Supplemental Materials

Supplementary Table 1

Summary statistics on demographic and cognitive baselines by group.

	Experimental Group	**Active control**
	n = 34 (13 female)	*n* = 20 (9 female)
Age (years)		
Mean (*SD*)	70.1 (3.7)	72.3 (5)
Median [min, max]	70 [65, 79]	72 [65, 82]
Hearing threshold (PTA)		
Mean (*SD*)	35.8 (9.4)	33.4 (9.5)
Median [min, max]	35 [20, 60.7]	31.1 [20, 58.1]
MoCA		
Mean (*SD*)	28 (1.7)	28.4 (1.6)
Median [min, max]	29 [24, 30]	28 [24, 30]
Training intensity (minutes)		
Mean (*SD*)	1007.1 (335.7)	981.4 (308.5)
Median [min, max]	930 [580, 1800]	917 [590, 1700]
Working memory		
Mean (*SD*)	0.7 (0.2)	0.7 (0.2)
Median [min, max]	0.8 [0.1, 1]	0.7 [0.2, 0.9]
Phonological Short-term memory		
Mean (*SD*)	5.3 (1.1)	4.8 (1.4)
Median [min, max]	5 [3, 8]	5 [3, 8]
Selective Attention		
Mean (*SD*)	12.3 (6.4)	11.9 (6.6)
Median [min, max]	12.8 [-5, 23.3]	10.8 [-2.2, 24.3]
Divided Attention		

Mean (*SD*)	0.64 (0.27)	0.49 (0.28)
Median [min, max]	0.67 [0.17, 1.15]	0.49 [0.04, 0.99]

Supplementary Table 2

Parameter estimates for the effects of session, number of training sessions, and subject_level random intercept on performance in trained cognitive tasks.

Independent Variable	Predictors	Estimate (β)	CI	*p*
Working Memory				
	(Intercept)	42.49	[31.23, 53.75]	**<.001**
	session [Post-Training]	27.92	[14.91, 40.93]	**<.001**
	age (z)	-1.22	[-7.75, 5.31]	.715
	pta_{4000} (z)	2.16	[-4.84, 9.16]	.548
	hearing aid [yes]	9.13	[-4.44, 22.70]	.189
	Random Effects			
	σ^2	683.00		
	$\tau_{00\ id}$	0.00		
Phonological STM				
	(Intercept)	45.81	[34.17, 57.45]	**<.001**
	session [Post-Training]	12.18	[1.89, 22.47]	**.020**
	age (z)	3.56	[-3.85, 10.97]	.346
	pta_{4000} (z)	0.73	[-7.25, 8.70]	.859
	hearing aid [yes]	17.58	[2.35, 32.80]	**.026**
	Random Effects			
	σ^2	427.00		
	$\tau_{00\ id}$	225.10		
Selective Attention				
	(Intercept)	87.41	[82.62, 92.20]	**<.001**
	session [Post-Training]	11.20	[5.68, 16.72]	**<.001**
	age (z)	-2.53	[-5.31, 0.25]	.074
	pta_{4000} (z)	1.50	[-1.49, 4.50]	.324

	hearing aid [yes]	-0.69	[-6.47, 5.09]	.815
	Random Effects			
	σ2	123.00		
	τ00 id	0.00		
Divided Attention				
	(Intercept)	47.49	[36.29, 58.70]	**<.001**
	session [Post-Training]	18.51	[9.21, 27.81]	**<.001**
	age (z)	-0.13	[-7.36, 7.10]	.971
	pta_{4000} (z)	-2.58	[-10.37, 5.21]	.517
	hearing aid [yes]	17.02	[1.92, 32.12]	**.027**
	Random Effects			
	σ^2	362.67		
	$\tau_{00\ id}$	272.36		
Contrasts				
session [Pre-Training]	-1			
session [Post-Training]	1			

Supplementary Table 3

Training effect model parameter estimates per untrained cognitive task.

Independent Variable	**Predictors**	**Estimate (β)**	**CI**	***p***
Working Memory				
	(Intercept)	40.996	[30.23, 51.76]	<.001
	session [Post-Training]	8.922	[3.57, 14.27]	**.001**
	group [EG-HL]	-7.554	[-16.64, 1.53]	.103
	age_z	-5.875	[-14.55, 2.80]	.184
	pta_4000_z	-0.396	[-8.43, 7.64]	.923
	hearing_aid [Yes]	1.920	[-14.73, 18.57]	.821
	session [Post-Training] × group [EG-HL]	-1.805	[-7.16, 3.55]	.508
	Random Effects			
	σ^2	148.5		

	$\tau_{00\ id}$	658.1		
Phonological STM				
	(Intercept)	29.795	[20.56, 39.03]	**<.001**
	timepoints [Post-Training]	11.952	[4.61, 19.30]	**.001**
	group [EG-HL]	-4.097	[-12.21, 4.01]	.322
	age_z	0.092	[-6.61, 6.79]	.978
	pta_4000_z	0.329	[-6.29, 6.95]	.922
	hearing_aid [yes]	-1.044	[-14.98, 12.89]	.883
	timepoints [Post-Training] : group [EG-HL]	-0.310	[-7.65, 7.03]	.934
	Random Effects			
	σ^2	336.9		
	$\tau_{00\ id}$	391.1		
Selective Attention				
	(Intercept)	37.979	[28.05, 47.91]	**<.001**
	session [Post-Training]	14.338	[5.94, 22.74]	**.001**
	group [EG-HL]	-1.700	[-10.61, 7.21]	.708
	age_z	1.620	[-6.51, 9.75]	.696
	pta_4000_z	-5.718	[-12.39, 0.95]	.093
	hearing aid [yes]	-3.118	[-17.78, 11.54]	.677
	session [Post-Training] : group [EG-HL]	-0.937	[-9.32, 7.45]	.827
	Random Effects			
	σ^2	329.6		
	$\tau_{00\ id}$	355.5		
Divided Attention				
	(Intercept)	54.431	[44.61, 64.25]	**<.001**
	timepoint [Post-Training]	1.496	[-7.00, 9.99]	.729
	group [EG-HL]	-6.569	[-15.21, 2.07]	.136
	age_z	-5.236	[-12.43, 1.96]	.154
	pta_4000_z	4.188	[-3.18, 11.56]	.265
	hearing aid [yes]	-6.435	[-20.96, 8.09]	.385

	session [Post-Training] : group [EG-HL]	1.092	[-7.41, 9.59]	.800
	Random Effects			
	σ^2	384.3		
	$\tau_{00\ id}$	365.0		
Contrasts				
session [Pre-Training]	-1			
session [Post-Training]	0			
session [Follow-Up]	1			
group [CG-HL]	-1			
group [EG-HL]	1			

Supplementary Table 4

Parameter estimates for the effects of session, group, and noise level on performance in the speech comprehension task.

Predictors	**Estimate (OR)**	**CI**	***p***
(intercept)	4.10	[3.53, 4.68]	<.001
session [Post-Training]	0.01	[−0.21, 0.24]	.897
group [EG-HL]	−0.16	[−0.51, 0.20]	.382
noise level [Low-Noise]	−2.81	[−3.50, −2.12]	<.001
noise level [High-Noise]	−5.05	[−5.76, −4.34]	<.001
pta_{4000} (z)	−0.43	[−0.59, −0.27]	<.001
age (z)	−0.16	[−0.33, 0.02]	.079
hearing aid [yes]	−0.07	[−0.42, 0.28]	.681
session : group	0.38	[0.22, 0.54]	<.001
session : noise level [Low-Noise]	−0.26	[−0.50, −0.02]	.035
session : noise level [High-Noise]	−0.20	[−0.44, 0.04]	.104
group : noise level [Low-Noise]	−0.09	[−0.44, 0.26]	.605
group : noise level [High-Noise]	−0.07	[−0.44, 0.31]	.733
session : group : noise level [Low-Noise]	−0.18	[−0.32, −0.05]	.009
session : group : noise level [High-Noise]	−0.26	[−0.40, −0.12]	<.001
Random Effects			

σ^2	3.29
$\tau_{00\ noise\_level:item}$	2.78
$\tau_{00\ id}$	1.20
$\tau_{11\ noise\_level:item.noise\_levellow\text{-}noise}$	0.88
$\tau_{11\ noise\_level:item.noise\_levelhigh\text{-}noise}$	0.76
$\tau_{11\ noise\_level:item.sessionPost\text{-}Training}$	0.20
$\tau_{11\ id.noise\_levellow\text{-}noise}$	0.57
$\tau_{11\ id.noise\_levelhigh\text{-}noise}$	0.18
$\tau_{11\ id.sessionPost\text{-}Training}$	0.12
Contrasts	
session [Pre-Training]	-1
session[Post-Training]	1
group [CG-HL]	-1
group [EG-HL]	1
noise_level [No-Noise]	-1
noise_level [Low-Noise]	0
noise_level [High-Noise]	1

Supplementary Table 5

Independent Variable	Predictors	Estimate (β)	CI	*p*
OLSA				
	(Intercept)	-5.388	[-6.236, -4.539]	**<.001**
	session [Post-Training]	-0.226	[-0.736, 0.284]	.385
	group [EG-HL]	0.421	[-0.618, 1.460]	.427
	pta_4000_z	1.003	[0.522, 1.483]	**<.001**
	age_z	0.332	[-0.132, 0.797]	.161
	hearing_aid [Yes]	0.764	[-0.152, 1.681]	.102
	session [Post-Training] ×	-0.189	[-0.820,	.558

	group [EG-HL]		0.443]	
	Random Effects			
	σ^2	0.612		
	$\tau_{00\ id}$	2.300		
SSQ				
	(Intercept)	0.148	[-0.152, 0.448]	.335
	session [Post-Training]	0.119	[-0.170, 0.409]	.419
	group [EG-HL]	0.062	[-0.315, 0.440]	.746
	pta_4000_z	-0.021	[-0.174, 0.132]	.783
	age_z	0.037	[-0.119, 0.194’]	.641
	hearing_aid [Yes]	-0.237	[-0.556, 0.081]	.146
	session [Post-Training] × group [EG-HL]	-0.014	[-0.378, 0.349]	.938
	Random Effects			
	Dispersion	19.2		
	$\tau_{00\ id}$	0.210		
Listening Effort				
	(Intercept)	0.280	[0.043, 0.517]	**.021**
	session [Post-Training]	-0.170	[-0.351, 0.011]	.063
	group [EG-HL]	-0.016	[-0.313, 0.281]	.917
	pta_4000_z	0.027	[-0.099, 0.154]	.677
	age_z	0.096	[-0.034, 0.226]	.149
	hearing_aid [Yes]	0.032	[-0.230, 0.294]	.811
	session [Post-Training] × group [EG-HL]	0.161	[-0.065, 0.387]	.161
	Random Effects			

	Dispersion	51.5
	$\tau_{00\ id}$	0.177
Contrasts		
session [Pre-Training]	-1	
session [Post-Training]	0	
session [Follow-Up]	1	
group [CG-HL]	-1	
group [EG-HL]	1	

Supplementary Table 6

Assessment games used in the auditory-cognitive training application, including baseline tests.

Test Name	Cognitive Domain	Description	Documentation Link
Digit Span Test	Short-Term Memory	Assesses the ability to recall sequences of numbers in the same or reverse order, measuring short-term and working memory capacity.	https://static.cognifit.com/manuals/Digit+Span+Test.pdf
Distance Estimation Test	Spatial Perception	Evaluates the capacity to estimate the relative distance between objects in a three-dimensional space.	https://static.cognifit.com/manuals/Distance+Estimation+Test.pdf
Divided Attention Test	Attention	Measures the ability to divide attention between two simultaneous tasks, such as tracking a moving object while responding to auditory stimuli.	https://static.cognifit.com/manuals/Divided+Attention+Test.pdf
Eye-Hand Coordination Test (MUD)	Coordination	Assesses the synchronization between visual input and motor responses by requiring participants to track moving objects with precise hand movements.	https://static.cognifit.com/manuals/Eye-Hand+Coordination+Test+(MUD).pdf
Maze Test	Planning & Problem-Solving	Evaluates planning skills by having participants navigate through increasingly complex mazes, requiring foresight and strategy.	https://static.cognifit.com/manuals/Maze+Test.pdf

Multimodal Lexical Memory Test	Verbal Memory	Tests the ability to recognize and recall words presented through different sensory modalities, assessing verbal memory and learning.	https://static.cognifit.com/manuals/Multimodal+Lexical+Memory+Test.pdf
Naming Test	Language	Measures the ability to accurately and rapidly name objects presented visually, assessing lexical access and verbal expression.	https://static.cognifit.com/manuals/Naming+Test.pdf
Number-Size Congruency Test	Inhibitory Control	Evaluates the ability to suppress automatic responses by requiring participants to identify numerical values while ignoring conflicting size cues.	https://static.cognifit.com/manuals/Number-Size+Congruency+Test.pdf
Speed Estimation Test	Processing Speed	Assesses the ability to estimate the speed of moving objects, crucial for tasks requiring rapid visual processing.	https://static.cognifit.com/manuals/Speed+Estimation+Test.pdf
Stroop Test	Inhibitory Control	Measures the capacity to inhibit cognitive interference by requiring participants to name the ink color of words that denote different colors.	https://static.cognifit.com/manuals/Stroop+Test.pdf

Tapping Test + Psychomotor Vigilance Test	Psychomotor Speed	Evaluates motor speed and alertness by measuring response times to visual stimuli and repetitive tapping tasks.	https://static.cognifit.com/manuals/Tapping+Test+++Psychomotor+Vigilance+Test.pdf
Time Estimation Test	Time Perception	Assesses the ability to perceive and estimate time intervals, important for time management and coordination.	https://static.cognifit.com/manuals/Time+Estimation+Test.pdf
Visual Memory Test	Visual Memory	Tests the capacity to recall visual information, such as shapes and patterns, after brief exposure.	https://static.cognifit.com/manuals/Visual+Memory+Test.pdf
Visual Working Memory Span Test	Working Memory	Measures the ability to temporarily hold and manipulate visual information, essential for complex cognitive tasks.	https://static.cognifit.com/manuals/Visual+Working+Memory+Span+Test.pdf

Note: Table displays cognitive assessment games used for evaluating trained cognitive domains, alongside additional tests used for the training algorithm's baseline cognitive performance evaluation.