Supplementary Material for the paper**:**

Machine Learning Framework for Speech Intelligibility Prediction using Binaural Room Impulse Responses

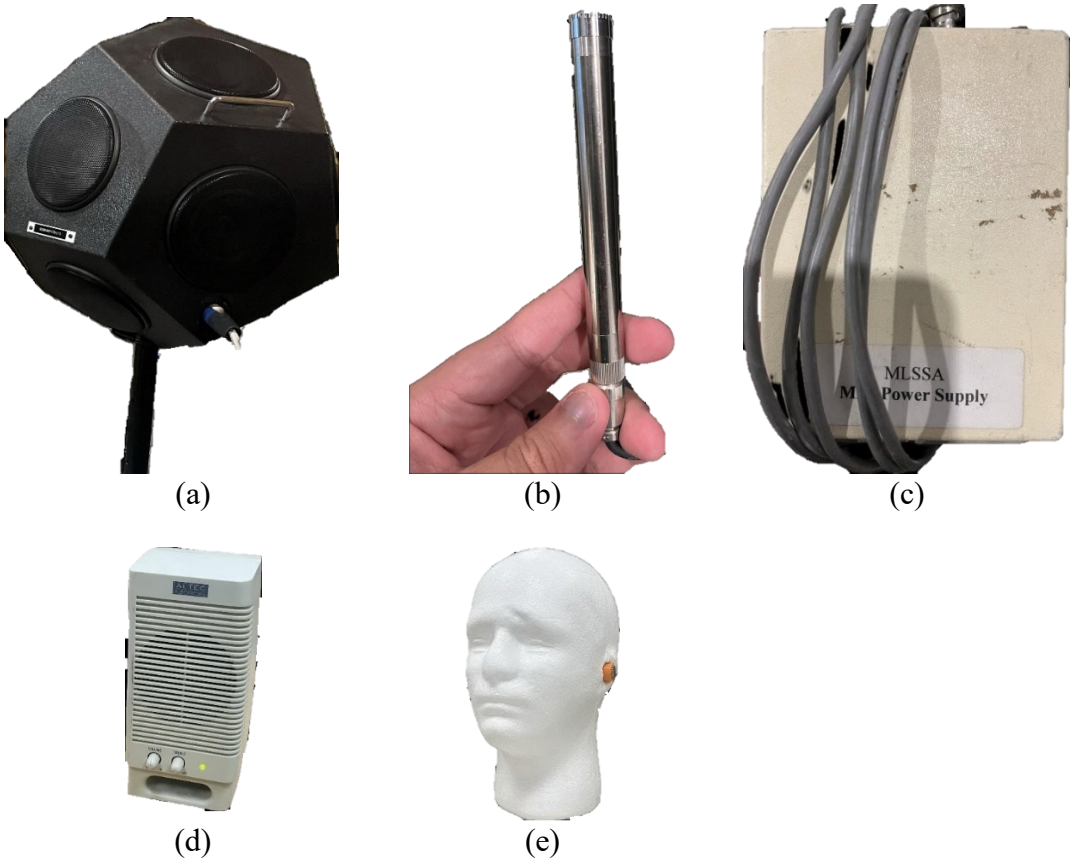
(a)

(b)

Supplementary Figure 1*. Field measurement location (Al-Wable Mosque, Saudi Arabia): (a) Interior view showing a large central dome, four columns as support, an open prayer hall layout, and decorative ceiling lighting, (b) Exterior view of the mosque showing external stone facade and dome illumination enhances its visibility and aesthetic prominence during nighttime (source: Google).*

***Supplementary Table 1**. Architectural characteristics of Al-Wabel Mosque.*

Name	Al-Wabel Mosque
Location	Dammam, Saudi Arabia
Function	Daily and Friday prayers
Length (L) x Width (W) x Height	36 x 36 x 7 m
Aspect ratio (L/W)	1
Floor area	1260 m^2
Number of columns and domes	4 and 1, respectively
Horizontal and Vertical diameters of the dome	14 m and 7 m, respectively

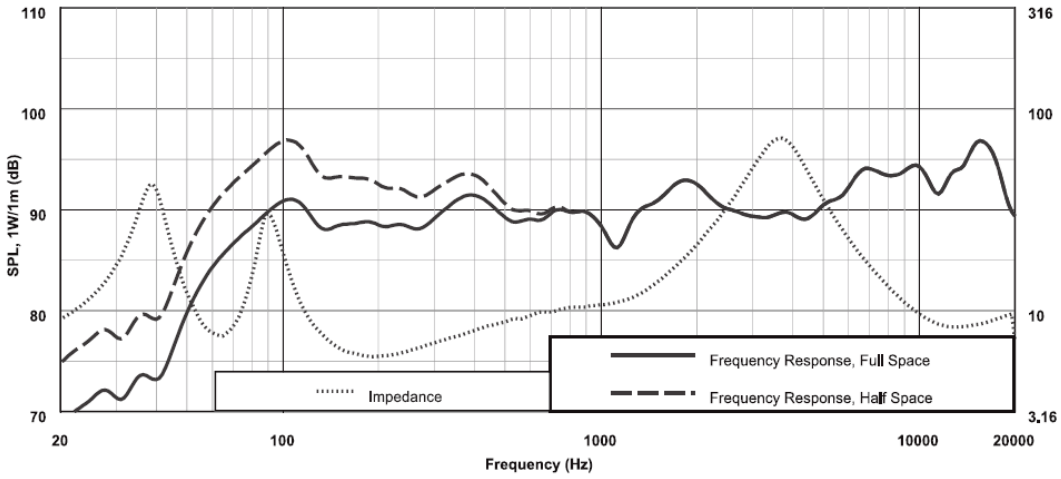


(a) (b) (c)

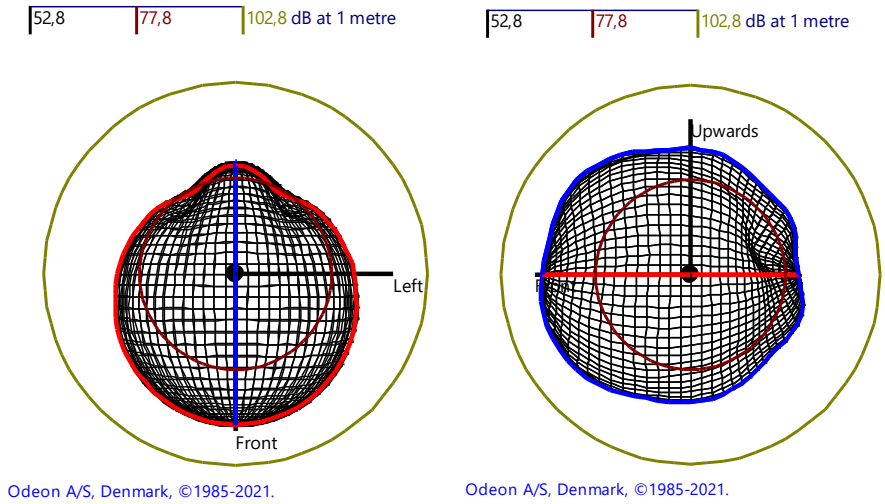
(d) (e)

***Supplementary Figure 2**. Equipments used during field measurement: (a) An omnidirectional source from 01dB that consists of a 12 loudspeaker-dodecahedron and contains a power amplifier and a noise generator. (b) A ½ inch condenser microphone from Brüel & Kjær that has a frequency response range of 5 Hz to 20kHz [168]. (c) An external microphone's amplifier. (d) A unidirectional loudspeaker from Altec Lansing (ACS 90 type) that mimics Imam's voice during preaching. (e) A dummy head made of foam with holes (lined with PLA material) designed to hold microphones in the ear position.*

(a)

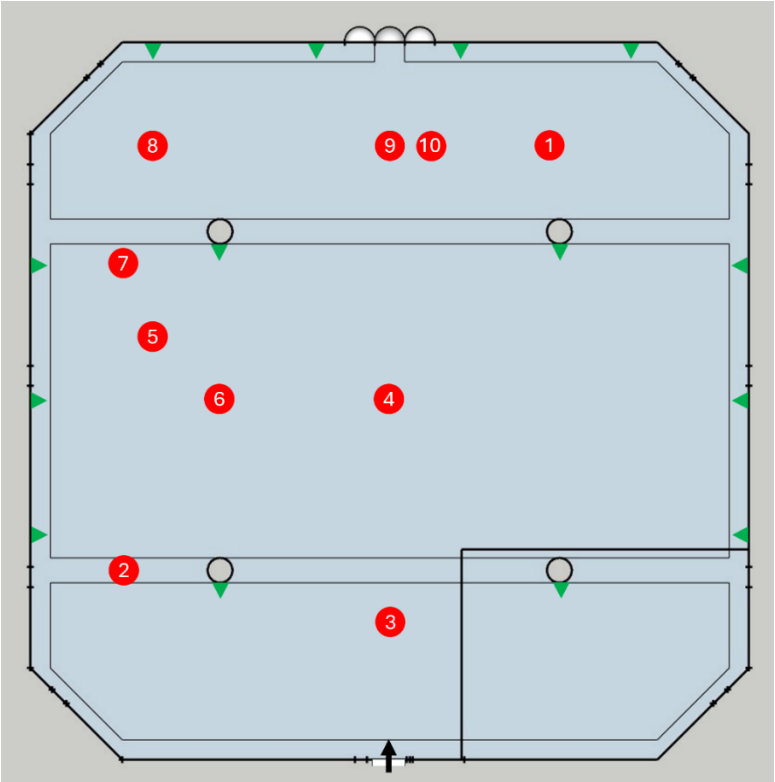


(b)



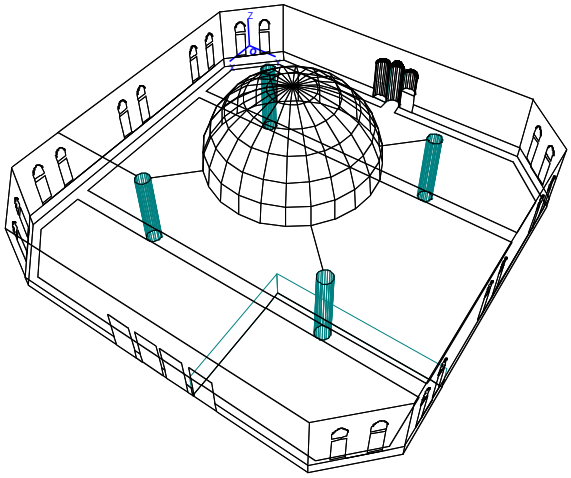
(c)

Supplementary Figure 3. *Technical specifications of the existing mosque's loudspeaker, ElectroVoice Zx1. (a) Physical form of the 8-inch loudspeaker unit. (b) Frequency response and impedance curves of the loudspeaker [171]. (c) Directivities of the loudspeaker: the left diagram shows the horizontal dispersion, while the right diagram shows the vertical dispersion.*



Supplementary Figure 4. *Field measurement setup showing 10 measurement positions. Symbol key: Red circle = measurement position; green triangle = installed mosque loudspeaker; and black arrow = entrance. The qibla direction is toward the qibla niche.*

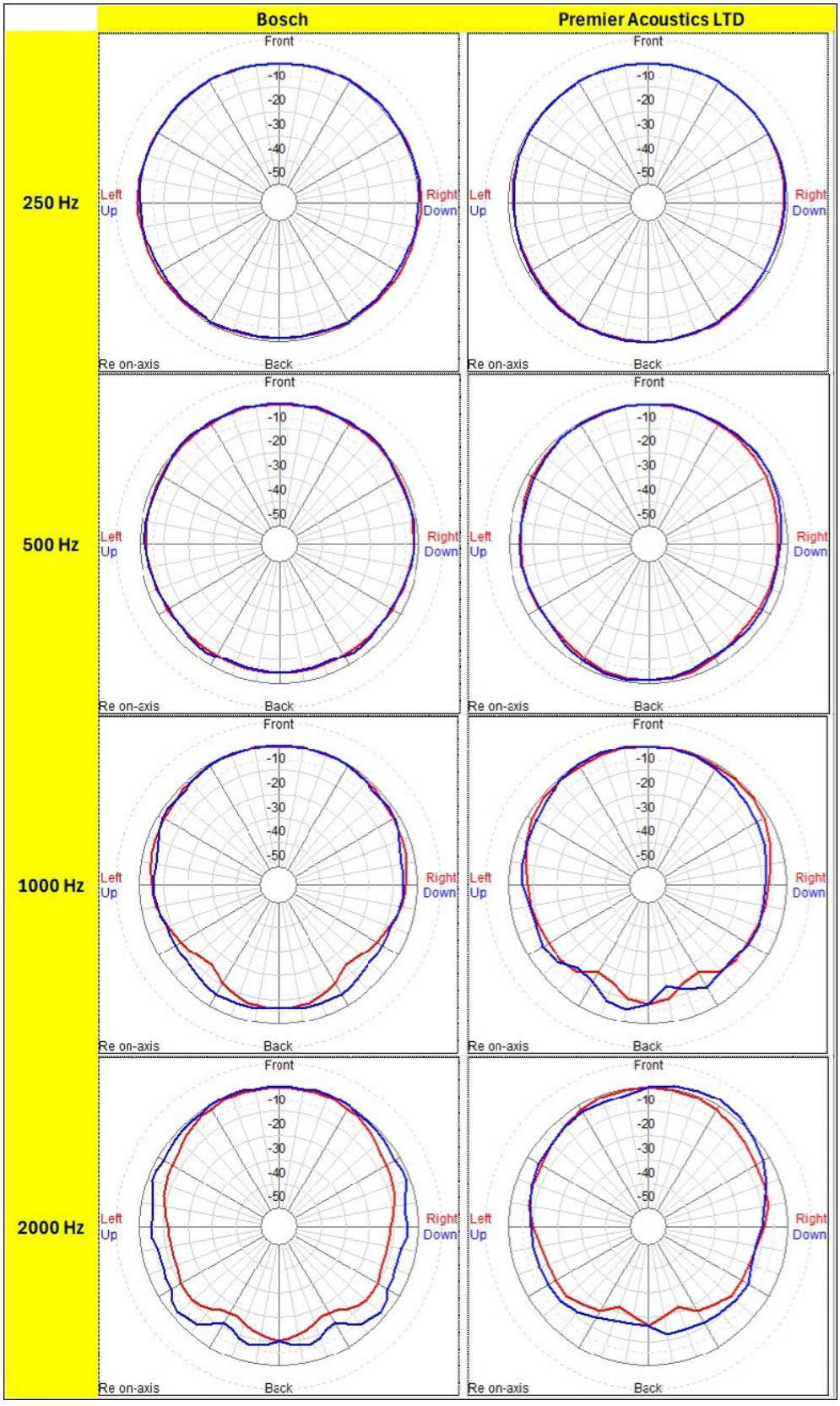
Supplementary Figure 5. *Set up of binaural acoustic measurements using a dummy head inside the mosque. A researcher positions a 1/2-inch condenser microphone into the dummy head's ear canal, which is mounted on a tripod at listener ear height (0.85 m) to simulate a seated listener during khutbah delivery.*



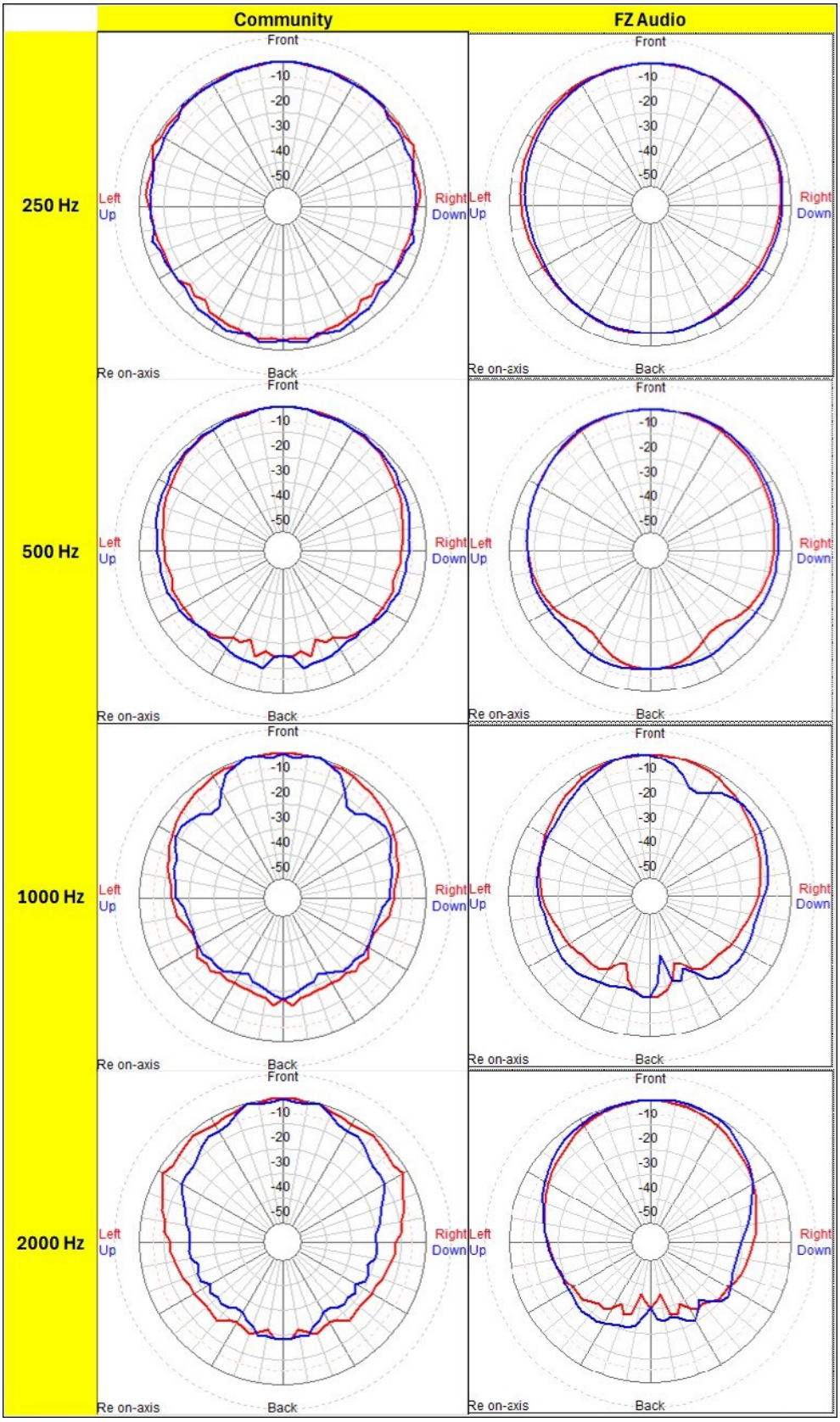
Supplementary Figure 6. *Wireframe representation of the Al Wabel Mosque, composed of 789 flat polygonal surfaces. The 3D model illustrates architectural elements, including a central hemispherical dome, cylindrical columns, arched windows, and perimeter walls, providing a simplified yet geometrically accurate depiction for analysis and simulation.*

1	went	sent	bent	18	way	may	say	35	heat	neat	feat
	dent	tent	rent		pay	day	gay		seat	meat	beat
2	hold	cold	told	19	pig	big	dig	36	dip	sip	hip
	fold	sold	gold		wig	rig	fig		tip	lip	rip
3	pat	pad	pan	20	pale	pace	page	37	kill	kin	kit
	path	pack	pass		pane	pay	pave		kick	king	kid
4	lane	lay	late	21	cane	case	cape	38	hang	sang	bang
	lake	lace	lame		cake	came	cave		rang	fang	gang
5	kit	bit	fit	22	shop	mop	cop	39	took	cook	look
	hit	wit	sit		top	hop	pop		hook	shook	book
6	must	bust	gust	23	coil	oil	soil	40	mass	math	map
	rust	dust	just		toil	boil	foil		mat	man	mad
7	teak	team	teal	24	tan	tang	tap	41	ray	raze	rate
	teach	tear	tease		tack	tam	tab		rave	rake	race
8	din	dill	dim	25	fit	fib	fizz	42	save	same	sale
	dig	dip	did		fill	fig	fin		sane	sake	safe
9	bed	led	fed	26	same	name	game	43	fill	kill	will
	red	wed	shed		lame	came	fame		hill	till	bill
10	pin	sin	tin	27	peel	reel	feel	44	sill	sick	sip
	fin	din	win		eel	keel	heel		sing	sit	sin
11	dug	dung	duck	28	hark	dark	mark	45	bale	gale	sale
	dud	dub	dun		bark	park	lark		tale	pale	male
12	sum	sun	sung	29	heave	hear	heat	46	wick	sick	kick
	sup	sub	sud		heal	heap	heath		lick	pick	tick
13	seep	seen	seethe	30	cup	cut	cud	47	peace	peas	peak
	seek	seem	seed		cuff	cuss	cub		peach	peat	peal
14	not	tot	got	31	thaw	law	raw	48	bun	bus	but
	pot	hot	lot		paw	jaw	saw		bug	buck	buff
15	vest	test	rest	32	pen	hen	men	49	sag	sat	sass
	best	west	nest		then	den	ten		sack	sad	sap
16	pig	pill	pin	33	puff	puck	pub	50	fun	sun	bun
	pip	pit	pick		pus	pup	pun		gun	run	nun
17	back	bath	bad	34	bean	beach	beat				
	bass	bat	ban		beak	bead	beam				

Supplementary Figure 7. *List of words during MRT-based listening test*


Bosch
Premier Acoustics LTD
250 Hz
500 Hz
1000 Hz
2000 Hz
Front
Back
Left
Right
Up
Down
Re on-axis
-10
-20
-30
-40
-50

(a)



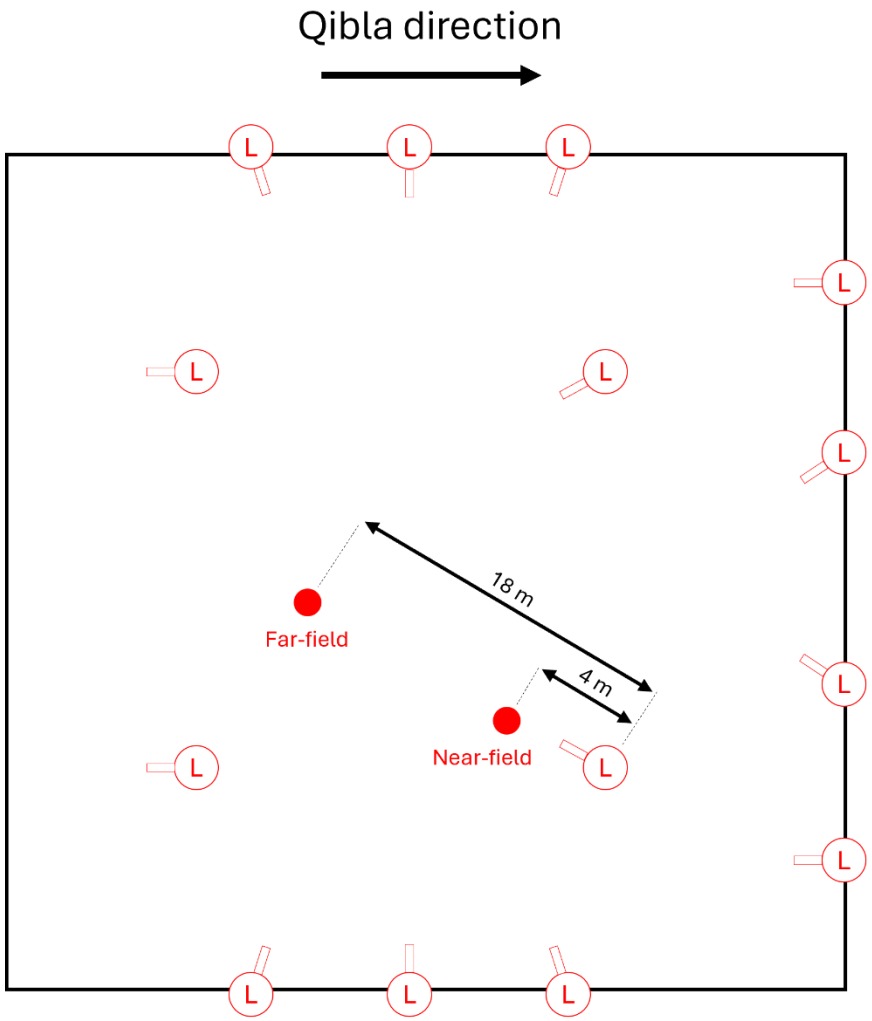
(b)

Supplementary Figure 8. *Directivities of loudspeakers at octave band mid frequencies of 250 Hz, 500 Hz, 1000 Hz, and 2000 Hz from four manufacturers: (a) Bosch and Premier Acoustics LTD; (b)*

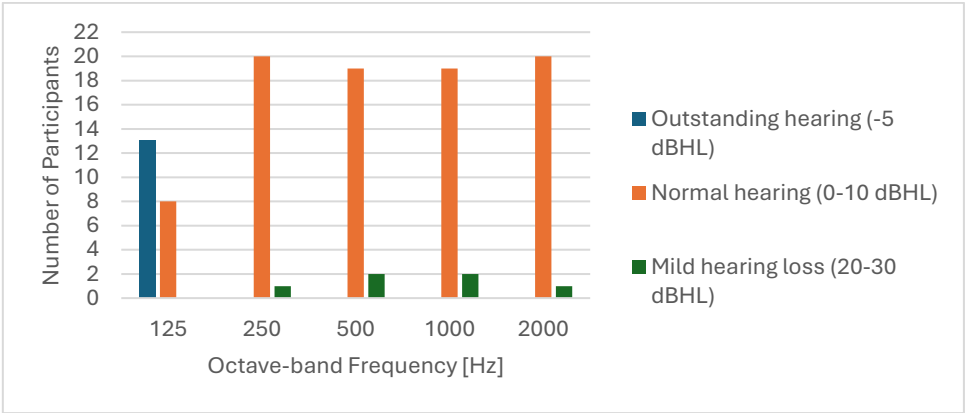
Community and FZ Audio. Each plot shows the directivity with red lines indicating horizontal directivity and blue lines indicating vertical directivity.

***Supplementary Table 2**. Summary of the eight simulated BRIR conditions used in the auralization process.*

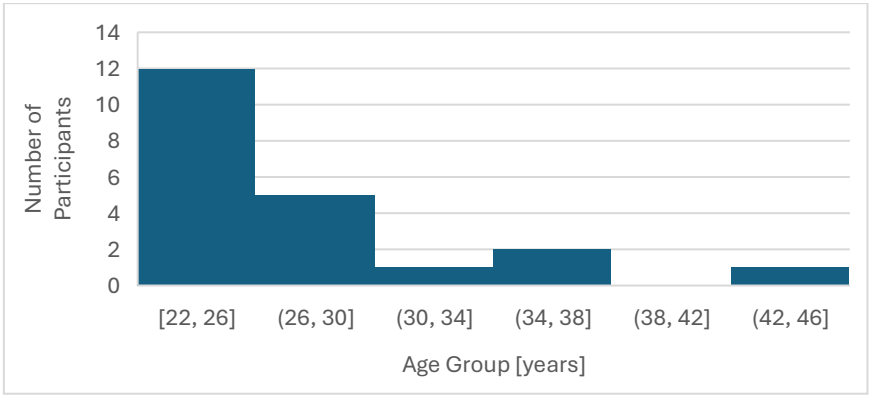
BRIR label	Simulation condition where the simulated BRIR is generated
1	High directivity at near-field (4 m away from the central column-mounted loudspeaker)
2	Low directivity at near-field (4 m away from the central column-mounted loudspeaker)
3	High directivity at far-field (18 m away from the central column-mounted loudspeaker)
4	Low directivity at far-field (18 m away from the central column-mounted loudspeaker)
5	-15° vertical angle at near-field (2 m away from the central column-mounted loudspeaker)
6	-45° vertical angle at near-field (2 m away from the central column-mounted loudspeaker)
7	-15° vertical angle at far-field (18 m away from the central column-mounted loudspeaker)
8	-45° vertical angle at far-field (18 m away from the central column-mounted loudspeaker)



Supplementary Figure 9. *Illustration of evaluation setup, indicating two analysis points: Near-field and Far-field, relative to the central column-mounted loudspeaker's directivity direction.*

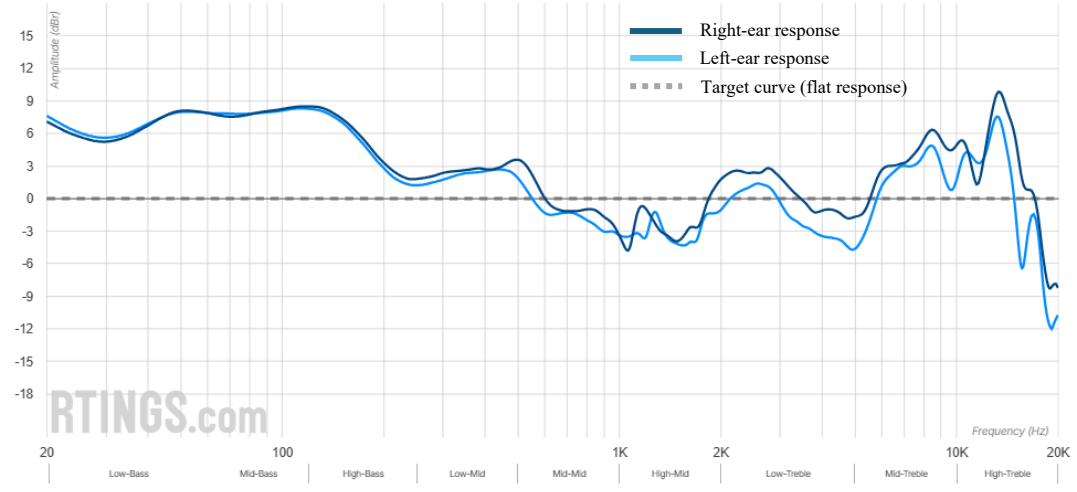


Supplementary Figure 10. *Hearing condition of participants across octave-band frequencies, categorized by hearing level: outstanding, normal, and mild hearing loss.*

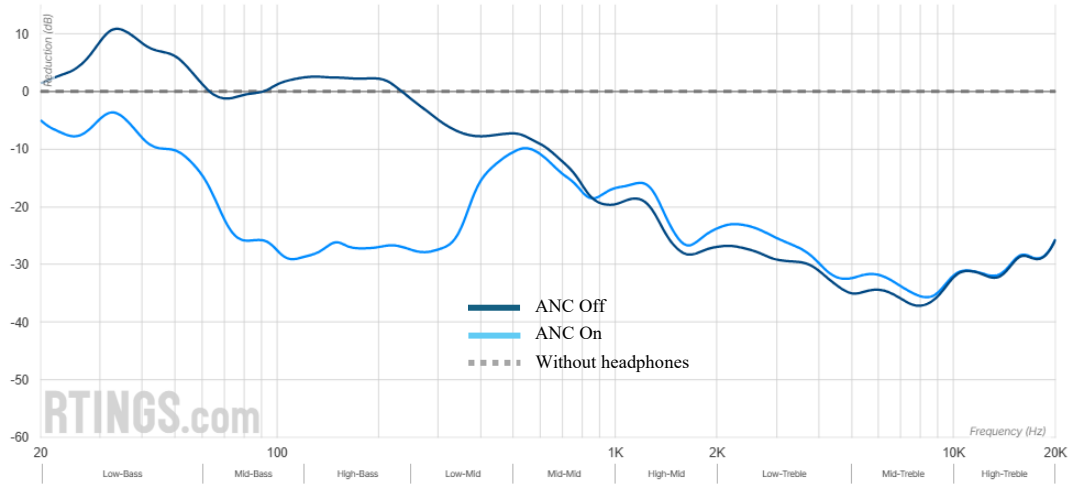


Supplementary Figure 11. *Histogram illustrates the age distribution of the respondents who participated in the listening test.*

(a)

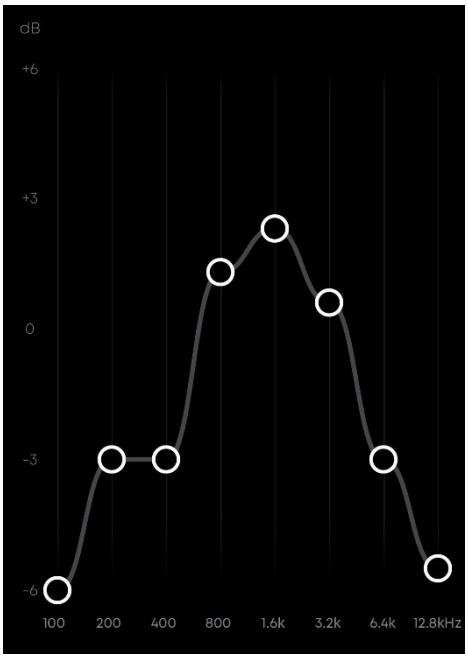


(b)

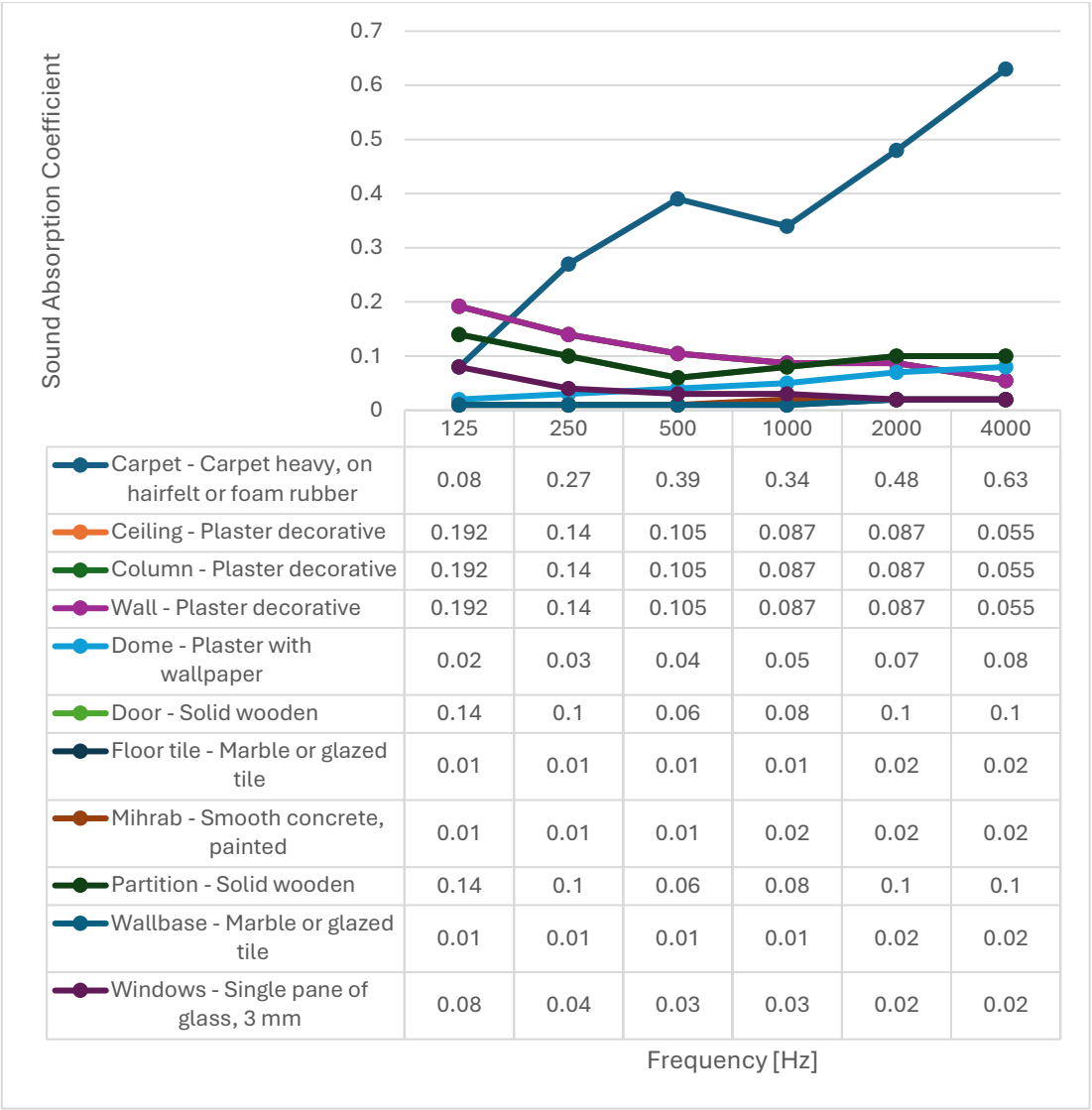


(c)

Supplementary Figure 12. *Acoustic characteristics of the headphones used in the listening test, Soundcore Life Q30. (a) Physical form of the headphones. (b) Sound profile representing amplitude relative to the target curve [dBr] over the frequency range from 20 to 20000 Hz. (c) Noise isolation performance measures how effectively outside noise is blocked. (source: rtings.com).*

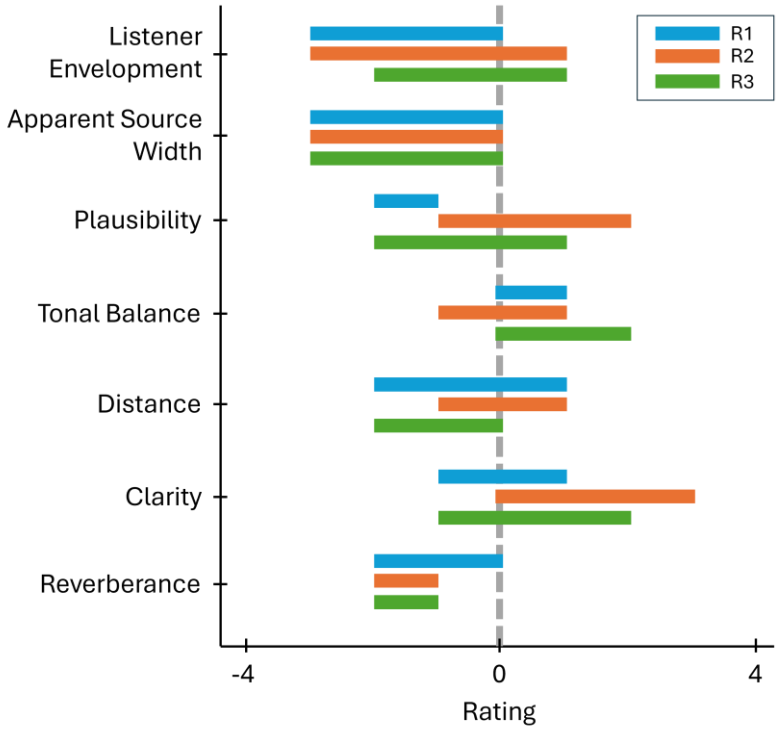


Supplementary Figure 13. *Custom equalizer setting designed to flatten a V-shaped headphone sound profile—taming excessive bass and treble peaks for a more balanced and neutral listening experience.*

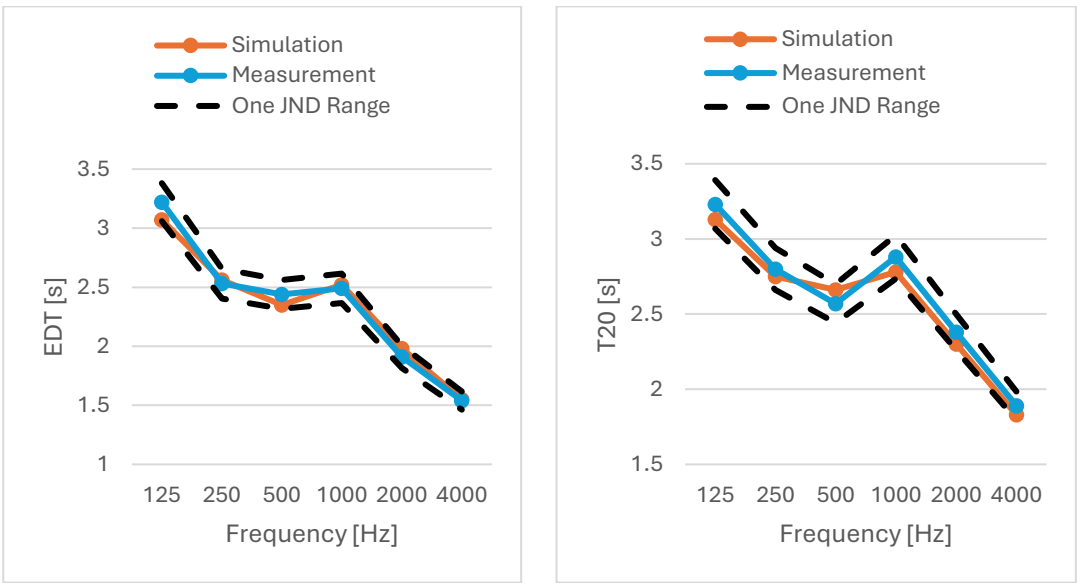


	125	250	500	1000	2000	4000
Carpet - Carpet heavy, on hairfelt or foam rubber	0.08	0.27	0.39	0.34	0.48	0.63
Ceiling - Plaster decorative	0.192	0.14	0.105	0.087	0.087	0.055
Column - Plaster decorative	0.192	0.14	0.105	0.087	0.087	0.055
Wall - Plaster decorative	0.192	0.14	0.105	0.087	0.087	0.055
Dome - Plaster with wallpaper	0.02	0.03	0.04	0.05	0.07	0.08
Door - Solid wooden	0.14	0.1	0.06	0.08	0.1	0.1
Floor tile - Marble or glazed tile	0.01	0.01	0.01	0.01	0.02	0.02
Mihrab - Smooth concrete, painted	0.01	0.01	0.01	0.02	0.02	0.02
Partition - Solid wooden	0.14	0.1	0.06	0.08	0.1	0.1
Wallbase - Marble or glazed tile	0.01	0.01	0.01	0.01	0.02	0.02
Windows - Single pane of glass, 3 mm	0.08	0.04	0.03	0.03	0.02	0.02

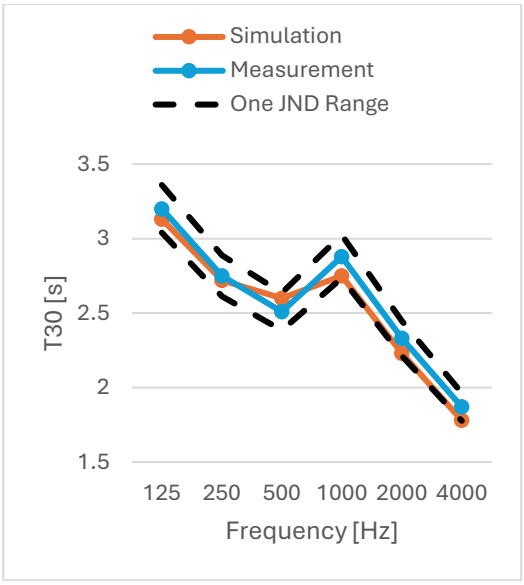
Supplementary Figure 14*. Sound absorption coefficients of materials applied to the surfaces. Floor tile refers to the floor area not used for praying. Wallbase refers to the wall area located 1 meter above the floor.*



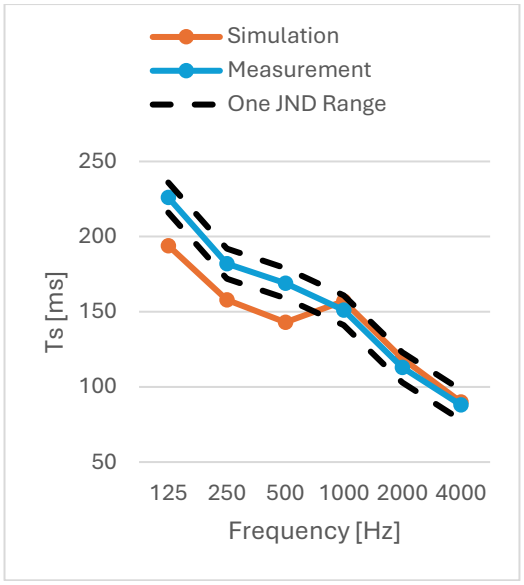
Supplementary Figure 15. *Subjective comparison of measured and simulated mosque audio recordings. The confidence intervals for seven acoustic metrics are shown for three positions: R1 (near the rear wall), R2 (near the side wall), and R3 (near the front wall). Positive ratings favor the measured recording, while negative ratings favor the simulated recording. The result is considered neutral (no differences between the two recordings) when the confidence intervals include 0.*



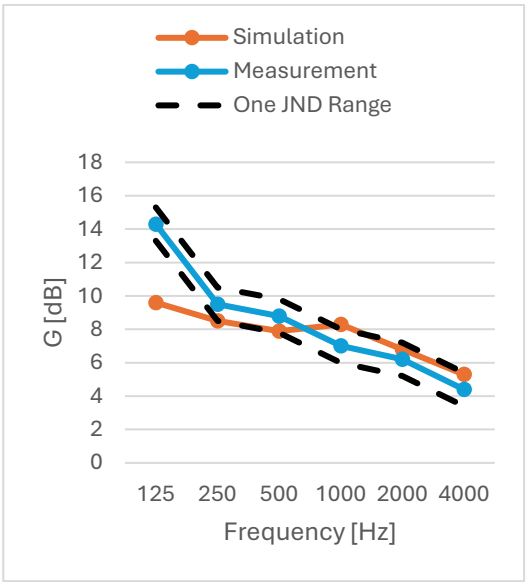
(a) (b)


Simulation
Measurement
One JND Range
3.5
3
2.5
2
1.5
T30 [s]
125 250 500 1000 2000 4000
Frequency [Hz]

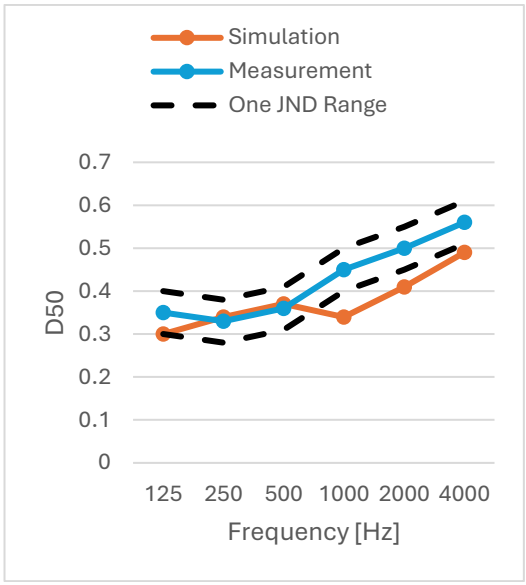
(c)


Simulation
Measurement
One JND Range
250
200
150
100
50
Ts [ms]
125 250 500 1000 2000 4000
Frequency [Hz]

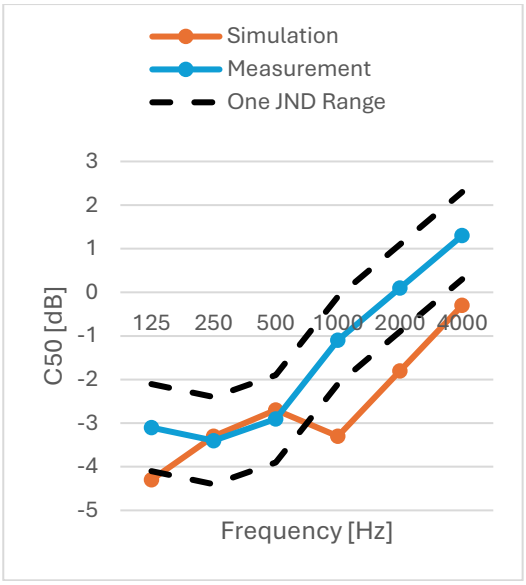
(d)


Simulation
Measurement
One JND Range
18
16
14
12
10
8
6
4
2
0
G [dB]
125 250 500 1000 2000 4000
Frequency [Hz]

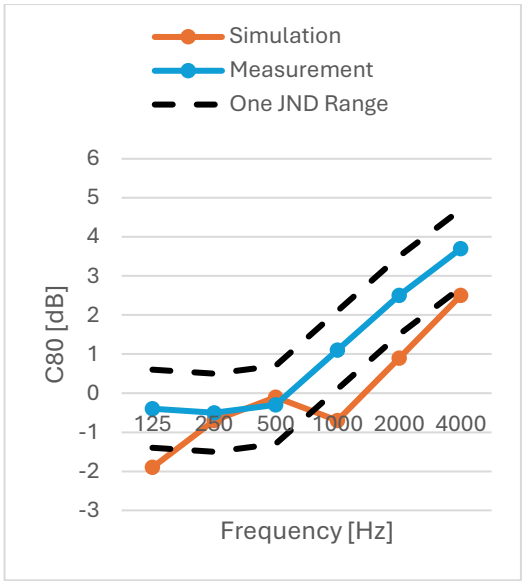
(e)


Simulation
Measurement
One JND Range
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
D50
125 250 500 1000 2000 4000
Frequency [Hz]

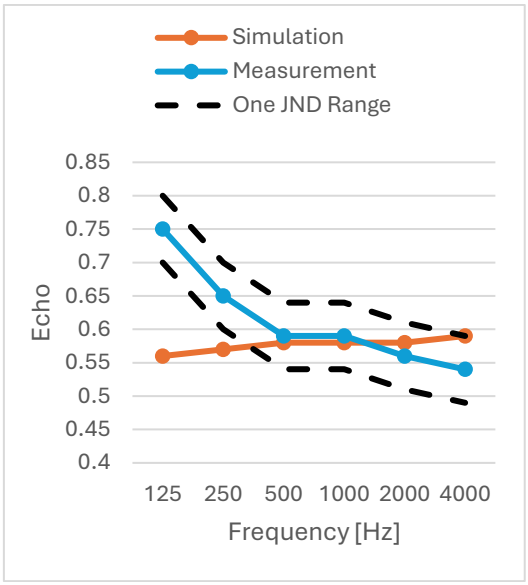
(f)



(g)

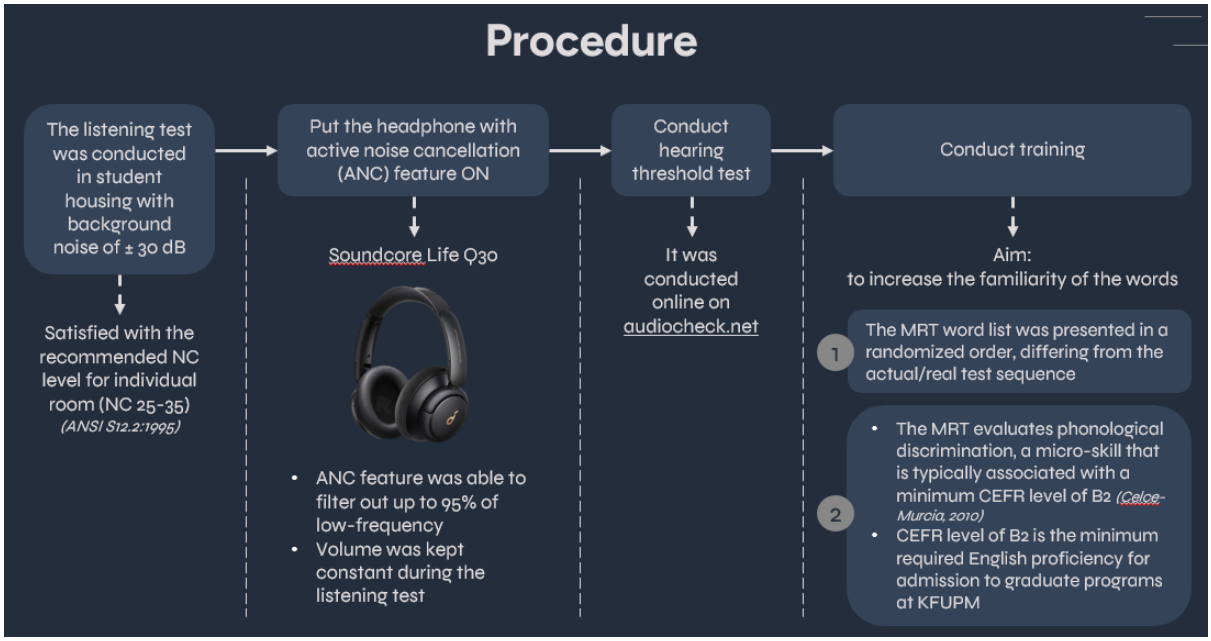


(h)



(i)

Supplementary Figure 16. *Comparison result of nine objective metrics between measured and simulated RIR for calibration: (a) EDT, (b) T20, (c) T30, (d) Ts, (e) G, (f) D50, (g) C50, (h) C80, and (i) Echo. Most of the metrics are within the one JND range, indicating that the simulation model is considered successfully calibrated.*



Supplementary Figure 17*. Procedure of listening tests.*