ONLINE SUPPLEMENT:

Confusingly similar: Discerning between Hardware Guitar Amplifier Sounds and Simulations with the *Kemper Profiling Amp*

Content: **Page**

A. Detailed list of the hardware used

a) Marshall Amplifier for Stimuli 1-4

- (original vintage) 1962 Fender Stratocaster (Candy Apple Red)
    - Pickup selection (volume and tone controls always turned to maximum): neck pickup for Stimuli 1-4
- (original vintage) 1968 Marshall JMP "Super Lead" 100 Watt amplifier
- Two Marshall cabinets (original vintage):
    - Cabinet 1: Marshall 100-watt speaker, mid 1960s "Pin Stripe" with 4 x Celestion "Green Back" G12M speakers, cabinet cloth removed
    - Cabinet 2: Marshall 100-watt speaker, 1970 "Basketweave" cloth with 4 x Celestion "Green Back" G12M speakers
- Microphones (close miking distances measured from front of microphone):
    - Electro-Voice RE 20 (cabinet cloth removed; distance to speaker-cloth level: 3 cm, off-center distance from speaker-cone center to side: 6 cm).
    - Neumann U89i (directionality: hyper-cardioid; distance to speaker-cloth: 5 cm; off-center distance from speaker-cone center to side: 3 cm, measured from middle of diaphragm (middle-bar of grill).
    - Royer R121 (with cabinet cloth; angled to avoid damage of ribbon; distance speaker cloth: 5 cm; off-center distance from speaker-cone center to sided: 3 cm; measured from ribbon [middle of magnets]).
    - Sennheiser MD441 (cabinet cloth removed; distance to speaker-cloth-level: 3.6 cm; off-center distance from speaker-cone center to side: 3.5 cm).
- Microphone types and positions for the recording and profiling of the Marshall cabinet. Upper left and right: Sennheiser MD 441 (left), Electrovoice RE 20 (right); lower left: Neumann U89i; lower right: Royer R121 (the Sennheiser MD 421 and Shure SM 57 were not used).

- Microphone preamplifier: 2 x Siemens V72s, 2 x Telefunken V72 (original vintage)
- The output signals of the microphone preamplifiers were mixed using a “TBG”-mixing console of the 610 series (custom-built for Bayerischer Rundfunk in 1991) with a summation amplifier by Manfred Reckmeyer.
- The output signal of the mixing console was converted using a Lavry Gold "AD 122-96 MKII" analogue-to-digital converter and recorded in Pro Tools HD.

b) Vox Amplifier for Stimuli 5-12

- (original vintage) 1953 Fender Telecaster (Blackguard)
    - Pickup selection/combinations: bridge pickup for Stimuli 5-12
- (original vintage) Vox AC 30, constructed in the mid-1970s, tuning by Manfred Reckmeyer
- Two Vox AC 30 cabinets without amplifier section:
    - Cabinet 1: (original vintage) 1970s with Celestion G12M (cabinet cloth removed)
    - Cabinet 2: (original vintage) 1960s with Grey Bulldog Alnico speakers
- Microphones (close miking distances measured from front of microphone):
    - Neumann U87i (directionality: cardioid; cabinet cloth removed; distance to speaker-cloth level: 6 cm; off-center distance from speaker-cone center to side: 5.5 cm, measured from middle of diaphragm [middle-bar of grill]).
    - Royer R121 (distance to speaker-cloth level: 6 cm; off-center distance above speaker cone: 5.5 cm; angled to avoid damage of ribbon, measured from ribbon/middle of magnets).
    - Sennheiser MD441 (cabinet cloth removed; distance to speaker-cloth level: 3.6 cm; off-center distance from speakercone center to side: 3.5 cm)
- Microphone types and positions for the recording and profiling of the Vox AC 30 cabinet. Upper left and right: Mid 70s Vox Cabinet with Celestion G12M, Sennheiser MD 441 (left), Neumann U87i (right); lower left and right: 60s Vox cabinet with Bulldog Speakers, Royer R121 (the Sennheiser MD 421 and Shure SM 57 were not used).




- Microphone preamplifier: 2 x API 512, Siemens V72s, (original vintage)
- The output signals of the microphone preamplifiers were mixed using a “TBG”-mixing console of the 610 series (custom-built for Bayerischer Rundfunk in 1991) with a summation amplifier by Manfred Reckmeyer.
- The output signal of the mixing console was converted using a Lavry Gold "AD 122-96 MKII" analogue-to-digital converter and recorded in Pro Tools HD.

B. Exact wording of questions and possible answers about the musical background

Musical profession: I am (or I am going to be)…

- a professional musician
- a hobby musician
- a teacher at a music school
- a music producer
- other: _______________ (to be filled out)
- I am not a musician

Electric guitar expertise: Do you play the electric guitar?

- No
- Yes, I am an amateur musician
- Yes, I am a semi-professional guitarist
- Yes, I am a professional guitarist

Knowledge of the KPA: Did you know about the KPA before participating in this study?

- No
- Yes, but I have not worked with it yet
- Yes, I have even used it before myself

C. Supplementary figures

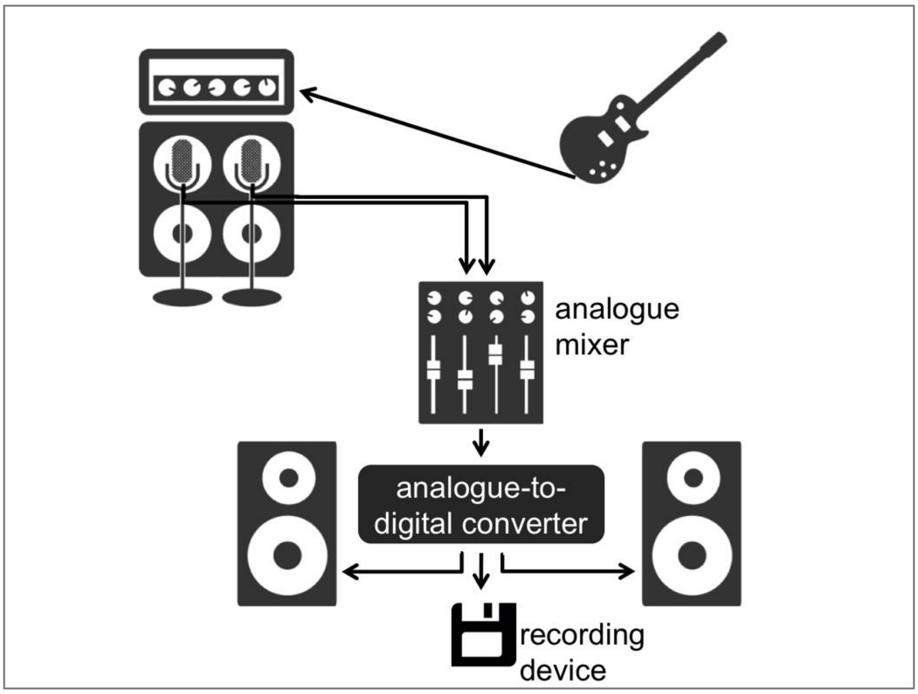

Figure S1: Setup for the recording of the OA stimuli

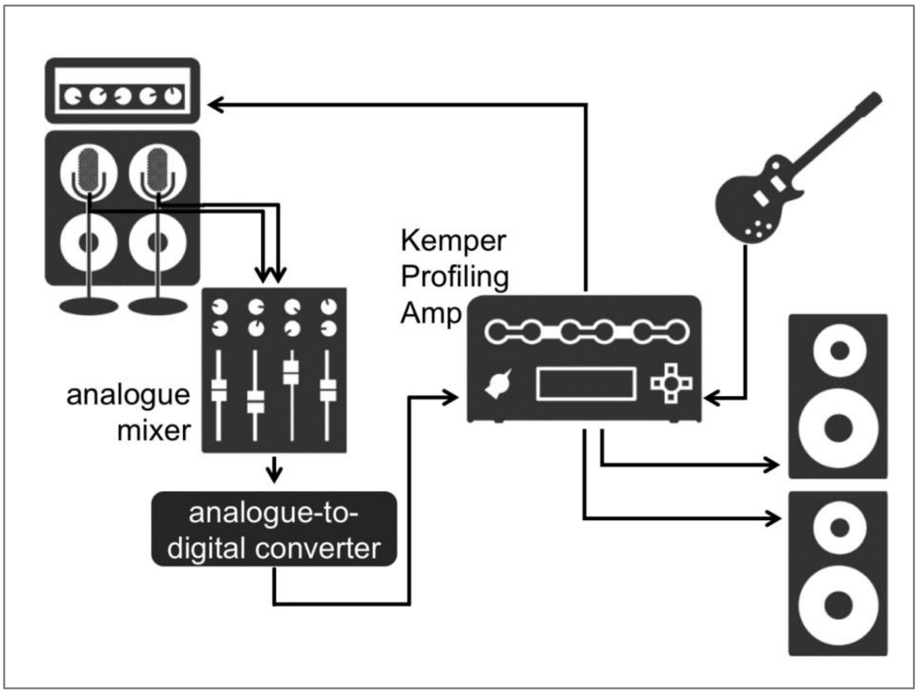

Figure S2: Setup for the profiling process

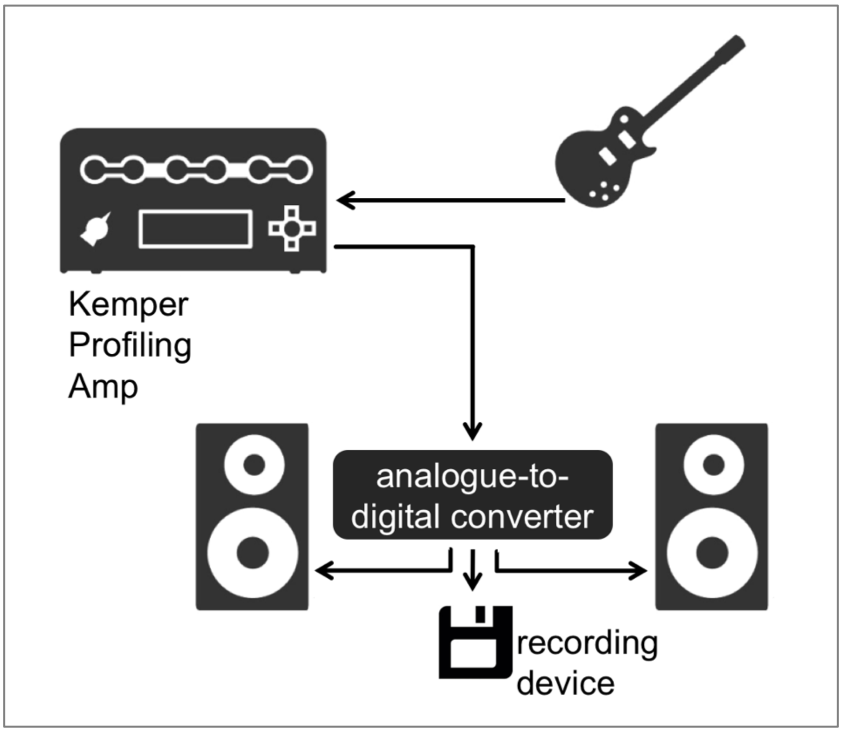

Figure S3: Setup for the recording of the KPA stimuli

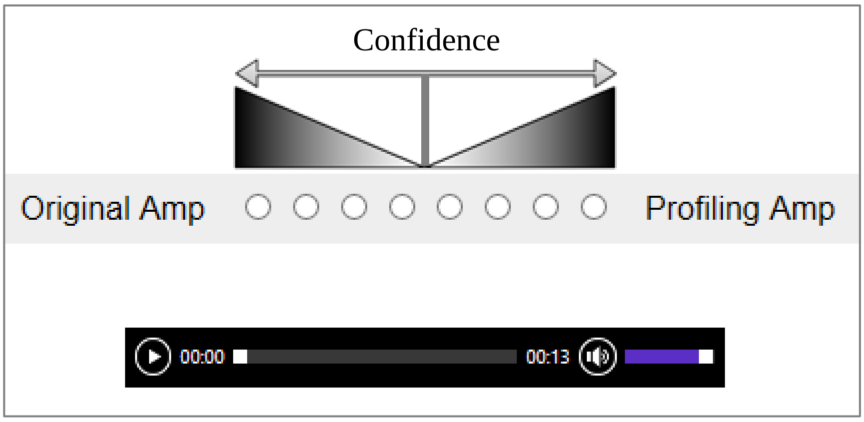

Figure S4: Response screen with audio control button and rating scale for the assignment of the audio examples to one of the two recording conditions (OA vs. KPA).

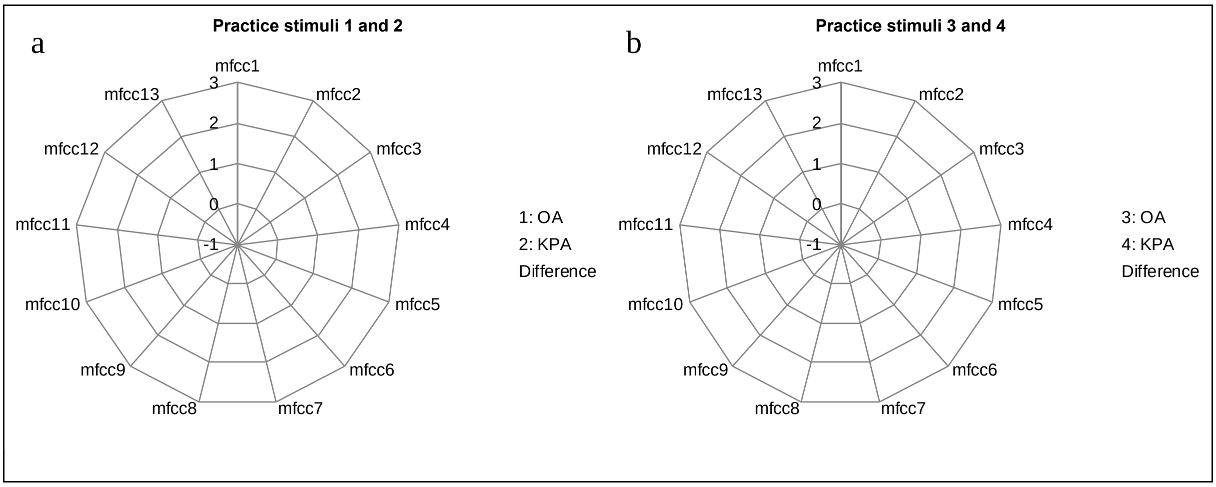

Figure S5 a and b: Radar plots of MFCC values for the 4 practice stimuli. The MFCCs of a pair of stimuli are displayed in one diagram along with the difference between each MFCC for the two stimuli.

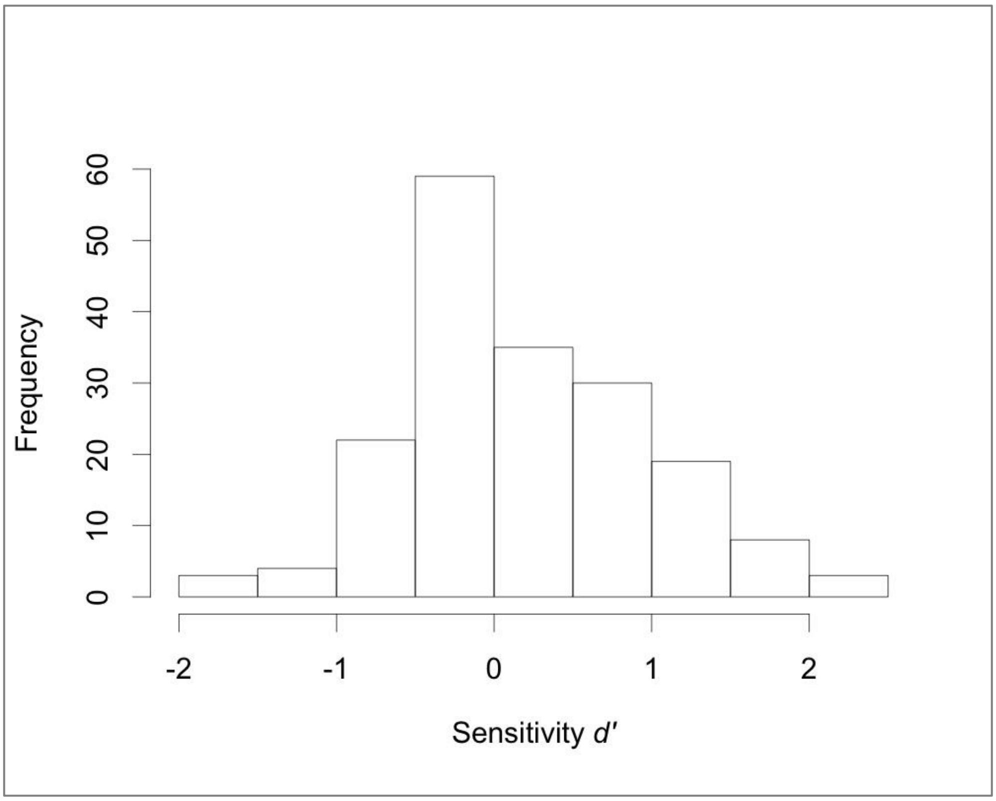

Figure S6: Sensitivity distribution of all N = 183 participants

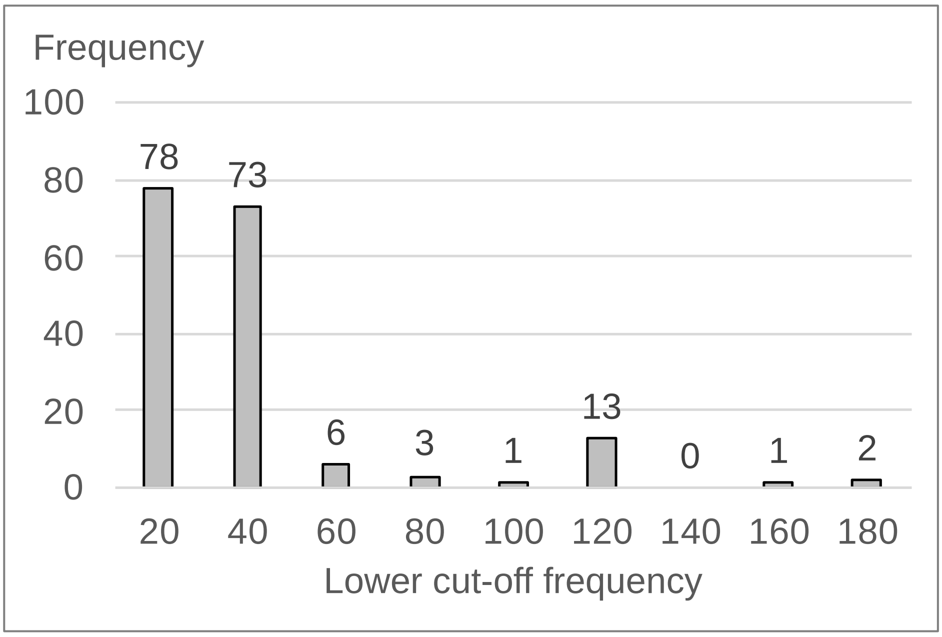

Figure S7: Lower cut-off frequency of the playback devices used by the participants

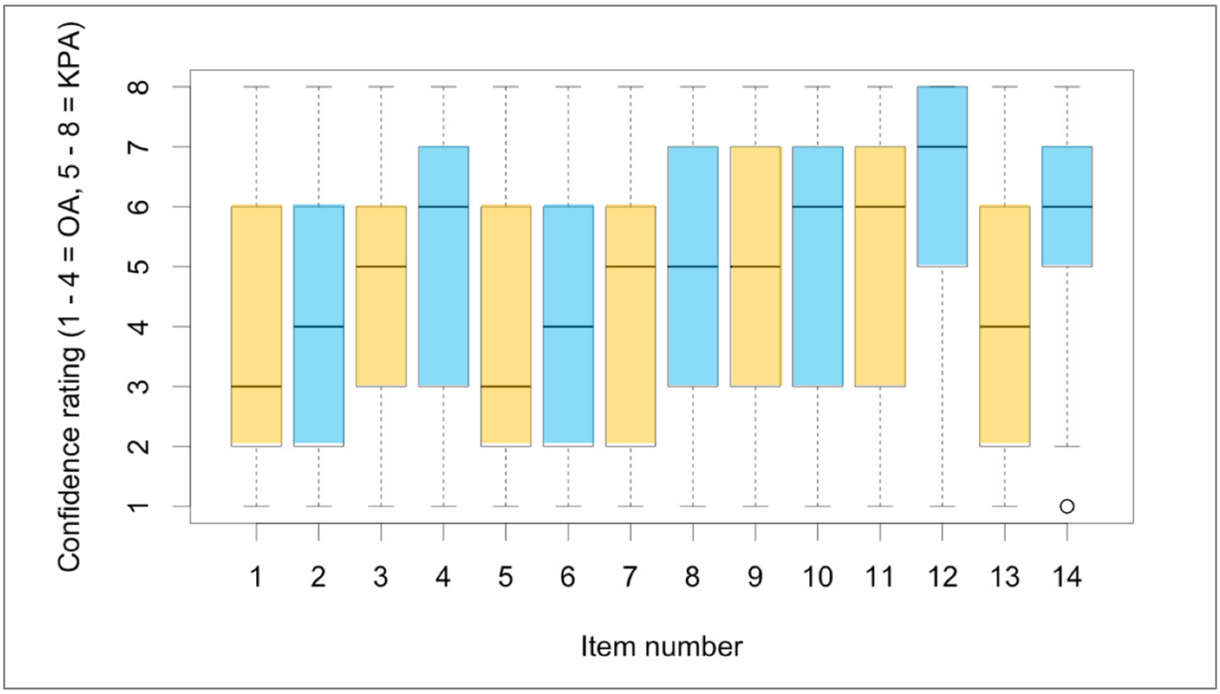

Figure S8: Participants' ratings of all 14 stimuli. OA stimuli = orange, KPA = blue. Number 13 is retest of Number 9, and Number 14 is retest of Number 12.

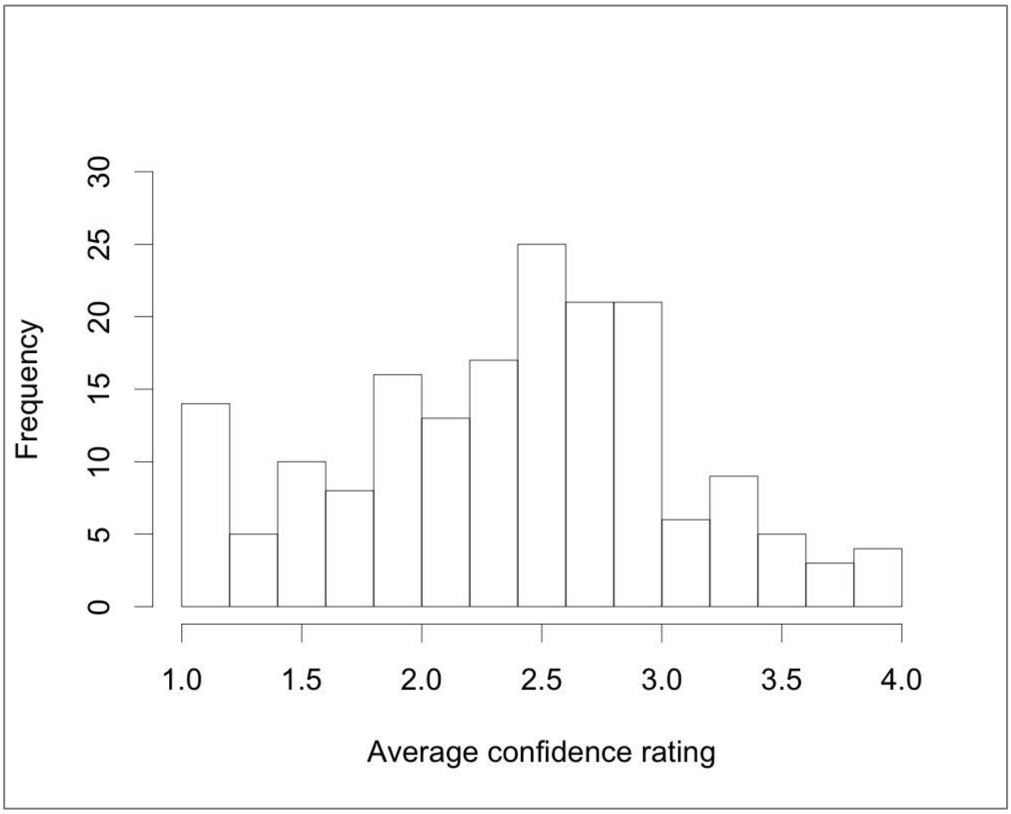

Figure S9: Mean confidence rating of the 177 participants averaged over the 12 stimuli (1 = maximum confidence in the classification task, 4 = minimum confidence)

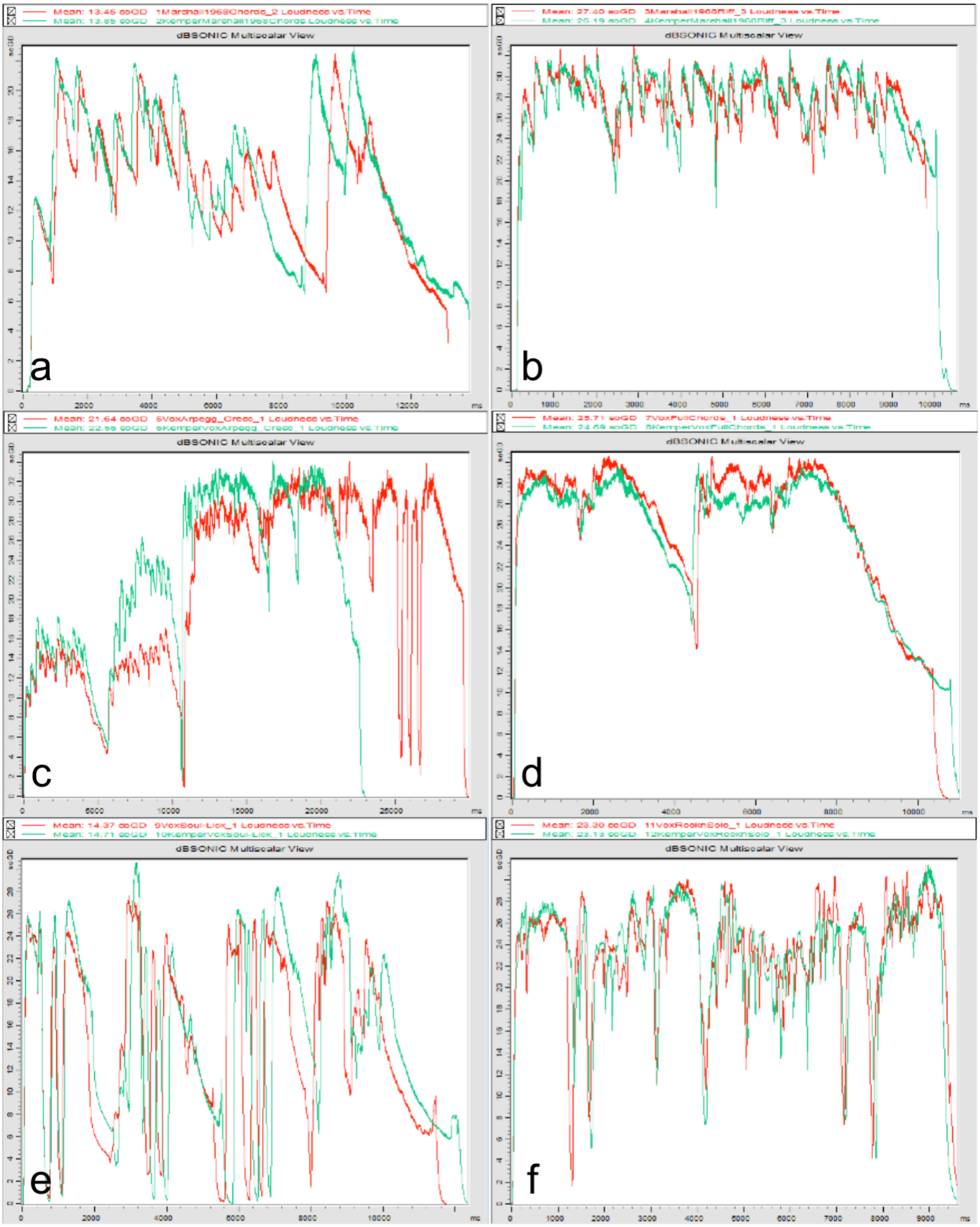

Figure S10 a-f: Comparison of loudness times series for the two versions of each stimulus (a: stimuli 1 and 2, …, f: stimuli 11 and 12). KPA = green line, OA = red line. Analysis by means of the software dBSONIC ("dBSONIC" 2012) with the following settings: loudness (sone), according to DIN 45631, sound field: diffuse, time interval: 2 ms. For a comment on deviating lengths of signals in Figure C, see endnote.[1]

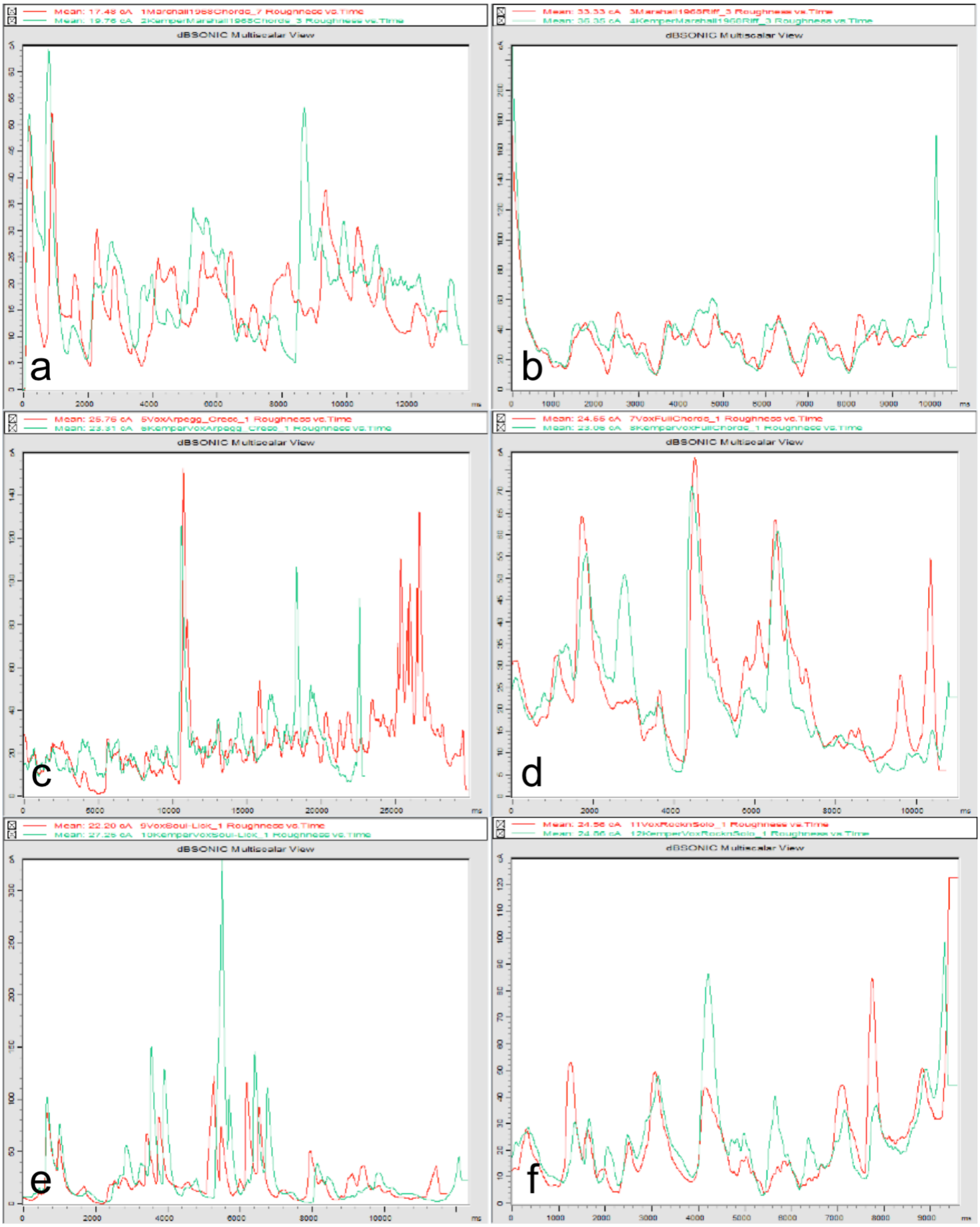

Figure S11 a-f: Comparison of roughness times series for the two versions of each stimulus (a: Stimuli 1 and 2, …, f: Stimuli 11 and 12). KPA = green line, OA = red line. Analysis by means of the software dBSONIC ("dBSONIC" 2012) with the following settings: roughness (centi Asper [cA]); time interval: 2 ms; sequence length: 200 ms. For a comment on deviating lengths of signals in Figure C, see endnote.[1]

D. Supplementary tables

Table S1: Descriptive data of the control variables electric guitar expertise, knowledge of the KPA, and musical profession

	n	**%**
Electric guitar expertise (Do you play the electric guitar?)		
No	19	10.7
Yes, I am an amateur.	50	28.2
Yes, I am a semi-professional guitarist.	60	33.9
Yes, I am a professional guitarist.	48	27.1
Knowledge of the KPA (Did you know about the KPA before participating in this study?)		
No	18	10.2
Yes, but I have not worked with it yet.	69	39.0
Yes, I have used it myself.	90	50.8
Musical profession (I am [or I am going to be] …)		
Not a musician	6	3.4
Hobby musician	65	36.7
Professional musician	22	12.4
Music producer	24	13.6
Teacher at a music school	16	9.0
Other musician	44	24.9

Table S2: Scores for musical sophistication of the sample as measured by the Gold-MSI; range = lowest and highest possible scores to achieve; last column: lower quartile, median and upper quartile of the norm sample (Schaal, Bauer, & Müllensiefen, 2014, p. 445).

Gold-MSI	***M***	***SD***	***Median***	***Min.***	***Max.***	**Range**	**Quartiles of norm sample**
General Factor	98.9	12.8	101	53	124	[18; 126]	56; 70; 85
Factor 1: Active Engagement	43.2	6.7	44	21	58	[9; 63]	26, 33, 40
Factor 2: Perceptual Abilities	56.5	4.9	57	36	63	[9; 63]	40, 46, 52
Factor 3: Musical Training	36.7	7.4	38	13	48	[7; 49]	14, 22, 31

Table S3: Proportion of monophonic and stereophonic playback

Mode of playback	***n***	**%**
stereophonic (correct polarity)	148	83.6
stereophonic (twisted channels)	15	8.5
monophonic	5	2.8
wrong answer	9	5.1

Table S4: Coding the four answering possibilities as hits, misses, false alarms and correct rejections according to Signal Detection Theory

	Participant allocates the stimulus to the OA-condition	Participant allocates the stimulus to the KPA-condition
Stimulus was recorded using the OA	Hit	Miss (false negative)
Stimulus was recorded using the KPA	False alarm (FA, false positive)	Correct rejection (CR)

Table S5. Proportion of correct responses among all N = 177 participants for each of the 12 musical examples and the 2 retest examples.

Stimulus	**Proportion of correct answers** (Hits/CRs for OA/KPA stimuli, respectively)
1 (OA)	0.655
2 (KPA)	0.492
3 (OA)	0.463
4 (KPA)	0.638
5 (OA)	0.627
6 (KPA)	0.463
7 (OA)	0.492
8 (KPA)	0.588
9 (OA)	0.497
Retest 9 = 13 (OA)	0.537
10 (KPA)	0.627
11 (OA)	0.424
12 (KPA)	0.774
Retest 12 = 14 (KPA)	0.757

Table S6: Descriptive statistics of the sensitivity of various sub-groups

			Sensitivity *d'*	
	n	**%**	***M***	***SD***
Electric guitar expertise (Do you play the electric guitar?)				
No	19	10.7	–0.017	0.756
Yes, amateur	50	28.2	0.401	0.809
Yes, semi-professionally	60	33.9	0.381	0.760
Yes, professionally	48	27.1	0.376	0.796
Knowledge of the KPA (Did you know about the KPA before participating in this study?)				
No	18	10.2	0.232	0.800
Yes, but I have not worked with it	69	39.0	0.281	0.772
Yes, I have used it myself	90	50.8	0.411	0.798
Musical profession (I am [or I am going to be] …)				
Non-musician	6	3.4	-0.144	0.445
Amateur musician	65	36.7	0.325	0.730
Teacher at a music school	16	9.0	0.602	0.908
Music producer	24	13.6	0.429	0.756
Professional musician	22	12.4	0.460	0.755
Other musician	44	24.9	0.234	0.875

Table S7: Between-group differences concerning electric guitar expertise, knowledge of the KPA, and musical profession

Cases	***SS*** (Type III)	***df***	***MS***	***F***	***p***	**η²**
Electric guitar expertise	2.771	3	0.924	1.504	.215	0.025
Residual	106.239	173	0.614			
Knowledge of the KPA	0.902	2	0.451	0.726	.485	0.008
Residual	108.107	174	0.621			
Musical profession	3.516	5	0.703	1.140	.341	0.032
Residual	105.494	171	0.617			

Table S8: Analysis of the relation between sensitivity and independent variables using Bayes statistics. (Models under consideration: Null model = no effect of the variable; *"variable name"* = the variable has an effect; P(M) = prior model probabilities; *P(M|data)* updated probability after having observed the data; BF_{M} = degree to which the data have changed the prior model odds; BF_{01} = Bayes factor for each row-model against the null model; Error % = size of the error in the integration routine relative to the Bayes factor. Explanations have been taken from Wagenmakers et al. (2018, p. 68)).

Models under consideration	***P(M)***	***P(M|data)***	BF_{M}	BF_{01}	**Error %**
Null model	.500	.866	6.448	1.000	
Electric guitar expertise	.500	.134	0.155	6.448	.001
Null model	.500	.881	7.391	1.000	
Knowledge of the KPA	.500	.119	0.135	7.391	.025
Null model	.500	.926	12.435	1.000	
Musical profession	.500	.074	0.080	12.345	.002

Table S9: Sensitivity in groups to different audio device quality

			Sensitivity *d'*		*t*-test
	n	**%**	***M***	***SD***	
Lower cut-off frequency					
≤ 40 Hz	151	85.3	0.349	0.813	*t*(175) = 0.283, *p* = .777, Cohen's *d* = 0.060, 95% CI [-0.356, 0.476]
> 40 Hz	26	14.7	0.302	0.624	
Headphones vs. loudspeakers					
Headphones	79	44.6	0.363	0.845	*t*(175) = 0.304, *p* = .761. Cohen's *d* = 0.046, 95% CI [-0.250, 0.342]
Loudspeakers	98	55.4	0.326	0.741	
Mode of playback					
Stereophonic (correct or swapped polarity)	163	92.1	0.334	0.772	*t*(175) = -0.466, *p* = .642, Cohens *d* = -0.130, 95% CI [-0.676, 0.416]
Monophonic or wrong answer	14	7.9	0.437	0.971	

Table S10: Values of psychoacoustic features entropy, inharmonicity, roughness, loudness, spectral flux (mean and median), and zero crossing rate for all pairs of stimuli including practice stimuli and relative and absolute differences between the stimulus pairs. Calculations for entropy, inharmonicity, spectral flux, and zero crossing rate are based on the MIRtoolbox V1.7.2 (Lartillot, Toiviainen, & Eerola, 2008). Analyses of roughness and loudness were conducted by means of the software dBSONIC ("dBSONIC" 2012). For analysis parameters, see captions for Figure S10 and S11.

	Entropy [0; 1]	**Inharmonicity [0; 1]**	**Roughness [cA] (mean)**	**Loudness [sone] (mean)**	**Spectral flux (mean)**	**Spectral flux (median)**	**Zero crossing rate (sum)**
1: OA	0.788	0.391	17.45	13.45	14.47	9.404	527.997
2: KPA	0.781	0.377	19.76	13.85	15.518	8.684	418.048
Absolute difference	0.007	0.014	2.31	0.40	1.048	0.72	109.949
Relative difference (smaller value divided by larger value)	0.991	0.964	0.883	0.971	0.932	0.923	0.792
3: OA	0.843	0.494	33.33	27.40	72.164	60.742	889.750
4: KPA	0.845	0.477	36.35	26.19	63.223	53.210	910.567
Absolute difference	0.001	0.017	3.02	1.21	8.941	7.533	20.817
Relative difference (smaller value divided by larger value)	0.998	0.967	0.917	0.956	0.884	0.876	0.977
5: OA	0.834	0.494	25.76	21.64	33.704	26.032	942.783

6: KPA	0.824	0.487	23.31	22.56	35.221	29.619	809.758
Absolute difference	0.009	0.007	2.45	0.92	1.517	3.587	133.025
Relative difference (smaller value divided by larger value)	0.989	0.987	0.904	0.959	0.957	0.879	0.859
7: OA	0.837	0.471	24.55	25.71	35.886	32.768	1053.702
8: KPA	0.833	0.442	23.06	24.69	35.956	34.815	1016.857
Absolute difference	0.004	0.029	1.49	1.02	0.070	2.047	36.845
Relative difference (smaller value divided by larger value)	0.995	0.939	0.939	0.960	0.998	0.941	0.965
9: OA	0.830	0.484	22.20	14.37	26.357	12.142	817.577
10: KPA	0.828	0.506	27.25	14.71	29.539	12.522	730.733
Absolute difference	0.003	0.022	5.05	0.34	3.182	0.381	86.844
Relative difference (smaller value divided by larger value)	0.997	0.956	0.815	0.977	0.892	0.970	0.894
11: OA	0.855	0.482	24.56	23.30	64.604	59.803	1738.503
12: KPA	0.858	0.500	24.86	23.13	63.465	63.929	1796.573
Absolute difference	0.003	0.018	0.30	0.17	1.139	4.126	58.070
Relative difference (smaller value divided by larger value)	0.996	0.964	0.988	0.993	0.982	0.935	0.968

Practice stimulus 1: OA	0.826	0.496	40.38	57.74	81.422	80.875	1743.333
Practice stimulus 2: KPA	0.834	0.484	48.43	57.50	90.556	85.755	1847.071
Absolute difference	0.008	0.012	8.05	0.24	9.135	4.880	103.738
Relative difference (smaller value divided by larger value)	0.990	0.975	0.834	0.996	0.899	0.943	0.944
Practice stimulus 3: OA	0.777	0.427	39.44	58.47	24.117	18.652	704.651
Practice stimulus 4: KPA	0.767	0.435	40.76	58.84	32.233	25.116	557.161
Absolute difference	0.010	0.008	1.32	0.37	8.117	6.463	147.490
Relative difference (smaller value divided by larger value)	0.987	0.981	0.968	0.994	0.748	0.743	0.791

Table S11: Descriptive statistics for the relative difference (smaller value divided by larger value) of psychoacoustic features across the experimental stimuli 1-12. Mean values close to 1.0 indicate a high degree of similarity between OA and KPA.

	Entropy	Inharmonicity	Roughness	Loudness	Spectral Flux (mean)	Spectral Flux (median)	Zero crossing rate
Mean	0.994	0.963	0.907	0.969	0.941	0.921	0.909
Std. Error of Mean	0.001	0.006	0.024	0.006	0.019	0.015	0.030
Median	0.996	0.964	0.911	0.966	0.945	0.929	0.929
Minimum	0.989	0.939	0.815	0.955	0.884	0.876	0.792
Maximum	0.998	0.987	0.987	0.993	0.998	0.970	0.977

E: Endnote

[1] Figure S10c and S11c reveal that Stimulus 5 (red line, OA) was significantly longer than the corresponding Stimulus 6 (green line, KPA). This was due to some accidental repetition of a short phrase in Stimulus 5: The two-bar pattern in the beginning was played four times in Stimulus 6 instead of three times as in Stimulus 5. Furthermore, the ending (rhythmic chords on the harmonic dominant) took not only two bars (as in Stimulus 6) but three bars (in Stimulus 5). However, no additional musical idea or material was presented in the longer stimulus. The inclusion of an additional repetition did not have an impact on the proportion of correct responses: The correct response rate for Stimulus 5 (62.7%) did not differ significantly from the overall correct response rate for OA stimuli (M = 52.6%, SD = 18.7%; z-test results in p = 70.5%; therefore, the probability of this difference being due to coincidence is very high). The correct response rate for Stimulus 6 (46.3%) did not differ significantly from the overall correct response rate for OA stimuli (M = 59.7%, SD = 18.3%; z-test results in p = 23.3%, which was also above the significance threshold of 5%). Therefore, we can conclude that the accidental variation between the stimuli pairs did not have an effect on the participants' allocation of the stimuli to the response categories. Considering that participants could listen to each audio example as often as they wanted and could repeat parts of the stimulus ad libitum, it can be concluded that the additional repetition in one of the stimuli did not influence the participants' response behavior.

F. References

dBSONIC [computer software] (Version 4.501). (2012). Limonest, France: 01dB-Metravib. Retrieved from http://www.01db-metravib.com

Lartillot, O., Toiviainen, P., & Eerola, T. (2008). A Matlab toolbox for music information retrieval. In C. Preisach, H. Burkhardt, L. Schmidt-Thieme, & R. Decker (Eds.), *Data analysis, machine learning and applications, studies in classification, data analysis, and knowledge organization* (pp. 261–268). Berlin, Heidelberg: Springer-Verlag.

Schaal, N. K., Bauer, A.-K. R., & Müllensiefen, D. (2014). Der Gold-MSI: Replikation und Validierung eines Fragebogeninstrumentes zur Messung Musikalischer Erfahrenheit anhand einer deutschen Stichprobe. *Musicae Scientiae, 18*(4), 423–447. doi:10.1177/1029864914541851

Wagenmakers, E.-J., Love, J., Marsman, M., Jamil, T., Ly, A., Verhagen, J., . . . Morey, R. D. (2018). Bayesian inference for psychology. Part II: Example applications with JASP. *Psychonomic bulletin & review, 25*(1), 58–76. doi:10.3758/s13423-017-1323-7