iScience, Volume *26*

Supplemental information

Beyond sense-specific processing:

decoding texture in the brain

from touch and sonified movement

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Supplementary information

Methods

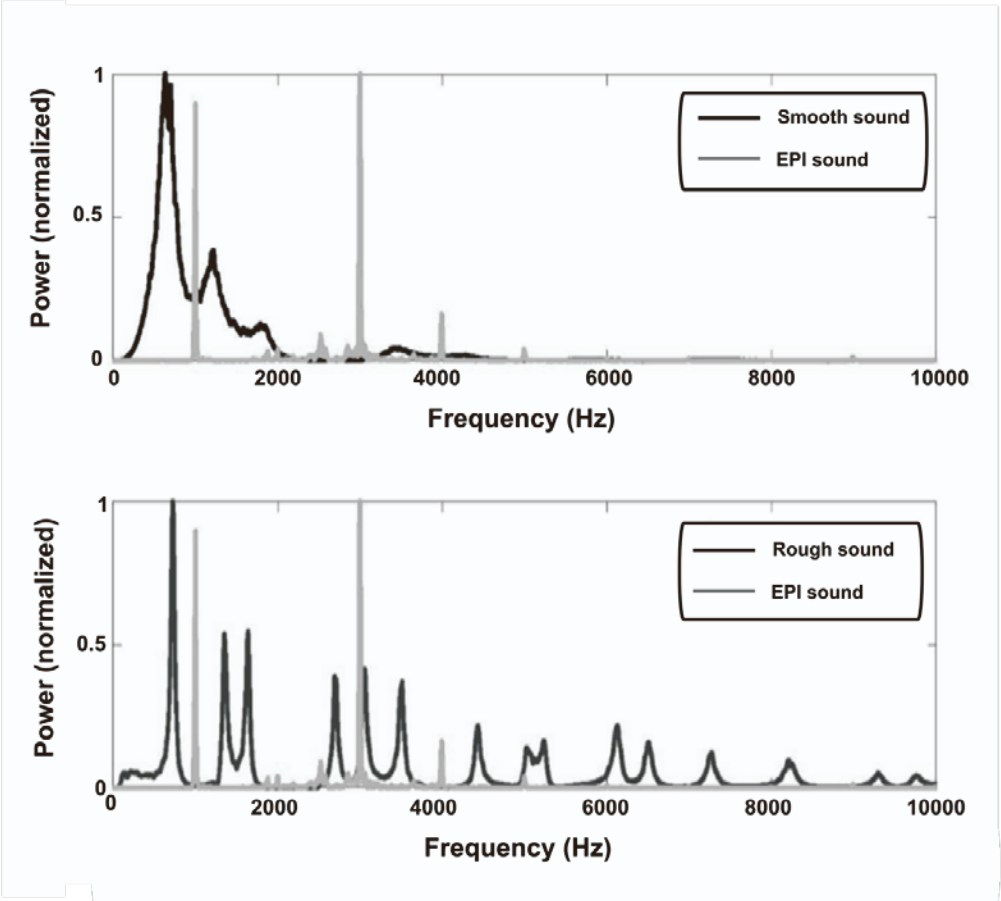

Figure S1 | Related to Figure1. Frequency spectrums of the smooth (Top) and rough (bottom) sounds compared to that of the EPI sound delivered during the functional scanning session

Figure S2 | Related to Figure 1. Finger position when the instruction "bouge" or fixe" were given to the participant

Result tables

Table S1 | Results of the univariate analysis during Haptic exploration of rough and smooth textures versus Rest condition as evidenced by the contrast [0.5*(H_{Rough}+H_{Smooth})>Rest]. Related to Figure 3A

	n cluster	*k*	*x*	*y*	*z*	*t-value*
Parietal cortex & Precentral gyrus						
L Postcentral gyrus (BA3)	1	14357	-45	-18	52	11.69
L Precentral gyrus (BA4)	1	14357	-33	-21	60	8.04
L Parietal Operculum (OP1,3,4)	1	14357	-55	-18	19	7.24
R Parietal Operculum (OP1,3,4)	3	204	**60**	**-18**	**15**	5.64
R Postcentral gyrus (BA3)	3	204	55	-12	35	5.54
R Inferior parietal sulcus (hIP1)	4	175	**35**	**-55**	**42**	5.01
Temporal cortex						
L Heschl's gyrus (TE 1.0)	1	14357	-50	-26	12	4.40
Frontal cortex						
Supplementary motor area (BA6)	1	14357	-8	-5	55	7.17
L Precentral gyrus (BA6)	1	14357	-37	-8	52	8.45
L Insula anterior	1	14357	-32	19	-3	8.31
L Inferior frontal gyrus (BA44)	1	14357	-55	5	15	5.80
R Insula anterior	1	14357	35	17	-2	7.93
L Inferior frontal gyrus (BA44)	1	14357	59	10	17	6.02
R Middle frontal gyrus (BA45)	1	155	**43**	**33**	**20**	**7.30**
Occipital cortex						
L intracalcarine cortex (V1)	1	14357	-28	-69	12	8.44
R intracalcarine cortex (V1)	1	14357	28	-65	7	7.50
Cerebellum						
R Cerebellum (V)	1	14357	**8**	**-62**	**-15**	16.55
R Cerebellum (VI)	1	14357	24	-60	-25	14.71
R Cerebellum (VIII)	1	14357	17	-60	-52	11.89
L Cerebellum (VI)	1	14357	-30	-60	-27	9.67
L Cerebellum (VII)	2	330	**-15**	**-75**	**-52**	7.26
Subcortical regions						
L Pallidium	1	14357	-20	2	0	10.89
L Thalamus	1	14357	-12	-19	0	10.83
L Putamen	1	14357	-19	2	8	10.09
L Brainstem, colliculus	1	14357	-7	-32	-7	6.02
R Putamen	1	14357	22	2	2	7.56
R Thalamus	1	14357	12	-15	2	6.67
Dorsal brainstem	4	72	3	-51	-65	7.33

Brain areas and t-values refer to peaks of significant activations after correction for multiple comparison at the cluster level (voxel uncorrected: $p<0.001$, cluster FWE-corrected $p < 0.05$). Coordinates of local maxima are denoted by x,y,z in millimetres (MNI space). k represents the number of voxels. L: Left, R: Right, BA: Brodmann area, OP: Parietal operculum. OP and hIP1 are nomenclatures proposed by Eickhoff et al., 2006.

Table S2 | Results of the univariate analysis during Auditory stimuli of rough and smooth textured sounds versus Rest condition as evidenced by the contrast [0.5*(A_{Rough}+A_{Smooth})>Rest]. Related to Figure 3B.

	n cluster	*k*	*x*	*y*	*z*	*t-value*
Temporal cortex						
L Planum polare (Id1)	2	2107	**-45**	**-22**	**0**	11.4
L Heschl's gyrus (TE 1.0)			-52	20	5	11.31
R Planum temporal (TE 1.1)	1	2121	**48**	**-26**	**10**	11.0
R Heschl's gyrus (TE 1.0)			51	-16	8	9.09
Frontal cortex						
R Precentral gyrus (BA 4)	1	2121	53	-6	39	6.74
L Insula anterior	2	2107	-32	20	0	8.51
L Paracingulate gyrus (BA 6)	3	1149	**-4**	**18**	**42**	9.72
L Precentral gyrus (BA 6)	4	640	**-47**	**-4**	**48**	6.81
L Inferior frontal gyrus (BA 44)	4	640	-37	9	25	5.14
R Insula anterior	8	187	**33**	**16**	**2**	6.42
L Frontal pole	12	115	**-29**	**45**	**15**	6.18
R Precentral gyrus (BA 4)	16	65	**28**	**-22**	**48**	4.56
R Frontal pole	18	45	**43**	**35**	**24**	4.99
Occipital Cortex						
L Calcarine gyrus (V1)	9	164	**-26**	**-61**	**31**	7.59
R Calcarine gyrus (V1)	11	119	**26**	**-67**	**5**	5.40
Parietal Cortex						
R IPS (hIP3)	10	142	**30**	**-52**	**42**	5.53
L IPS (hIP3)	14	82	**-27**	**-54**	**-45**	5.35
Cerebellum						
R Cerebellum (VI)	5	258	**10**	**-79**	**-22**	8.03
L Cerebellum (VI)	5	258	-10	-76	-22	5.14
R Cerebellum (VI)	6	231	**28**	**-59**	**-28**	6.93
L Cerebellum (VI)	7	192	**-27**	**-62**	**-28**	6.72
L Cerebellum (VII)	15	76	**-30**	**-64**	**-52**	6.42
Subcortical regions						
L Putamen	13	107	**-20**	**6**	**5**	6.37
R Thalamus	17	45	**13**	**-19**	**8**	6.22

Brain areas and t-values refer to peaks of significant activations after correction for multiple comparison at the cluster level (voxel uncorrected: p<0.001, cluster FWE-corrected p < 0.05). Coordinates of local maxima are denoted by x, y, z in millimetres (MNI space). k represents the number of voxels. L: Left, R: Right, BA: Brodmann area, OP: Parietal operculum. OP, hIP3 and Id1 are nomenclatures proposed by Eickhoff et al., 2006 and TE by Morosan et al., 2001.

Table S3 | Results of the univariate analysis during Audio-Haptic exploration of rough and smooth textures versus Rest condition as evidenced by the contrast [0.5*(AH_{Rough}+AH_{Smooth})>Rest]. Related to Figure 3C.

	n cluster	*k*	*x*	*y*	*z*	*t-value*
Temporal cortex						
L Heschl's gyrus (TE 1.0)	1	13031	-45	-20	0	12.4
L Heschl's gyrus (TE 1.1)	1	13031	-42	-28	6	10.4
R Planum polare (TE 1.0)	2	2041	**52**	**-13**	**2**	12.18
R Heschl's gyrus (TE 1.1)	2	2041	49	-22	5	10.70
Parietal cortex & Precentral gyrus						
L Postcentral gyrus (BA1)	1	13031	-50	-17	47	10.02
L Precentral gyrus (BA6)	1	13031	-3	-9	55	9.16
L Parietal Operculum (OP1)	1	13031	-55	-18	15	7.65
R Postcentral gyrus (BA3)	2	2041	55	-12	34	5.33
R Parietal Operculum (OP1)	2	2041	55	-16	18	3.60
R Inferior parietal sulcus (hIP3)	6	152	40	-60	48	5.13
Frontal cortex						
Supplementary motor area (BA 6)	1	13031	-8	1	50	6.90
L Insula anterior	1	13031	-30	20	3	5.57
L Precentral gyrus (BA 6)	1	13031	-55	-2	35	4.7
R Insula anterior	3	533	**35**	**25**	**3**	7.01
R Inferior frontal gyrus (BA45)	3	533	43	33	18	6.3
R Inferior frontal gyrus (BA 44)	5	155	**58**	**10**	**18**	5.25
Occipital Cortex						
L Intracalcarine gyrus (V1)	1	13031	-28	-66	5	8.60
R Intracalcarine gyrus (V1)	1	13031	30	-65	5	7.41
Cerebellum						
R Cerebellum (V)	1	13031	**8**	**-63**	**-15**	16.57
R Cerebellum (VI)	1	13031	25	-60	-25	14.3
L Cerebellum (VIII)	4	304	**-28**	**-65**	**-58**	7.21
L Cerebellum (VI)	1	13031	-30	-64	-22	5.65
Subcortical regions						
L Thalamus	1	13031	-13	-20	0	9.23
L Putamen	1	13031	-22	-2	7	6.28
L Brainstem, colliculus	1	13031	-5	-24	-16	3.55
R Thalamus	7	71	**13**	**-15**	**3**	6.32
R Putamen	3	533	23	-3	8	5.35

Brain areas and t-values refer to peaks of significant activations after correction for multiple comparison at the cluster level (voxel uncorrected: $p<0.001$, cluster FWE-corrected $p < 0.05$). Coordinates of local maxima are denoted by x, y, z in millimetres (MNI space). k represents the number of voxels. L: Left, R: Right, BA: Brodmann area, OP: Parietal Operculum. OP and hIP3 are nomenclatures proposed by Eickhoff et al., 2006 and TE by Morosan et al., 2001.

Table S4 | Multisensory integration: Brain areas specifically activated during Bimodal versus Unimodal exploration of rough and smooth textures as evidenced by the conjunction [AH-A ∩ AH-H] >0. Related to Figure 4

	n cluster	*k*	*x*	*y*	*z*	*t-value*
L Heschl's gyrus (TE 1.1)	1	493	**-48**	**-28**	**10**	6.7
L Heschl's gyrus (OP1)	1	493	-55	-30	12	3.6

Brain areas and t-values refer to peaks of significant activations after correction for multiple comparison at the cluster level (voxel uncorrected: p<0.01, cluster FWE-corrected p < 0.05). Coordinates of local maxima are denoted by x,y,z in millimetres (MNI space). k represents the number of voxels. L: Left, R: Right, OP: Parietal Operculum, OP and TE are nomenclatures proposed respectively by Eickhoff, S.B et al. (2006) and Morosan, P. et al. (2001).

Table S5 | Results of the within-modality decoding in Haptic condition. The classifier was trained to discriminate the texture on 3 Haptic runs and tested it on the 2 remaining runs. Related to Figure 5A.

	n cluster	*k*	*x*	*y*	*z*	*t-value*
Temporal cortex						
L Auditory cortex (TE 1.2)	1	762	-52	-13	2	4.16
R Auditory cortex (TE 1.0)	2	584	55	-11	0	3.4
Parietal cortex & Precentral gyrus						
L Parietal Operculum (OP1)	1	762	**-42**	**-19**	**17**	6.03
L Postcentral gyrus (BA2)	1	762	-48	-19	44	4.04
L Precentral gyrus (BA4)	1	762	-46	-3	52	3.20
R Parietal operculum (OP1)	2	584	**63**	**-18**	**10**	5.69
R Poscentral gyrus (BA3)	2	584	58	-13	30	4.35
R Insula (id1)	2	584	48	-11	-9	3.83
L Precentral gyrus (BA 6)	3*	103	**-50**	**1**	**-27**	4.55
R Inferior parietal sulcus (hIP3)	4*	103	**38**	**-59**	**45**	3.79

Brain areas and t-values refer to peaks of significant decoding accuracy after correction for multiple comparison at the cluster level (voxel uncorrected: p<0.001, cluster FWE-corrected p < 0.05 or * cluster uncorrected p<0.005). Coordinates of local maxima are denoted by x, y, z in millimetres (MNI space). k represents the number of voxels. L: Left, R: Right, BA: Brodmann area, OP: Parietal Operculum. OP, id1 and hIP3 are nomenclatures proposed by Eickhoff et al., 2006 and TE by Morosan et al., 2001.

Table S6 | Results of the within-modality decoding in Audio condition. The classifier was trained to discriminate the texture on 3 Audio runs and tested it on the 2 remaining runs. Related to Figure 5A.

	n cluster	*k*	*x*	*y*	*z*	*t-value*
Temporal cortex						
L Auditory cortex (TE 1.0)	1	1615	**-50**	**-19**	**2**	8.84
R Auditory cortex (TE 1.1)	2	1601	**45**	**-17**	**0**	10.5
Parietal cortex & Precentral gyrus						
L Parietal Operculum (OP1)	1	1615	-49	-22	16	5.6
L Postcentral gyrus (BA3)	1	1615	-52	-19	34	3.5
R Parietal Operculum (OP1)	2	1601	59	-19	17	5.18
R Postcentral gyrus (BA2)	2	1601	58	-17	23	2.08
R Precentral gyrus (BA4)	5*	122	**50**	**-9**	**40**	4.61
Frontal cortex						
Paracingulate gyrus (BA6)	3*	191	**8**	**16**	**60**	4.01
Subcortical						
R Putamen	4*	130	**23**	**6**	**5**	4.93

Brain areas and t-values refer to peaks of significant decoding accuracy after correction for multiple comparison at the cluster level (voxel uncorrected: p<0.001, cluster FWE-corrected p < 0.05 or * cluster uncorrected p<0.005). Coordinates of local maxima are denoted by x, y, z in millimetres (MNI space). k represents the number of voxels. L: Left, R: Right, BA: Brodmann area, OP: Parietal Operculum. OP is a nomenclature proposed by Eickhoff et al., 2006 and TE by Morosan et al., 2001.

Table S7 | Results of the within-modality decoding in Bimodal condition. The classifier was trained to discriminate the texture on 3 Bimodal runs and tested it on the 2 remaining runs. Related to Figure 5A.

	n cluster	*k*	*x*	*y*	*z*	*t-value*
Temporal cortex						
L Auditory cortex (TE1.1)	1	2517	**-37**	**-24**	**5**	9.20
R Auditory cortex (TE 1.1)	2	1743	**35**	**-21**	**7**	8.35
Parietal cortex						
L Parietal Operculum (OP1)	1	2517	-52	-20	12	7.14
L Postcentral gyrus (BA2)	1	2517	-47	-32	50	5.20
R Parietal Operculum (OP1)	2	1743	61	-21	14	7.65
Frontal cortex						
L Precentral gyrus (BA4)	1	2517	-52	-9	42	3.26
L Precentral gyrus (BA6)	1	2517	-45	4	50	3.7
Paracingulate gyrus (BA6)	3*	174	**-4**	**8**	**50**	4.76
R Precentral gyrus (BA6)	4*	121	53	4	40	4.48

Brain areas and t-values refer to peaks of significant decoding accuracy after correction for multiple comparison at the cluster level (voxel uncorrected: p<0.001, cluster FWE-corrected p < 0.05 or * cluster uncorrected p<0.005). Coordinates of local maxima are denoted by x, y, z in millimetres (MNI space). k represents the number of voxels. L: Left, R: Right, BA: Brodmann area, OP: Operculum parietal. OP is a nomenclature proposed by Eickhoff et al., 2006 and TE by Morosan et al., 2001.

Table S8 | Results of the cross-modality decoding. The classifier was trained to discriminate the texture on 3 Audio runs and tested it on the 2 Haptic runs and *vice versa*. Related to Figure 5B.

	n cluster	*k*	*x*	*y*	*z*	*t-value*
Temporal cortex						
L Auditory cortex (TE1.1)	2*	96	**-47**	**-29**	**8**	5.43
Parietal cortex						
L Postcentral gyrus (BA2)	1	354	**-45**	**-26**	**62**	5.05
L Parietal Operculum (OP2)	3*	75	**-62**	**-6.5**	**20**	3.73
Frontal cortex						
L Precentral gyrus (BA6)	1	354	-27	-13	57	3.03

Brain areas and t-values refer to peaks of significant decoding accuracy after correction for multiple comparison at the cluster level (voxel uncorrected: p<0.001, cluster FWE-corrected p < 0.05 or * cluster uncorrected p<0.005. Coordinates of local maxima are denoted by x, y, z in millimetres (MNI space). k represents the number of voxels. L: Left, R: Right, BA: Brodmann area, OP: Parietal Operculum. OP is a nomenclature proposed by Eickhoff et al., 2006 and TE by Morosan et al., 2001.

Cross-modal decoding

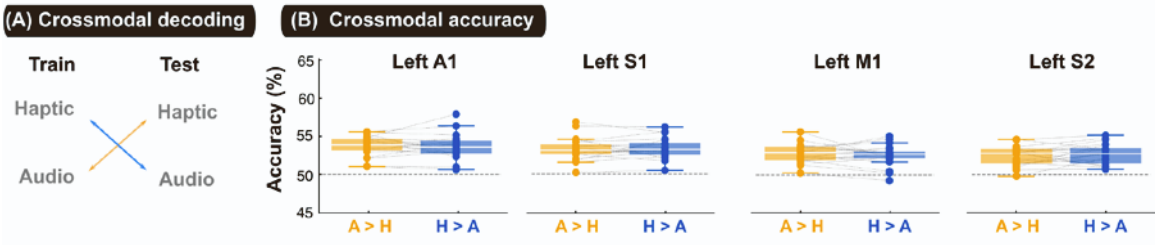

Figure S3 | Cross-modal accuracy decoding. Related to Figure 5B. **A.** Schematic illustration of the different cross-decoding protocols. **B.** Comparison of the maximal accuracy values extracted for A1, S1, M1 and S2 left region of interest. Boxplot of the accuracy values for Audio to Haptic decoding (in yellow) an Haptic to Audio decoding (blue). The symbols represent individual values . Each box represent the distribution (ie, from the 25th to the 75th percentile) whereas the medians are represented by the horizontal white line inside the box. Vertical extending lines denote the extreme values within a 1.5 interquartile range.