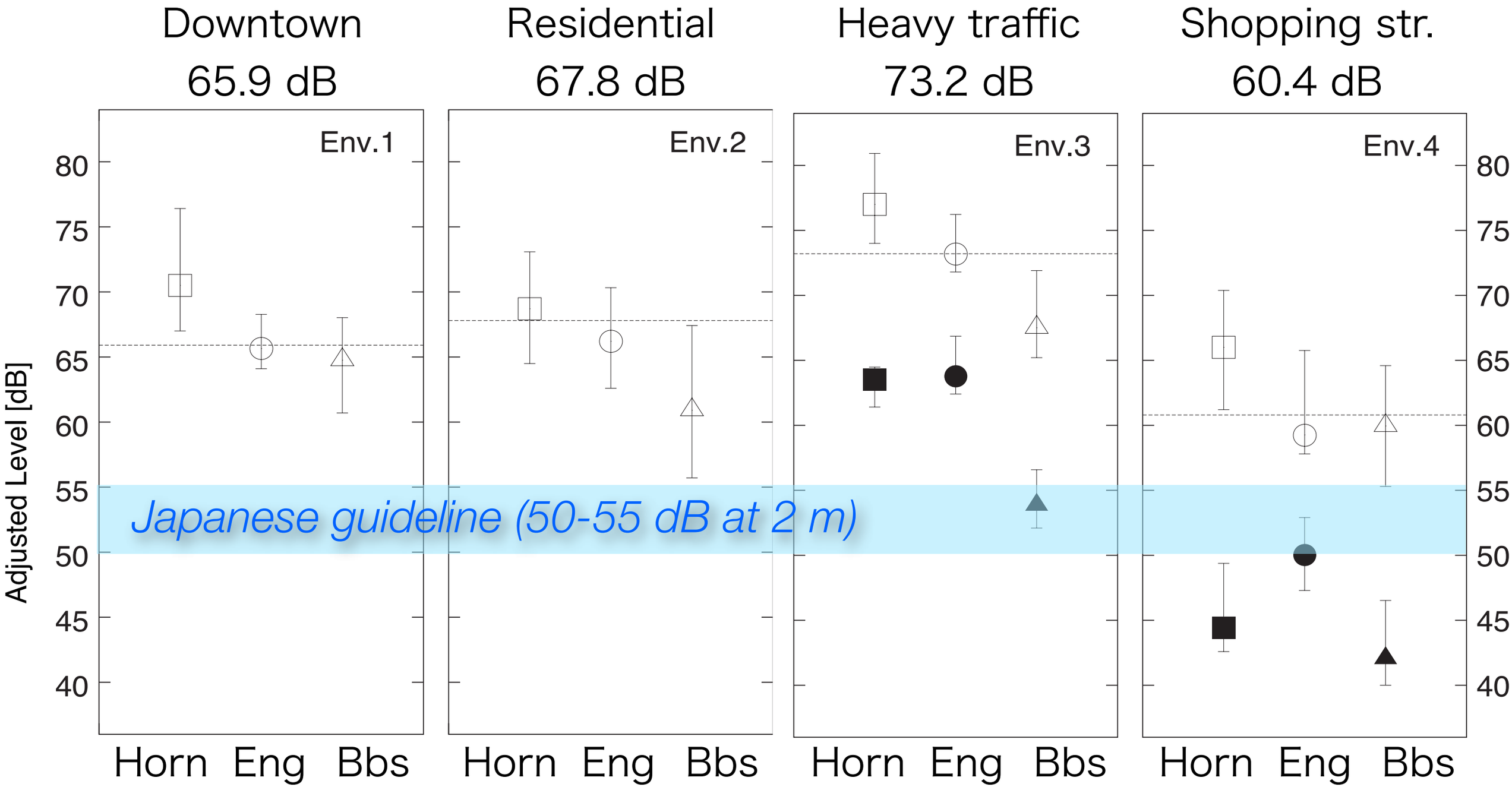

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Future works

- Comparison with Japanese examination will be done near future.
- Another qualitative comparison (using questionnaire survey) is now carried in Japan and Germany.

Questions

Have you ever...
met EV/HEV in motion?
heard AVAS sound?
felt dangerous due to the quietness as a driver/pedestrian?