

The psychomechanics of simulated sound sources: Material properties of impacted plates
Supplementary Online Materials

Stephen McAdams
McGill University

Vincent Roussarie
PSA Peugeot-Citroën

Antoine Chaigne
ENSTA-UME

Bruno L. Giordano
McGill University

Correspondence concerning this article should be addressed to Stephen McAdams, Schulich School of Music, McGill University, 555 Sherbrooke Street West, H3A 1E3, Montréal, Québec, Canada. E-mail: smc@music.mcgill.ca.

Table S1
Sound synthesis variables and related acoustical descriptors for the experimental stimulus sets. W = simulated wood mallet (upper part); R = simulated rubber mallet (lower part); ERBr = ERB-rate. The principal-component-based acoustical descriptors are described in Section VI.

Mallet	H	c (km/s)	α_1 (dB/s)	α_2 (dB/s)	ED_{3dB} (ms)	ED_{10dB} (ms)	f_1 (Hz)	p_a (s^{-1})	p_b $s^{-2} \times 10^6$	f_c (Hz)	$\tan\phi_{aud}$ $\times 10^3$	Lou_{att} (p.s.)	Lou_{mea} (p.s.)	Lou_{sl1} (p.s./s)	Lou_{sl2} (p.s./s)	SCG_{att} (ERBr)	SCG_{mea} (ERBr)	SCG_{slo} (ERBr/s)	Dur (s)
W	1.20	1.51	−166.62	−8.43	38.19	261.97	114	54.40	103.97	8509	0.29	7.50	1.96	−34.68	−0.75	25.32	20.16	−2.10	1.95
W	−0.20	1.52	−239.14	−7.94	31.79	65.49	117	97.36	80.39	9289	1.83	7.39	2.36	−82.24	−5.80	25.22	20.61	−22.01	0.31
W	0.80	1.53	−183.76	−9.15	35.53	160.68	120	61.98	97.76	8586	0.60	7.49	2.09	−44.83	−1.69	25.32	20.33	−5.57	0.95
W	0.20	1.54	−206.64	−5.80	32.45	95.24	123	85.83	79.88	8894	1.34	7.40	2.26	−77.73	−4.10	25.24	20.42	−15.22	0.43
W	0.50	1.55	−197.67	−6.28	33.88	129.32	116	69.98	82.12	8304	1.11	6.94	2.07	−61.82	−2.79	24.99	20.12	−10.26	0.56
W	1.00	1.56	−176.24	−11.15	35.53	299.89	129	55.73	102.71	8308	0.34	7.48	2.00	−35.45	−1.01	25.32	20.38	−2.64	1.53
W	−0.10	1.57	−221.55	−7.70	31.29	83.51	129	97.48	77.01	9003	1.73	7.34	2.30	−99.69	−5.37	25.20	20.49	−20.29	0.33
W	0.40	1.59	−192.73	−6.42	33.88	121.27	134	78.42	85.29	8544	1.10	7.37	2.22	−66.95	−3.18	25.23	20.33	−12.15	0.51
W	0.10	1.60	−204.76	−5.01	32.18	102.63	126	86.70	71.85	8329	1.65	6.97	2.18	−78.76	−4.53	24.95	20.17	−16.58	0.37
W	0.70	1.61	−143.11	−7.45	39.57	211.45	140	68.46	90.33	8214	0.66	7.47	2.14	−47.81	−2.06	25.17	20.14	−6.07	0.82
W	0.00	1.62	−225.86	−5.19	31.66	96.55	143	95.00	76.69	8611	1.59	7.37	2.26	−96.72	−4.70	25.25	20.27	−17.46	0.37
W	0.90	1.63	−130.14	−10.89	41.79	309.93	146	64.38	88.22	8012	0.42	7.48	2.09	−41.33	−1.41	25.18	20.19	−3.65	1.18
W	0.30	1.64	−184.20	−6.17	34.74	132.65	148	84.54	78.42	8229	1.15	7.50	2.30	−80.95	−3.64	25.21	20.21	−12.20	0.48
W	0.60	1.66	−173.39	−6.78	35.74	168.71	151	74.39	81.89	7977	0.77	7.51	2.16	−67.06	−2.40	25.22	20.07	−7.48	0.71
W	1.10	1.67	−148.18	−9.09	38.93	415.49	154	63.14	86.30	7788	0.26	7.53	1.96	−36.48	−0.77	25.24	19.80	−2.15	1.94
W	−0.30	1.68	−214.82	−8.56	31.38	88.75	156	106.21	68.84	8486	1.87	7.53	2.37	−105.75	−6.12	25.23	20.31	−21.43	0.30
PC of acoustical descriptors			PC_H	PC_{α_2}	PC_H	PC_H	PC_c	PC_H	PC_H	PC_c	PC_H	PC_K	PC_H	PC_H	PC_H	PC_K	PC_H	PC_H	PC_H
Correlation with PC			−0.92	1.00	−0.93	−0.95	0.89	0.96	−0.88	−0.83	0.99	−0.81	0.93	−0.96	−0.99	−0.84	0.56	−0.99	−0.99
R	1.20	1.51	−37.25	−7.53	303.15	1136.24	114	54.40	103.97	8509	0.18	7.92	2.88	−5.74	−0.92	20.86	18.37	−1.01	2.50
R	−0.20	1.52	−87.15	−7.59	60.09	211.75	117	97.36	80.39	9289	1.32	7.87	2.43	−42.37	−3.07	20.80	16.82	−10.06	0.60
R	0.80	1.53	−43.23	−7.88	130.68	542.79	120	61.98	97.76	8586	0.40	7.92	2.43	−12.82	−1.13	20.87	17.63	−2.43	1.71
R	0.20	1.54	−70.36	−5.64	73.13	299.52	123	85.83	79.88	8894	0.91	7.87	2.35	−31.99	−2.13	20.82	16.72	−6.85	0.89
R	0.50	1.55	−69.05	−6.66	102.81	370.05	126	69.98	82.12	8304	0.65	7.89	2.35	−19.28	−1.59	20.83	17.14	−4.23	1.19
R	1.00	1.56	−46.74	−9.68	224.35	823.47	129	55.73	102.71	8308	0.23	7.91	2.54	−6.75	−0.87	20.86	18.40	−0.99	2.50
R	−0.10	1.57	−78.37	−7.39	62.36	208.93	132	97.48	77.01	9003	1.22	7.85	2.49	−42.45	−3.47	20.78	16.96	−9.71	0.61
R	0.40	1.59	−62.90	−6.28	85.51	311.36	134	78.42	85.29	8544	0.74	7.86	2.39	−25.23	−1.75	20.80	17.06	−5.11	1.04
R	0.10	1.60	−76.46	−5.45	66.73	251.47	137	86.70	71.85	8329	1.00	7.85	2.30	−36.41	−2.10	20.80	16.64	−6.96	0.86
R	0.70	1.61	−47.33	−6.99	125.35	430.70	140	68.46	90.33	8214	0.49	7.84	2.48	−14.22	−1.39	20.81	17.54	−3.11	1.46
R	0.00	1.62	−70.59	−5.11	76.05	245.44	143	95.00	76.69	8611	1.09	7.86	2.38	−36.50	−2.50	20.82	16.70	−8.11	0.76
R	0.90	1.63	−30.91	−8.55	170.50	598.32	146	64.38	88.22	8012	0.33	7.85	2.44	−8.14	−0.95	20.82	17.89	−1.70	2.11
R	0.30	1.64	−65.53	−5.97	82.49	281.52	148	84.54	78.42	8229	0.84	7.85	2.41	−25.82	−1.93	20.84	16.80	−6.33	0.97
R	0.60	1.66	−51.46	−6.45	106.89	366.03	151	74.39	81.89	7977	0.59	7.86	2.41	−15.98	−1.45	20.84	17.10	−4.17	1.32
R	1.10	1.67	−29.82	−7.04	264.38	957.73	154	63.14	86.30	7788	0.20	7.87	2.88	−4.97	−0.93	20.86	18.12	−1.37	2.50
R	−0.30	1.68	−92.74	−8.25	55.44	170.32	156	106.21	68.84	8486	1.44	7.86	2.48	−42.66	−3.36	20.85	16.91	−10.55	0.57
PC of acoustical descriptors			PC_H	PC_{α_2}	PC_H	PC_H	PC_c	PC_H	PC_H	PC_c	PC_H	PC_K	PC_H	PC_H	PC_H	PC_K	PC_H	PC_H	PC_H
Correlation with PC			−0.96	1.00	−0.99	−0.99	0.89	0.99	−0.90	−0.90	1.00	−0.89	−0.46	−0.99	−0.99	−0.91	−0.86	−1.00	−1.00

Table S2
Spearman rank correlations between acoustical features for the wood-mallet and rubber-mallet sound sets (lower and upper triangular matrices, respectively; $df = 14$). The rows and columns marked H and c show the correlation between these sound synthesis parameters and the acoustical features within each set ($df = 14$). The last row shows the correlation between the mallet-related parameter K and the acoustical descriptors in both the wood- and rubber-mallet sets ($df = 30$). *: p–value ≤ 0.05.

	α_1	α_2	ED_{3dB}	ED_{10dB}	f_1	p_a	p_b	f_c	$\tan\phi_{aud}$	Lou_{att}	Lou_{mea}	Lou_{sl1}	Lou_{sl2}	SCG_{att}	SCG_{mea}	SCG_{slo}	Dur	H	c
α_1	–	−0.30	0.97*	0.95*	0.02	−0.93*	0.85*	−0.60*	−0.97*	0.30	0.44	0.97*	0.94*	0.55*	0.81*	0.95*	0.96*	0.97*	0.02
α_2	−0.46	–	−0.31	−0.33	0.13	0.36	−0.50	0.07	0.32	−0.18	−0.74*	−0.32	−0.37	−0.47	−0.70*	−0.36	−0.34	−0.32	0.13
ED_{3dB}	0.97*	−0.44	–	0.98*	−0.08	−0.97*	0.89*	−0.57*	−0.99*	0.41	0.47	0.99*	0.97*	0.61*	0.86*	0.98*	0.99*	0.99*	−0.08
ED_{10dB}	0.94*	−0.49	0.93*	–	−0.17	−0.98*	0.91*	−0.54*	−0.99*	0.47	0.42	0.99*	0.98*	0.59*	0.85*	0.98*	0.99*	0.99*	−0.17
f_1	0.21	−0.09	0.11	0.19	–	0.23	−0.39	−0.63*	0.10	−0.56*	0.05	−0.08	−0.09	0.05	−0.13	−0.11	−0.09	−0.10	1.00*
p_a	−0.83*	0.51*	−0.86*	−0.89*	0.22	–	−0.93*	0.49	0.98*	−0.50*	−0.41	−0.97*	−0.98*	−0.64*	−0.85*	−0.98*	−0.98*	−0.98*	0.23
p_b	0.74*	−0.61*	0.80*	0.76*	−0.33	−0.93*	–	−0.29	−0.89*	0.46	0.50*	0.89*	0.89*	0.49	0.89*	0.90*	0.89*	0.89*	−0.39
f_c	−0.79*	0.20	−0.73*	−0.78*	−0.53*	0.49	−0.29	–	0.58*	0.19	−0.18	−0.60*	−0.60*	−0.38	−0.45	−0.57*	−0.59*	−0.58*	−0.63*
$\tan\phi_{aud}$	−0.88*	0.51*	−0.89*	−0.95*	0.02	0.96*	−0.88*	0.58*	–	−0.41	−0.46	−0.99*	−0.98*	−0.60*	−0.86*	−0.99*	−1.00*	−1.00*	0.10
Lou_{att}	0.53*	−0.55*	0.50*	0.51*	0.52*	−0.36	0.29	−0.48	−0.45	–	0.11	0.42	0.42	0.65*	0.38	0.41	0.40	0.41	−0.56*
Lou_{mea}	−0.77*	0.39	−0.78*	−0.86*	0.24	0.93*	−0.81*	0.54*	0.91*	−0.22	–	0.44	0.43	0.46	0.73*	0.45	0.45	0.46	0.05
Lou_{sl1}	0.82*	−0.52*	0.85*	0.88*	−0.25	−0.98*	0.93*	−0.48	−0.95*	0.31	−0.95*	–	0.98*	0.60*	0.85*	0.99*	0.99*	0.99*	−0.08
Lou_{sl2}	0.89*	−0.50*	0.90*	0.94*	−0.09	−0.98*	0.89*	−0.58*	−0.99*	0.43	−0.94*	0.97*	–	0.64*	0.85*	0.99*	0.99*	0.98*	−0.09
SCG_{att}	0.00	−0.37	0.05	0.16	−0.13	−0.36	0.38	0.31	−0.36	0.40	−0.21	0.31	0.31	–	0.61*	0.61*	0.60*	0.60*	0.05
SCG_{mea}	−0.63*	−0.07	−0.60*	−0.63*	−0.29	0.44	−0.21	0.83*	0.49	−0.33	0.58*	−0.41	−0.52*	0.31	–	0.87*	0.86*	0.86*	−0.13
SCG_{slo}	0.90*	−0.51*	0.89*	0.95*	−0.06	−0.97*	0.87*	−0.60*	−0.99*	0.45	−0.94*	0.96*	1.00*	0.31	−0.54*	–	1.00*	0.99*	−0.11
Dur	0.88*	−0.50*	0.89*	0.94*	−0.09	−0.98*	0.89*	−0.57*	−0.99*	0.43	−0.94*	0.97*	1.00*	0.33	−0.51*	1.00*	–	1.00*	−0.09
H	0.89*	−0.50*	0.90*	0.94*	−0.09	−0.98*	0.89*	−0.58*	−0.99*	0.43	−0.94*	0.97*	1.00*	0.31	−0.52*	1.00*	1.00*	–	–
c	0.21	0.03	0.10	0.20	0.96*	0.23	−0.39	−0.63*	0.05	0.42	0.19	−0.25	−0.10	−0.29	−0.45	−0.06	−0.10	–	–
K	−0.87*	−0.15	−0.87*	−0.66*	−0.05	0.00	0.00	0.00	0.30	−0.87*	−0.83*	−0.75*	−0.35	0.87*	0.87*	−0.43*	−0.49*	–	–

Table S3

*Participant–specific perceptual weighting of acoustical information across variations in task and sound set. For both the dissimilarity-rating and identification tasks, perceptual weights are given by the partial R^2 (R^2_p) for each of the principal components (PC) of clustered acoustical descriptors (PC_{α_2}, PC_H, PC_K, PC_c). For the dissimilarity-rating task, alternative perceptual weights are also given by the latent-class-specific range of the dimensions of the MDS spaces (MDS_H and $MDS{-}c$ for the first two dimensions of the perceptual spaces for both sound sets and MDS_3 for the third dimension of the wood-mallet space). The last two rows report the across-participant average R^2_p and the number of participants out of 20 with a significant effect, respectively. * = p–value ≤ 0.05.*

	Dissimilarity ratings													Identification							
	Wood-mallet							Rubber-mallet						Wood-mallet				Rubber-mallet			
Participant	MDS_H	MDS_c	MDS_3	PC_H	PC_c	PC_{α_2}	PC_K	MDS_H	MDS_c	PC_H	PC_c	PC_{α_2}	PC_K	PC_H	PC_c	PC_{α_2}	PC_K	PC_H	PC_c	PC_{α_2}	PC_K
1	0.96	0.31	0.13	0.24*	0.24*	0.00	0.00	0.73	0.40	0.33*	0.36*	0.00	0.07*	0.95*	−0.16	0.05	−0.17	0.93*	−0.03	−0.03	0.16
2	0.96	0.31	0.13	0.32*	0.12*	0.00	0.00	0.91	1.20	0.20*	0.03*	0.00	0.02	0.85*	0.02	0.23	0.31	0.88*	0.17	0.35	0.19
3	0.69	0.88	0.85	0.23*	0.09*	0.00	0.02	0.91	1.20	0.29*	0.12*	−0.01	0.00	0.98*	0.40*	0.00	0.02	0.93*	0.24	0.03	0.28
4	0.69	0.88	0.85	0.05*	0.22*	0.00	0.00	0.91	1.20	0.03*	0.29*	0.00	0.03	0.93*	0.00	0.24*	0.00	0.98*	0.01	0.74*	0.36
5	0.96	0.31	0.13	0.40*	0.01	0.00	0.03*	0.73	0.40	0.47*	0.00	0.02	0.01	0.94*	0.04	0.64*	−0.19	0.92*	−0.15	0.70	−0.13
6	0.69	0.88	0.85	0.10*	0.16*	0.00	0.00	0.91	1.20	0.04*	0.24*	0.00	−0.01	0.94*	0.46	0.60*	0.06	0.77*	0.72*	0.41*	0.12
7	0.96	0.31	0.13	0.57*	0.00	0.02	0.00	0.91	1.20	0.44*	0.16*	0.01	0.00	0.90*	−0.44	0.81*	−0.08	0.91*	0.42	0.25*	−0.40
8	0.96	0.31	0.13	0.20*	0.39*	0.03*	0.02*	0.73	0.40	0.16*	0.25*	0.00	0.01	0.35	0.01	0.23	0.01	0.94*	0.15	0.07*	0.26
9	0.96	0.31	0.13	0.27*	0.14*	0.02	0.01	0.73	0.40	0.22*	0.26*	0.00	0.01	0.96*	−0.28	−0.10	−0.11	0.91*	0.47	0.17*	−0.02
10	0.69	0.88	0.85	0.08*	0.31*	0.00	0.02	0.91	1.20	0.04*	0.41*	0.05*	0.06	0.83*	−0.04	−0.10*	0.03	0.96*	−0.02	0.16	−0.31
11	0.69	0.88	0.85	0.19*	0.30*	0.01	0.01*	0.73	0.40	0.10*	0.48*	−0.01	0.08*	0.90*	0.04	−0.09*	−0.08	0.94*	0.29	0.05	−0.20
12	0.69	0.88	0.85	0.08*	0.16*	0.00	0.01	0.91	1.20	0.00	0.23*	0.03	0.00	0.68*	0.00	0.49*	−0.24	0.94*	0.02	−0.98*	0.05
13	0.96	0.31	0.13	0.40*	0.21*	0.00	0.00	0.73	0.40	0.33*	0.27*	−0.02	0.06*	0.98*	−0.07	0.49*	0.62*	0.88*	0.00	0.18	0.06
14	0.96	0.31	0.13	0.62*	0.13*	−0.03	0.01	0.73	0.40	0.50*	0.18*	−0.03	0.13*	0.87*	0.12	0.19	−0.51	0.80*	0.01	0.21*	−0.22
15	0.96	0.31	0.13	0.16*	0.27*	0.07*	0.00	0.73	0.40	0.16*	0.25*	0.00	0.01	0.87*	0.35	0.08	0.02	0.80*	0.14	0.01	−0.10
16	0.96	0.31	0.13	0.50*	0.06*	0.04	0.01	0.73	0.40	0.58*	0.01	0.03*	0.02	0.88*	0.12	0.49*	−0.58	0.98*	0.48	0.45*	−0.25
17	0.96	0.31	0.13	0.45*	0.07*	0.00	0.00	0.73	0.40	0.39*	0.12*	0.01	0.04	0.96*	−0.05	−0.16*	−0.05	0.90*	0.37	0.10	−0.02
18	0.69	0.88	0.85	0.00	0.25*	0.00	0.00	0.91	1.20	0.01	0.37*	0.00	0.01	0.97*	0.29	0.68*	0.10	0.94*	0.10	0.24	0.33
19	0.96	0.31	0.13	0.68*	−0.10*	0.04	0.00	0.73	0.40	0.70*	0.07*	0.02	0.05*	0.91*	0.07	0.69*	−0.03	0.98*	−0.25	0.82*	−0.81
20	0.69	0.88	0.85	0.12*	0.22*	0.01	0.01	0.91	1.20	0.11*	0.21*	0.01	0.01	0.95*	0.06	0.65*	−0.19	0.86*	0.04	0.39*	−0.04
Mean R^2_p				0.28	0.16	0.01	0.01			0.26	0.22	0.00	0.03	0.88	0.05	0.30	−0.05	0.91	0.16	0.22	−0.03
N significant				19	18	2	3			18	18	2	5	19	1	13	1	20	1	10	0