

Quality Assessment of Selected Technical Limitations for 5.1 Surround Systems

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0 Introduction

In the experiment preceding this study listeners were asked to grade only basic audio quality defined as the global attribute describing any and all detected differences between the reference and the evaluated excerpt. In this experiment each item was graded using three direct attributes:

- timbral fidelity,
- frontal spatial fidelity,
- surround spatial fidelity.

In the case of the first attribute (timbral fidelity), listeners were asked to “grade each stimulus according to how similar it is to the reference, taking into account changes in timbre only”. They were requested to ignore any spatial aspects to the sound reproduction.

As far as the frontal spatial fidelity is concerned, listeners were asked to “grade each stimulus according to how similar it is to the reference, taking into account changes in spatial sound reproduction within the frontal arc (between the left and right loudspeaker)” – see Fig. 1. They were instructed to ignore timbral changes, as well as any spatial changes outside the frontal arc.

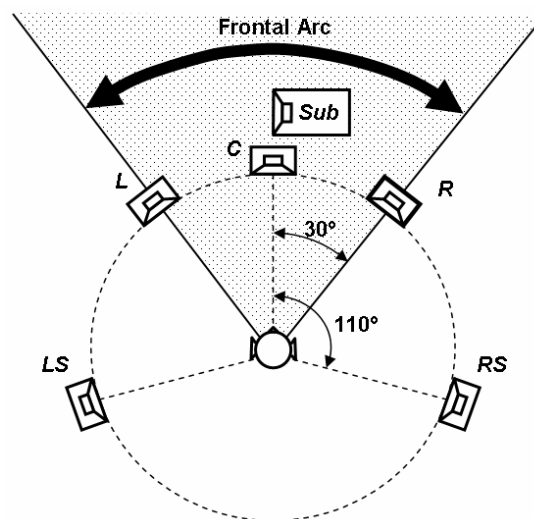


Fig. 1. Illustration used in order to help the listeners to identify the area within the frontal arc.

The last graded attribute was surround spatial fidelity. In this case the listeners were asked to “grade each stimulus according to how similar it is to the reference, taking into account changes in spatial sound reproduction outside the frontal arc (not between the left and right loudspeaker)” – see Fig. 2. They were instructed to ignore timbral changes, as well as any spatial changes inside the frontal arc.

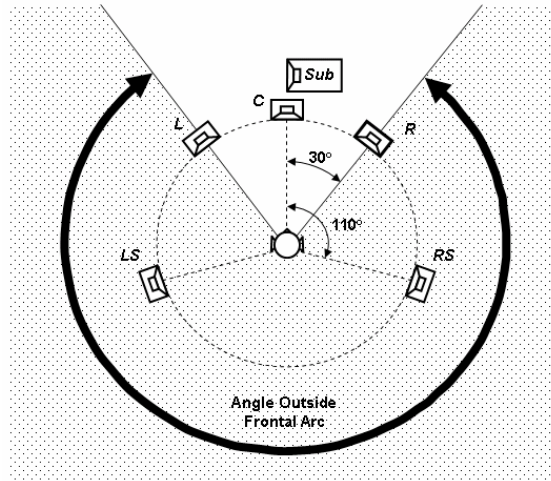


Fig. 2. Illustration used in order to help the listeners to identify the area outside the frontal arc.

For all attributes a 100-point continuous scale with labels was employed. Listeners were expected to use the maximum value of the scale for evaluation of a hidden reference.

The results are presented separately for four main experimental conditions (see Tab. 1).

Tab. 1. Main experimental conditions.

Experimental Condition No.	Spatial Characteristic of Programme Material	Overall bandwidth of multichannel audio material
Condition 1	F-B	60 kHz
Condition 2	F-F	
Condition 3	F-B	40 kHz
Condition 4	F-F	

Tab. 2 shows the description of the programme material used in the experiment.

Tab. 2 Programme material used in the experiment.

Genre	Spatial characteristic	Item No.	Description
Classical music	<i>F-B</i>	1	Typical orchestra music recording with pronounced violin and cello sections.
		2	Orchestra music recording with pronounced brass and percussion instruments (high-frequency content).
Pop music	<i>F-B</i>	3	Live recording. Instruments balanced to front channels with reverb in rear channels. Pronounced high-frequency content.
		4	Live recording. Instruments balanced to front channels with reverb in the rear channels. Centre channel: mainly leading vocal.
Pop music	<i>F-F</i>	5	Live recording. Instruments mixed to all channels. Centre channel: leading vocal and bass guitar. Rear channels: mainly percussion instruments.
		6	Live recording. Instruments mixed to all channels. Centre channel: leading vocal, kick and snare drum. Rear channels: piano and a string section.
Movie	<i>F-B</i>	7	Dialogue in the centre channel. Front left and right channels - some special audio effects. Orchestral music spread around all loudspeakers except the centre one. Front loudspeakers louder than the rear ones.
		8	Dialogue and special effects in the centre channel. Orchestral music spread around all loudspeakers. Front loudspeakers louder than the rear ones.
TV Show / Sport	<i>F-F</i>	9	“Tennis from Wimbledon”. Crowd effects in all channels. Commentary between the front left and the centre channel. Umpire’s voice between the centre and the front right channel.
		10	Typical TV show with audience (live). Audience laughter and applause in all channels. Centre channel: mainly voice of the presenter, also audience laughter.
Ambient	<i>F-F</i>	11	Applause in all channels. Very spatial and enveloping item.
		12	Sound of a heavy rain in all channels. Very spatial and enveloping item.

1 Results

1.1 Condition 1

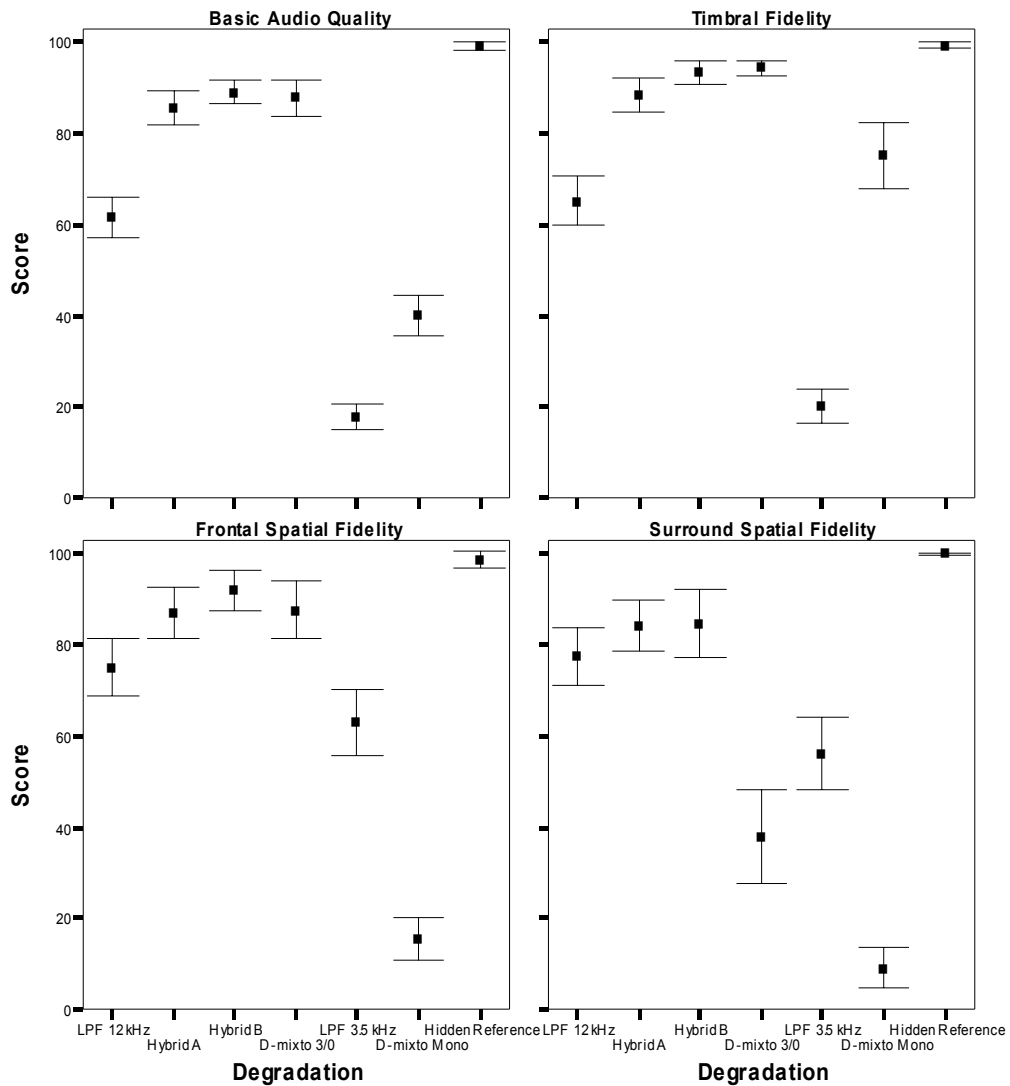


Fig. 3. Classical music F-B. Effects of limiting the overall bandwidth from 100 down to 60 kHz. Means and 95 % confidence intervals averaged across subjects and two excerpts.

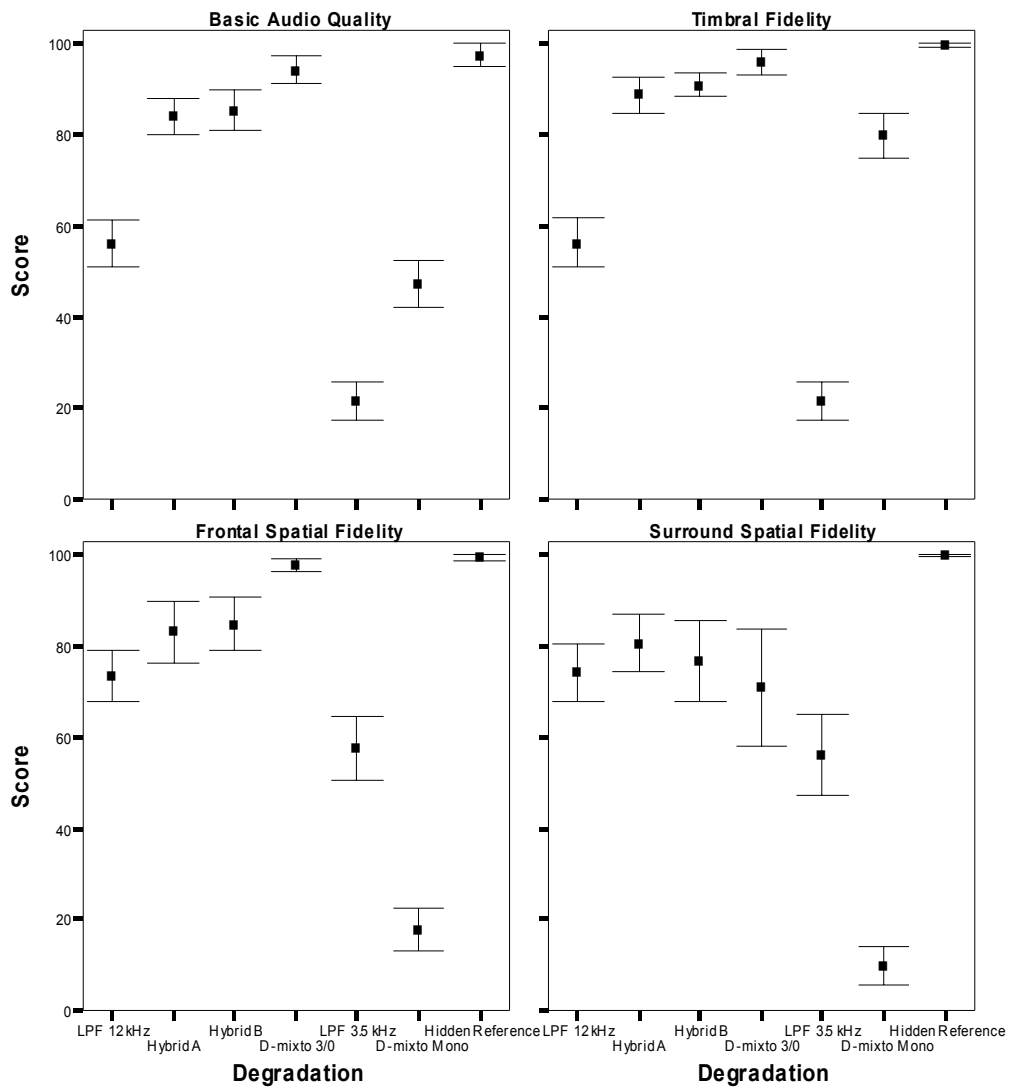


Fig. 4. Pop music F-B. Effects of limiting the overall bandwidth from 100 down to 60 kHz. Means and 95 % confidence intervals averaged across subjects and two excerpts.

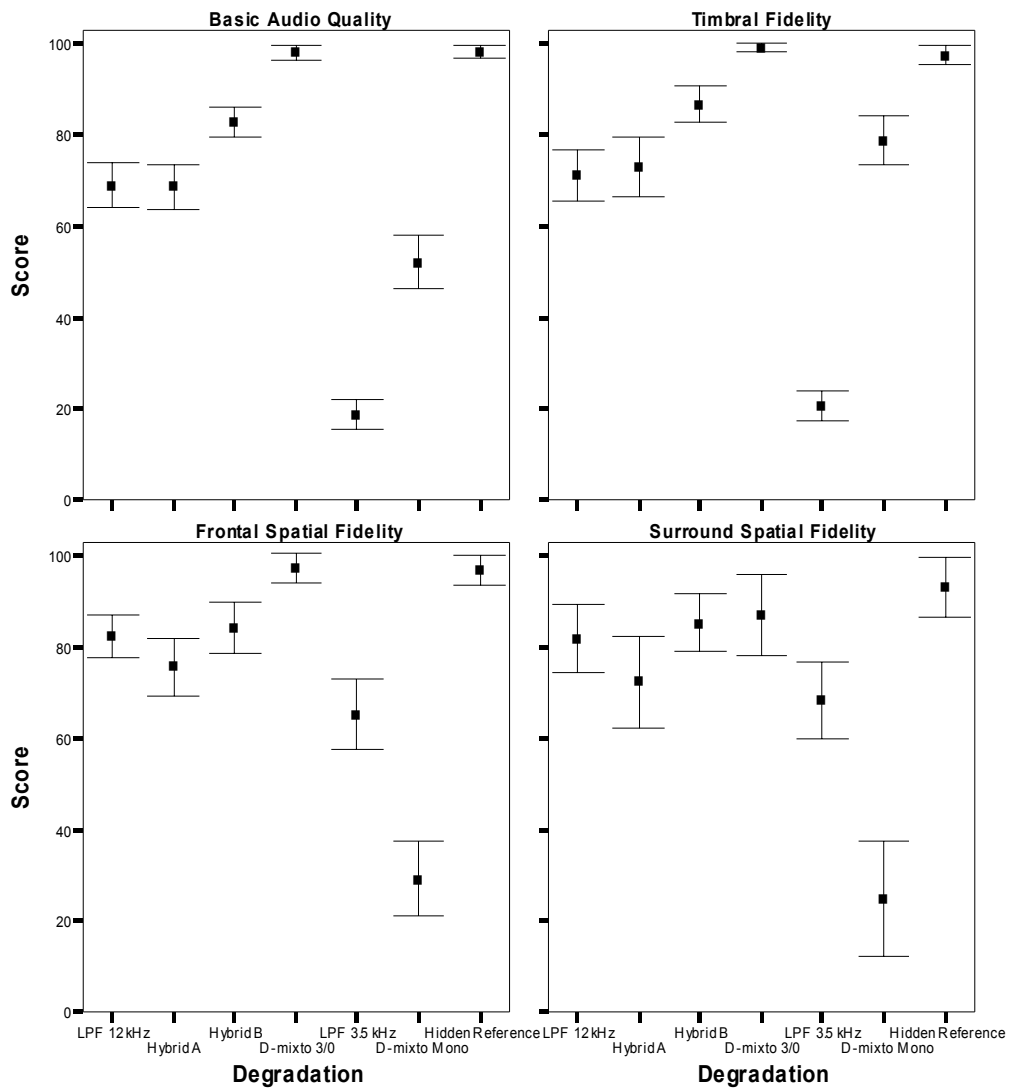


Fig. 5. Movie F-B. Effects of limiting the overall bandwidth from 100 down to 60 kHz. Means and 95 % confidence intervals averaged across subjects and two excerpts.

1.2 Condition 2

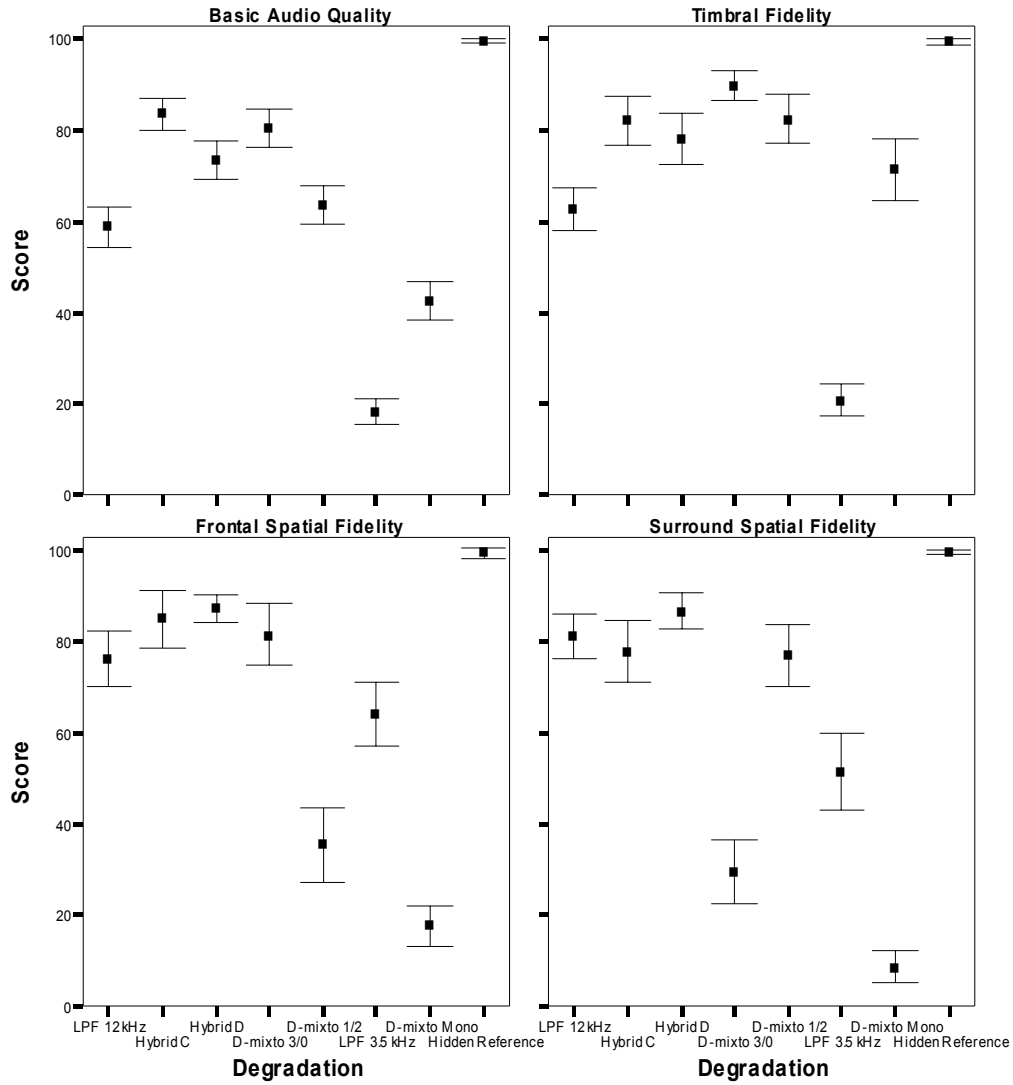


Fig. 6. Pop music F-F. Effects of limiting the overall bandwidth from 100 down to 60 kHz. Means and 95 % confidence intervals averaged across subjects and two excerpts.

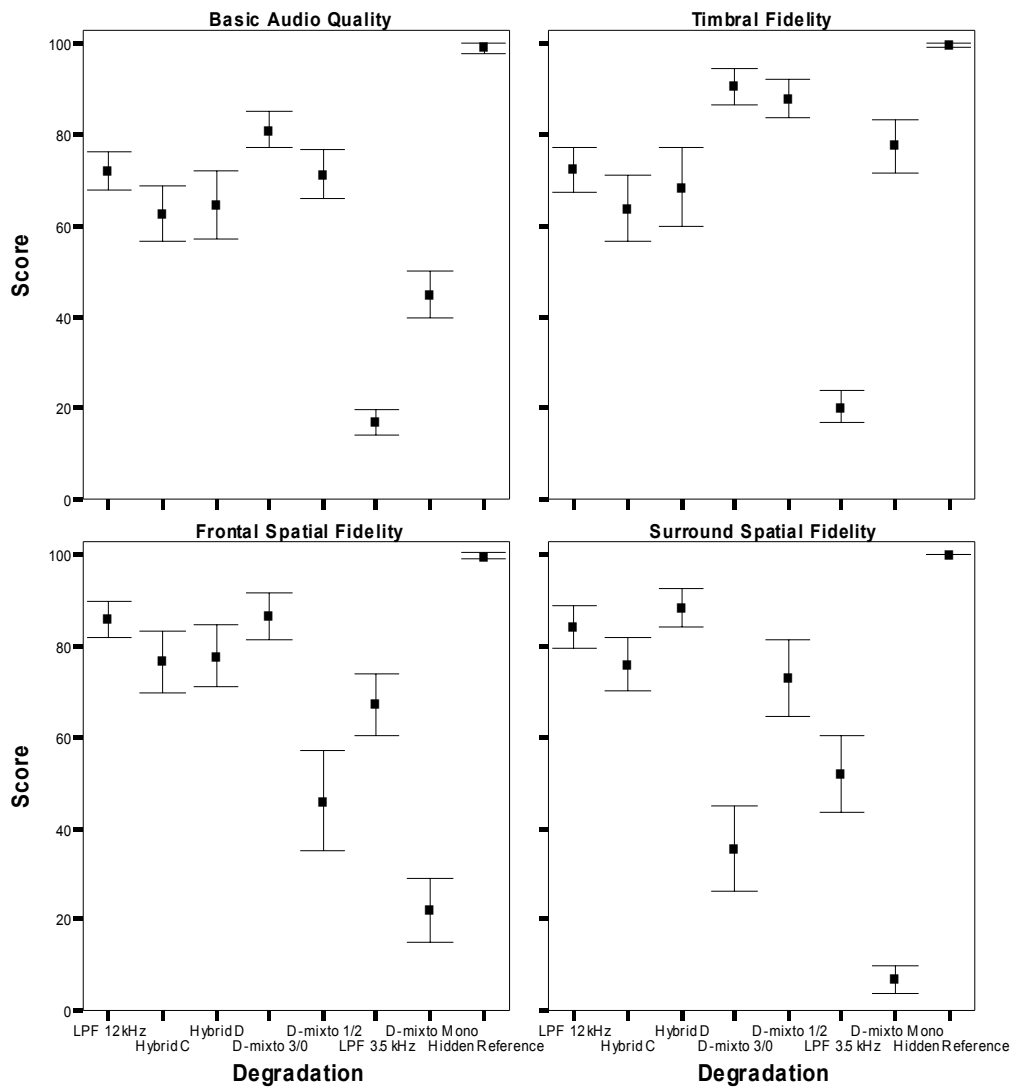


Fig. 7. Sport / Show F-F. Effects of limiting the overall bandwidth from 100 down to 60 kHz. Means and 95 % confidence intervals averaged across subjects and two excerpts.

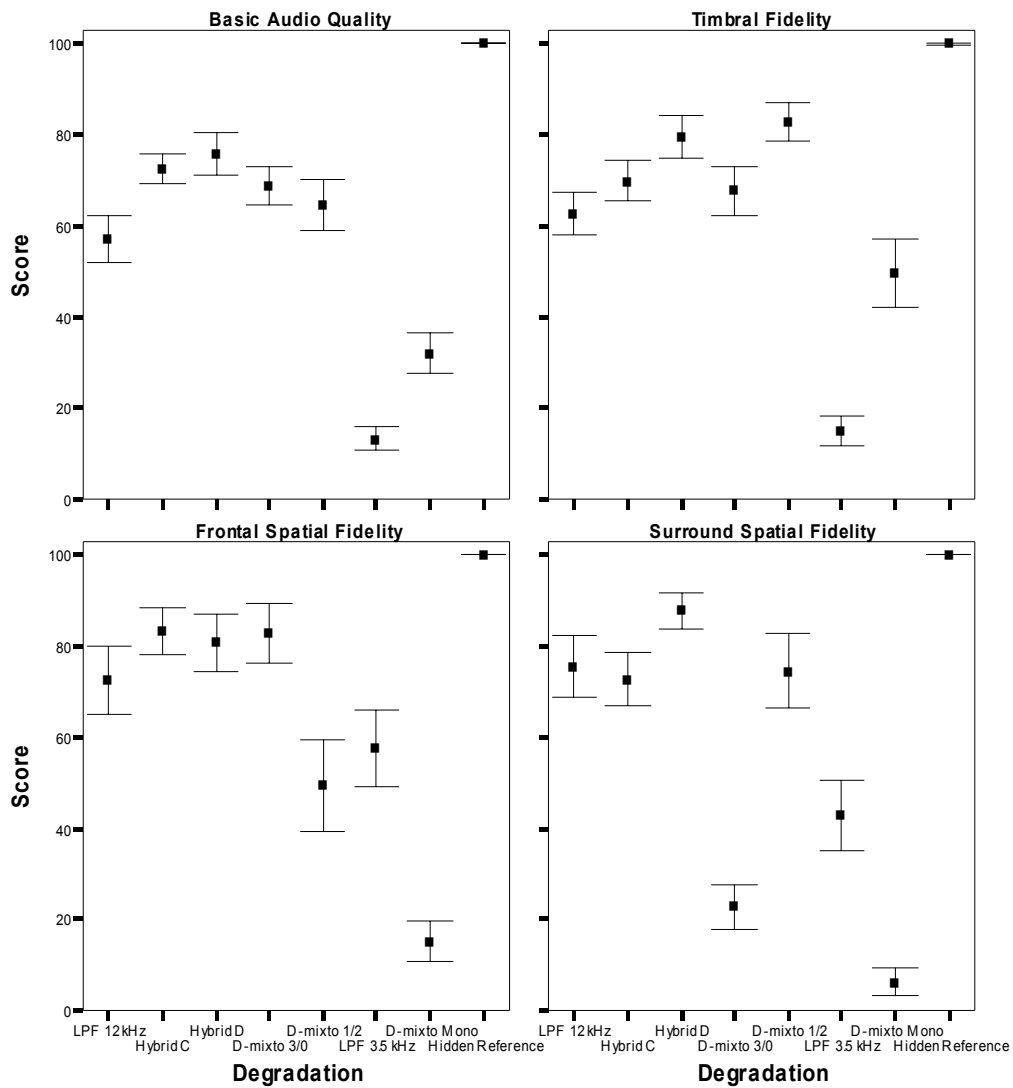


Fig. 8. Ambient F-F. Effects of limiting the overall bandwidth from 100 down to 60 kHz. Means and 95 % confidence intervals averaged across subjects and two excerpts ('rain' and 'applause').

1.3 Condition 3

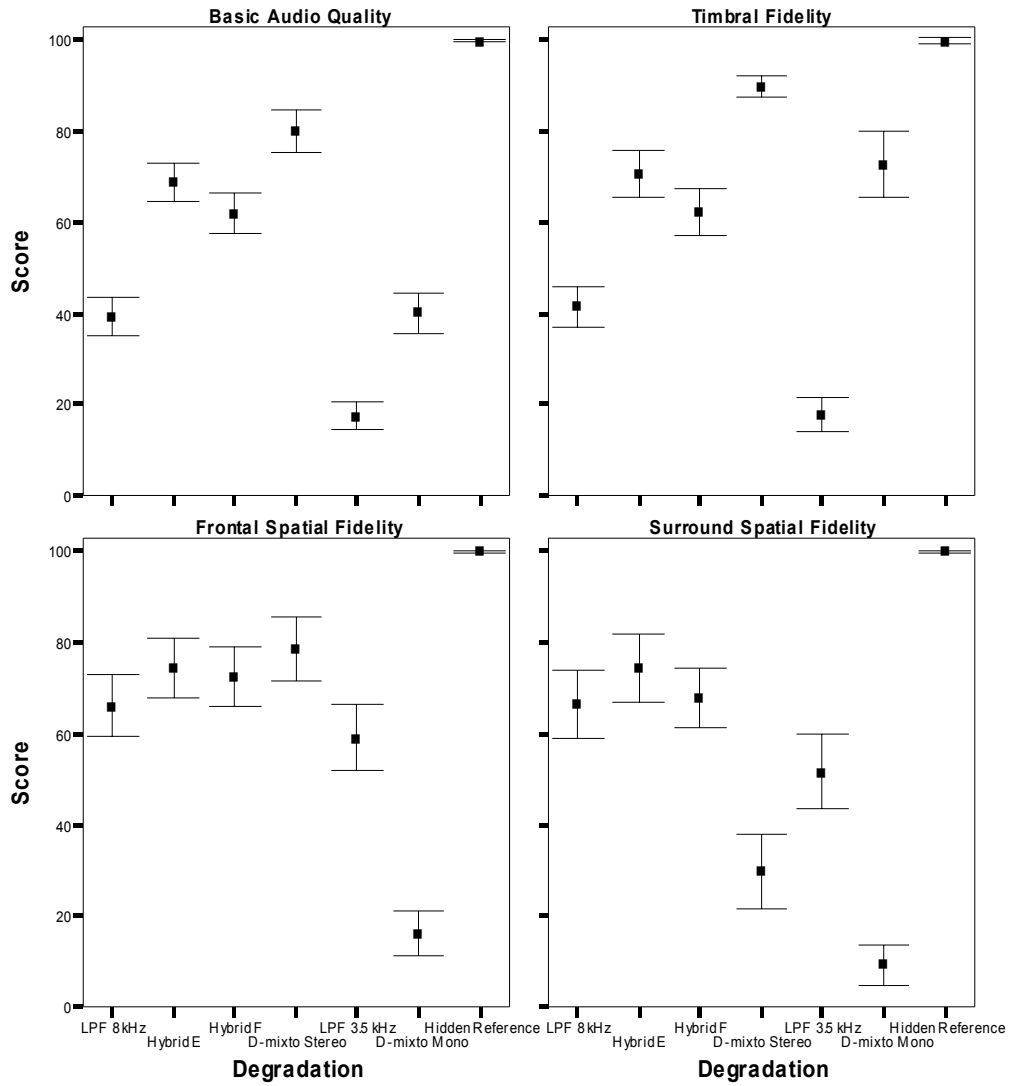


Fig. 9. Classical music F-B. Effects of limiting the overall bandwidth from 100 down to 40 kHz. Means and 95 % confidence intervals averaged across subjects and two excerpts.

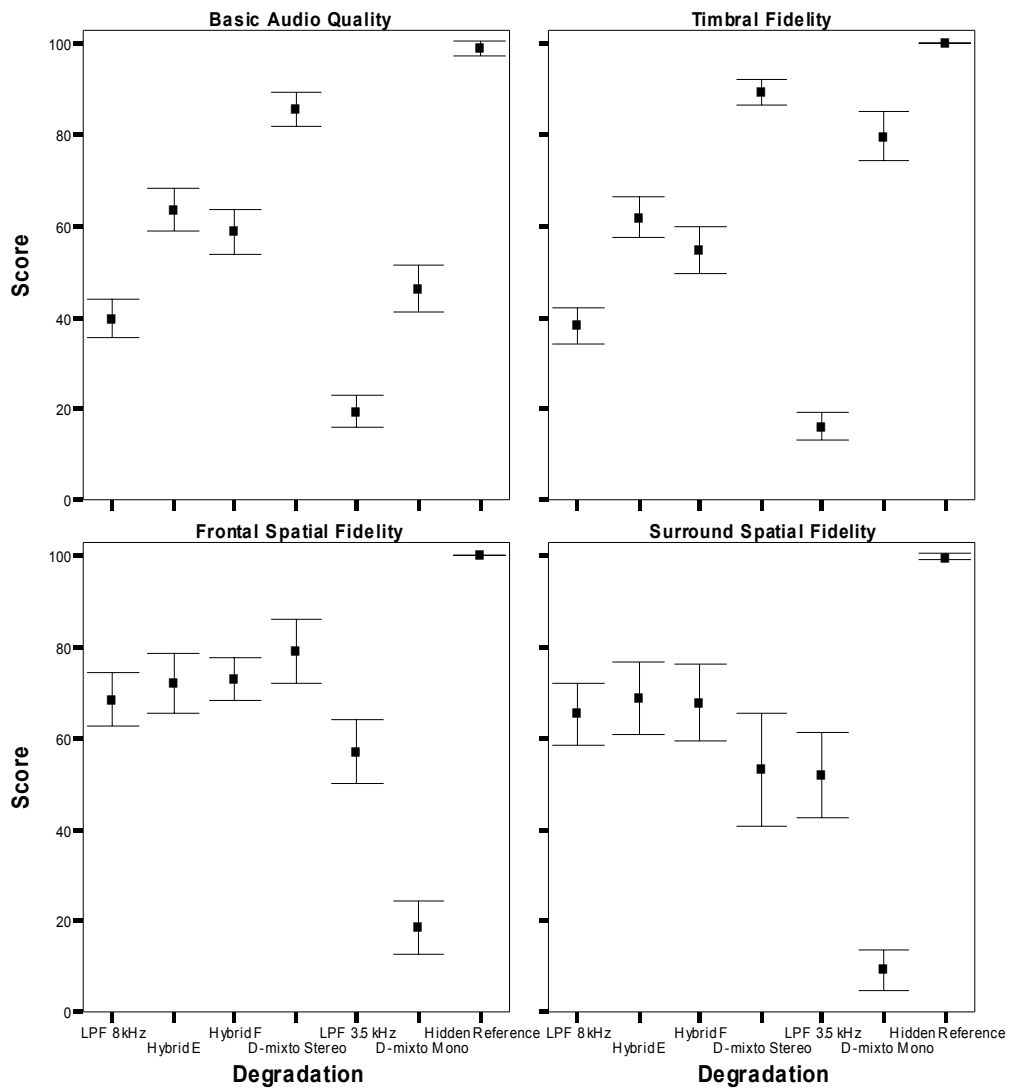


Fig. 10. Pop music F-B. Effects of limiting the overall bandwidth from 100 down to 40 kHz. Means and 95 % confidence intervals averaged across subjects and two excerpts.

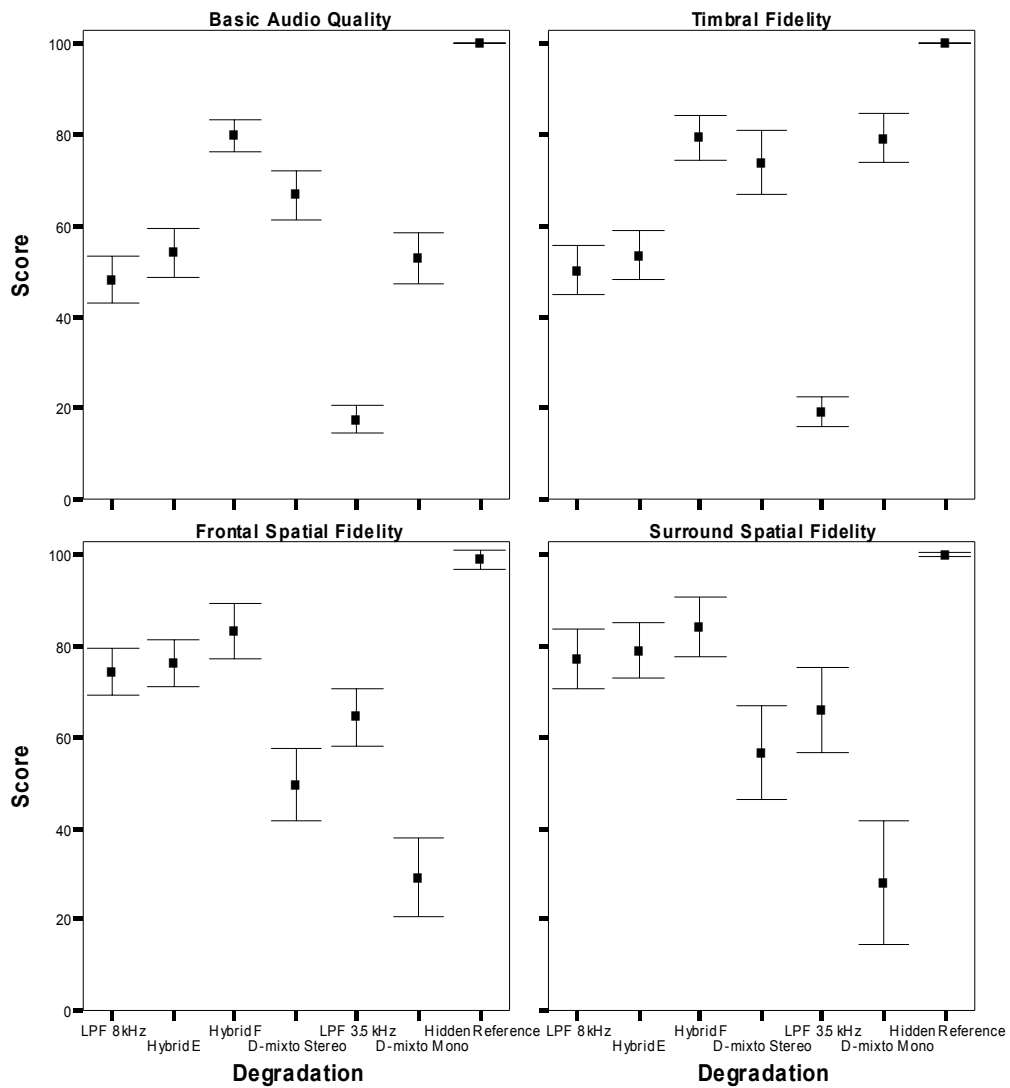


Fig. 11. Movie F-B. Effects of limiting the overall bandwidth from 100 down to 40 kHz. Means and 95 % confidence intervals averaged across subjects and two excerpts.

1.4 Condition 4

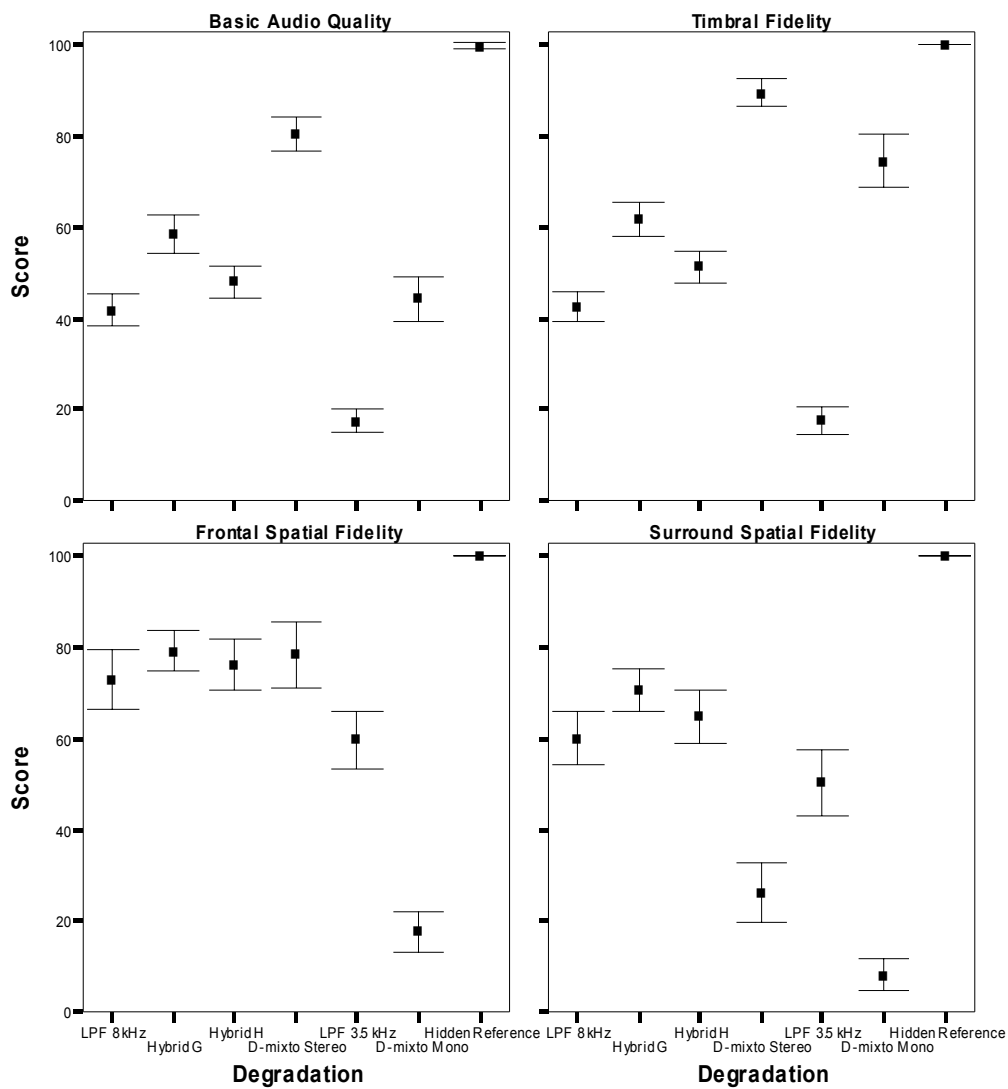


Fig. 12. Pop music F-F. Effects of limiting the overall bandwidth from 100 down to 40 kHz. Means and 95 % confidence intervals averaged across subjects and two excerpts.

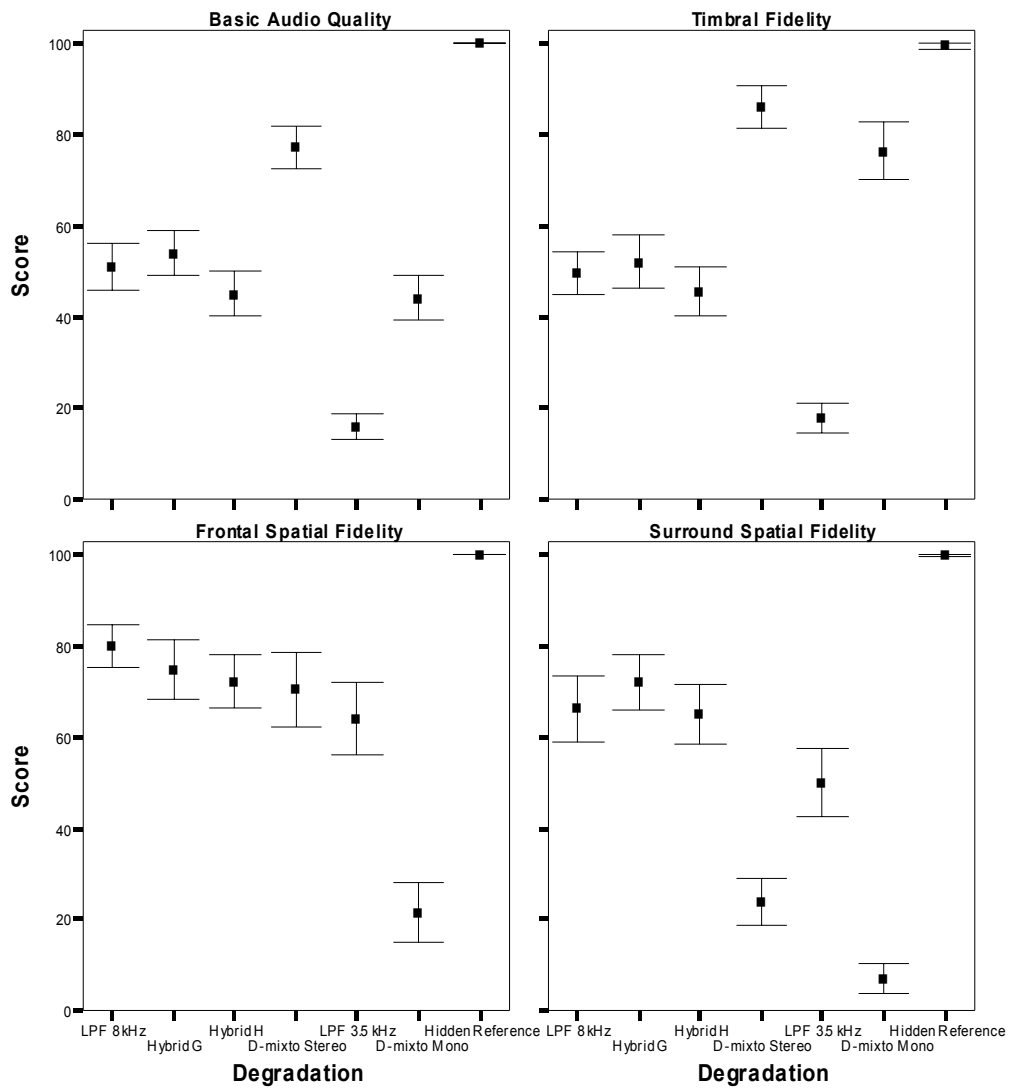


Fig. 13. Sport / Show F-F. Effects of limiting the overall bandwidth from 100 down to 40 kHz. Means and 95 % confidence intervals averaged across subjects and two excerpts.

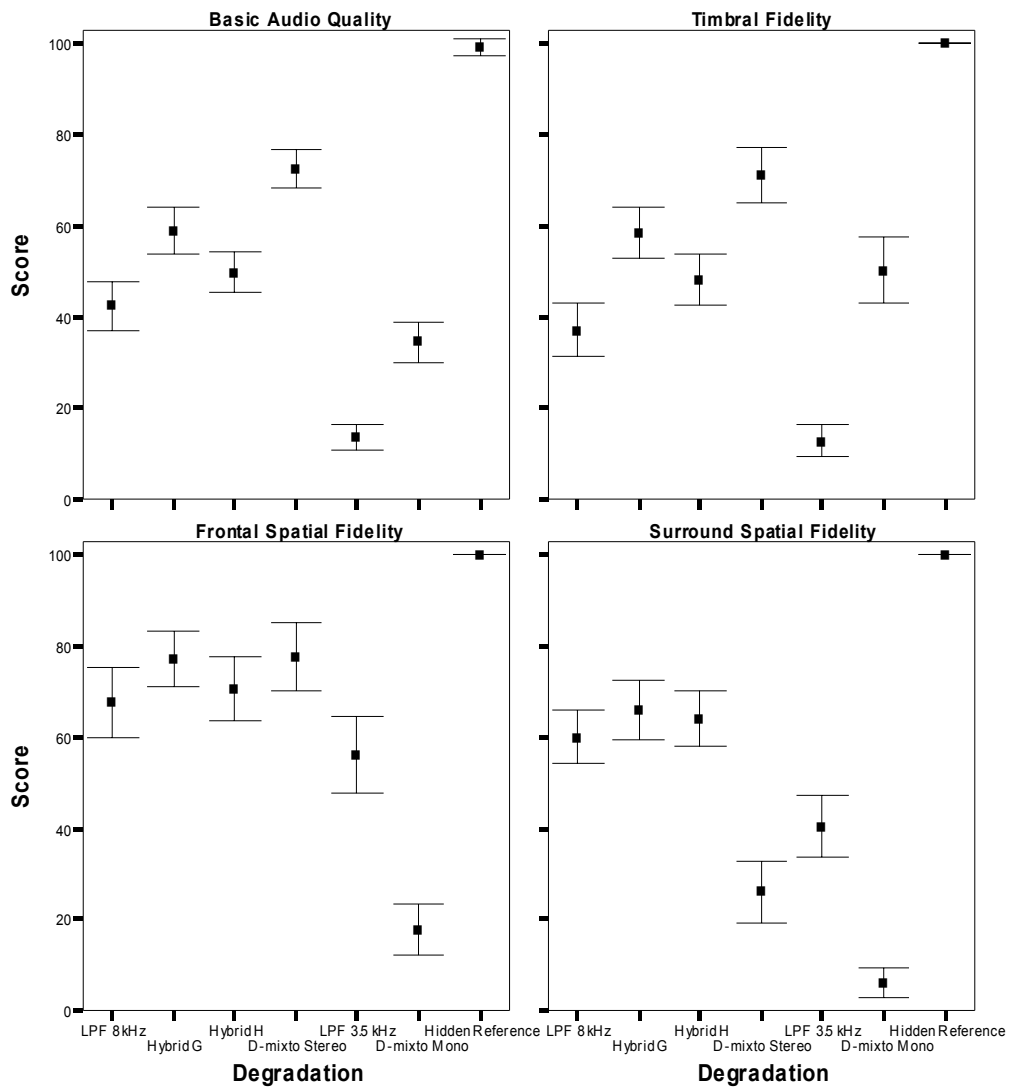


Fig. 14. Ambient F-F. Effects of limiting the overall bandwidth from 100 down to 40 kHz. Means and 95 % confidence intervals averaged across subjects and two excerpts ('rain' and 'applause').

2 MANOVA Test

2.1 Condition 1

Multivariate Tests^c

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.995	27822.077 ^a	4.000	513.000	.000	.995
	Wilks' Lambda	.005	27822.077 ^a	4.000	513.000	.000	.995
	Hotelling's Trace	216.936	27822.077 ^a	4.000	513.000	.000	.995
	Roy's Largest Root	216.936	27822.077 ^a	4.000	513.000	.000	.995
DEGRAD	Pillai's Trace	1.973	83.693	24.000	2064.000	.000	.493
	Wilks' Lambda	.006	253.486	24.000	1790.853	.000	.725
	Hotelling's Trace	26.784	570.835	24.000	2046.000	.000	.870
	Roy's Largest Root	20.939	1800.788 ^b	6.000	516.000	.000	.954
GENRE	Pillai's Trace	.068	4.553	8.000	1028.000	.000	.034
	Wilks' Lambda	.932	4.616 ^a	8.000	1026.000	.000	.035
	Hotelling's Trace	.073	4.678	8.000	1024.000	.000	.035
	Roy's Largest Root	.070	9.054 ^b	4.000	514.000	.000	.066
SUB	Pillai's Trace	.977	11.122	60.000	2064.000	.000	.244
	Wilks' Lambda	.286	12.623	60.000	2004.722	.000	.269
	Hotelling's Trace	1.674	14.275	60.000	2046.000	.000	.295
	Roy's Largest Root	1.093	37.606 ^b	15.000	516.000	.000	.522
DEGRAD * GENRE	Pillai's Trace	.579	7.273	48.000	2064.000	.000	.145
	Wilks' Lambda	.497	8.201	48.000	1978.168	.000	.160
	Hotelling's Trace	.865	9.221	48.000	2046.000	.000	.178
	Roy's Largest Root	.667	28.661 ^b	12.000	516.000	.000	.400
DEGRAD * SUB	Pillai's Trace	1.379	3.016	360.000	2064.000	.000	.345
	Wilks' Lambda	.174	3.125	360.000	2053.450	.000	.354
	Hotelling's Trace	2.275	3.232	360.000	2046.000	.000	.363
	Roy's Largest Root	.888	5.090 ^b	90.000	516.000	.000	.470
GENRE * SUB	Pillai's Trace	.405	1.937	120.000	2064.000	.000	.101
	Wilks' Lambda	.649	1.955	120.000	2041.906	.000	.102
	Hotelling's Trace	.463	1.972	120.000	2046.000	.000	.104
	Roy's Largest Root	.194	3.341 ^b	30.000	516.000	.000	.163

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept+DEGRAD+GENRE+SUB+DEGRAD * GENRE+DEGRAD * SUB+GENRE * SUB

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Basic Audio Quality	516542.496 ^a	155	3332.532	45.917	.000	.932
	Timbral Fidelity	478751.202 ^b	155	3088.717	44.271	.000	.930
	Frontal Spatial Fidelity	488571.482 ^c	155	3152.074	21.727	.000	.867
	Surround Spatial Fidelity	584101.083 ^d	155	3768.394	10.907	.000	.766
Intercept	Basic Audio Quality	3223310.537	1	3223310.537	44412.008	.000	.989
	Timbral Fidelity	3872964.667	1	3872964.667	55512.292	.000	.991
	Frontal Spatial Fidelity	3718155.054	1	3718155.054	25628.931	.000	.980
	Surround Spatial Fidelity	3113859.429	1	3113859.429	9012.947	.000	.946
DEGRAD	Basic Audio Quality	449663.702	6	74943.950	1032.606	.000	.923
	Timbral Fidelity	419826.583	6	69971.097	1002.915	.000	.921
	Frontal Spatial Fidelity	402313.405	6	67052.234	462.185	.000	.843
	Surround Spatial Fidelity	403772.905	6	67295.484	194.784	.000	.694
GENRE	Basic Audio Quality	216.298	2	108.149	1.490	.226	.006
	Timbral Fidelity	196.726	2	98.363	1.410	.245	.005
	Frontal Spatial Fidelity	674.580	2	337.290	2.325	.099	.009
	Surround Spatial Fidelity	9495.705	2	4747.853	13.742	.000	.051
SUB	Basic Audio Quality	21511.153	15	1434.077	19.759	.000	.365
	Timbral Fidelity	22142.143	15	1476.143	21.158	.000	.381
	Frontal Spatial Fidelity	26851.804	15	1790.120	12.339	.000	.264
	Surround Spatial Fidelity	43756.810	15	2917.121	8.443	.000	.197
DEGRAD * GENRE	Basic Audio Quality	12405.057	12	1033.755	14.243	.000	.249
	Timbral Fidelity	10011.774	12	834.314	11.958	.000	.218
	Frontal Spatial Fidelity	10594.774	12	882.898	6.086	.000	.124
	Surround Spatial Fidelity	44336.274	12	3694.689	10.694	.000	.199
DEGRAD * SUB	Basic Audio Quality	28087.774	90	312.086	4.300	.000	.429
	Timbral Fidelity	22835.940	90	253.733	3.637	.000	.388
	Frontal Spatial Fidelity	42983.071	90	477.590	3.292	.000	.365
	Surround Spatial Fidelity	57598.190	90	639.980	1.852	.000	.244
GENRE * SUB	Basic Audio Quality	4658.512	30	155.284	2.140	.001	.111
	Timbral Fidelity	3738.036	30	124.601	1.786	.007	.094
	Frontal Spatial Fidelity	5153.848	30	171.795	1.184	.233	.064
	Surround Spatial Fidelity	25141.199	30	838.040	2.426	.000	.124
Error	Basic Audio Quality	37449.967	516	72.577			
	Timbral Fidelity	36000.131	516	69.768			
	Frontal Spatial Fidelity	74859.464	516	145.076			
	Surround Spatial Fidelity	178271.488	516	345.487			
Total	Basic Audio Quality	3777303.000	672				
	Timbral Fidelity	4387716.000	672				
	Frontal Spatial Fidelity	4281586.000	672				
	Surround Spatial Fidelity	3876232.000	672				
Corrected Total	Basic Audio Quality	553992.463	671				
	Timbral Fidelity	514751.333	671				
	Frontal Spatial Fidelity	563430.946	671				
	Surround Spatial Fidelity	762372.571	671				

- a. R Squared = .932 (Adjusted R Squared = .912)
b. R Squared = .930 (Adjusted R Squared = .909)
c. R Squared = .867 (Adjusted R Squared = .827)
d. R Squared = .766 (Adjusted R Squared = .696)

2.2 Condition 2

Multivariate Tests^c

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.991	15912.078 ^a	4.000	591.000	.000	.991
	Wilks' Lambda	.009	15912.078 ^a	4.000	591.000	.000	.991
	Hotelling's Trace	107.696	15912.078 ^a	4.000	591.000	.000	.991
	Roy's Largest Root	107.696	15912.078 ^a	4.000	591.000	.000	.991
DEGRAD	Pillai's Trace	2.407	128.217	28.000	2376.000	.000	.602
	Wilks' Lambda	.005	253.616	28.000	2132.303	.000	.733
	Hotelling's Trace	17.608	370.716	28.000	2358.000	.000	.815
	Roy's Largest Root	11.235	953.342 ^b	7.000	594.000	.000	.918
GENRE	Pillai's Trace	.127	9.998	8.000	1184.000	.000	.063
	Wilks' Lambda	.875	10.244 ^a	8.000	1182.000	.000	.065
	Hotelling's Trace	.142	10.491	8.000	1180.000	.000	.066
	Roy's Largest Root	.133	19.679 ^b	4.000	592.000	.000	.117
SUB	Pillai's Trace	.815	10.131	60.000	2376.000	.000	.204
	Wilks' Lambda	.379	10.863	60.000	2309.195	.000	.215
	Hotelling's Trace	1.178	11.570	60.000	2358.000	.000	.227
	Roy's Largest Root	.640	25.328 ^b	15.000	594.000	.000	.390
DEGRAD * GENRE	Pillai's Trace	.420	4.971	56.000	2376.000	.000	.105
	Wilks' Lambda	.624	5.293	56.000	2301.037	.000	.111
	Hotelling's Trace	.535	5.630	56.000	2358.000	.000	.118
	Roy's Largest Root	.384	16.299 ^b	14.000	594.000	.000	.278
DEGRAD * SUB	Pillai's Trace	1.313	2.764	420.000	2376.000	.000	.328
	Wilks' Lambda	.196	2.837	420.000	2365.687	.000	.335
	Hotelling's Trace	2.074	2.911	420.000	2358.000	.000	.341
	Roy's Largest Root	.841	4.757 ^b	105.000	594.000	.000	.457
GENRE * SUB	Pillai's Trace	.314	1.684	120.000	2376.000	.000	.078
	Wilks' Lambda	.718	1.700	120.000	2351.974	.000	.079
	Hotelling's Trace	.349	1.716	120.000	2358.000	.000	.080
	Roy's Largest Root	.156	3.090 ^b	30.000	594.000	.000	.135

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept+DEGRAD+GENRE+SUB+DEGRAD * GENRE+DEGRAD * SUB+GENRE * SUB

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Basic Audio Quality	492483.751 ^a	173	2846.727	22.884	.000	.870
	Timbral Fidelity	467886.992 ^b	173	2704.549	19.267	.000	.849
	Frontal Spatial Fidelity	592636.600 ^c	173	3425.645	18.099	.000	.841
	Surround Spatial Fidelity	777692.404 ^d	173	4495.332	28.333	.000	.892
Intercept	Basic Audio Quality	3108335.783	1	3108335.783	24987.344	.000	.977
	Timbral Fidelity	3821101.021	1	3821101.021	27221.568	.000	.979
	Frontal Spatial Fidelity	3628487.658	1	3628487.658	19170.216	.000	.970
	Surround Spatial Fidelity	3041643.521	1	3041643.521	19170.414	.000	.970
DEGRAD	Basic Audio Quality	412074.290	7	58867.756	473.227	.000	.848
	Timbral Fidelity	376849.708	7	53835.673	383.526	.000	.819
	Frontal Spatial Fidelity	461041.061	7	65863.009	347.971	.000	.804
	Surround Spatial Fidelity	670025.042	7	95717.863	603.276	.000	.877
GENRE	Basic Audio Quality	2856.924	2	1428.462	11.483	.000	.037
	Timbral Fidelity	8552.424	2	4276.212	30.464	.000	.093
	Frontal Spatial Fidelity	901.596	2	450.798	2.382	.093	.008
	Surround Spatial Fidelity	2709.159	2	1354.579	8.537	.000	.028
SUB	Basic Audio Quality	27730.363	15	1848.691	14.861	.000	.273
	Timbral Fidelity	25904.479	15	1726.965	12.303	.000	.237
	Frontal Spatial Fidelity	41007.280	15	2733.819	14.443	.000	.267
	Surround Spatial Fidelity	23369.146	15	1557.943	9.819	.000	.199
DEGRAD * GENRE	Basic Audio Quality	17438.659	14	1245.618	10.013	.000	.191
	Timbral Fidelity	27297.221	14	1949.802	13.890	.000	.247
	Frontal Spatial Fidelity	10901.341	14	778.667	4.114	.000	.088
	Surround Spatial Fidelity	3700.716	14	264.337	1.666	.059	.038
DEGRAD * SUB	Basic Audio Quality	29005.397	105	276.242	2.221	.000	.282
	Timbral Fidelity	22119.458	105	210.662	1.501	.002	.210
	Frontal Spatial Fidelity	70165.168	105	668.240	3.530	.000	.384
	Surround Spatial Fidelity	68405.292	105	651.479	4.106	.000	.421
GENRE * SUB	Basic Audio Quality	3378.117	30	112.604	.905	.614	.044
	Timbral Fidelity	7163.701	30	238.790	1.701	.012	.079
	Frontal Spatial Fidelity	8620.154	30	287.338	1.518	.039	.071
	Surround Spatial Fidelity	9483.049	30	316.102	1.992	.001	.091
Error	Basic Audio Quality	73891.466	594	124.396			
	Timbral Fidelity	83379.987	594	140.370			
	Frontal Spatial Fidelity	112430.742	594	189.277			
	Surround Spatial Fidelity	94246.076	594	158.663			
Total	Basic Audio Quality	3674711.000	768				
	Timbral Fidelity	4372368.000	768				
	Frontal Spatial Fidelity	4333555.000	768				
	Surround Spatial Fidelity	3913582.000	768				
Corrected Total	Basic Audio Quality	566375.217	767				
	Timbral Fidelity	551266.979	767				
	Frontal Spatial Fidelity	705067.342	767				
	Surround Spatial Fidelity	871938.479	767				

- a. R Squared = .870 (Adjusted R Squared = .832)
- b. R Squared = .849 (Adjusted R Squared = .805)
- c. R Squared = .841 (Adjusted R Squared = .794)
- d. R Squared = .892 (Adjusted R Squared = .860)

2.3 Condition 3

Multivariate Tests^c

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.994	19797.958 ^a	4.000	513.000	.000	.994
	Wilks' Lambda	.006	19797.958 ^a	4.000	513.000	.000	.994
	Hotelling's Trace	154.370	19797.958 ^a	4.000	513.000	.000	.994
	Roy's Largest Root	154.370	19797.958 ^a	4.000	513.000	.000	.994
DEGRAD	Pillai's Trace	2.004	86.303	24.000	2064.000	.000	.501
	Wilks' Lambda	.006	251.857	24.000	1790.853	.000	.724
	Hotelling's Trace	24.484	521.807	24.000	2046.000	.000	.860
	Roy's Largest Root	17.818	1532.366 ^b	6.000	516.000	.000	.947
GENRE	Pillai's Trace	.159	11.080	8.000	1028.000	.000	.079
	Wilks' Lambda	.843	11.408 ^a	8.000	1026.000	.000	.082
	Hotelling's Trace	.183	11.736	8.000	1024.000	.000	.084
	Roy's Largest Root	.169	21.702 ^b	4.000	514.000	.000	.144
SUB	Pillai's Trace	1.276	16.114	60.000	2064.000	.000	.319
	Wilks' Lambda	.181	18.350	60.000	2004.722	.000	.348
	Hotelling's Trace	2.458	20.952	60.000	2046.000	.000	.381
	Roy's Largest Root	1.572	54.079 ^b	15.000	516.000	.000	.611
DEGRAD * GENRE	Pillai's Trace	.754	9.995	48.000	2064.000	.000	.189
	Wilks' Lambda	.378	11.852	48.000	1978.168	.000	.216
	Hotelling's Trace	1.320	14.069	48.000	2046.000	.000	.248
	Roy's Largest Root	1.048	45.055 ^b	12.000	516.000	.000	.512
DEGRAD * SUB	Pillai's Trace	1.399	3.082	360.000	2064.000	.000	.350
	Wilks' Lambda	.168	3.204	360.000	2053.450	.000	.359
	Hotelling's Trace	2.340	3.325	360.000	2046.000	.000	.369
	Roy's Largest Root	.962	5.518 ^b	90.000	516.000	.000	.490
GENRE * SUB	Pillai's Trace	.521	2.574	120.000	2064.000	.000	.130
	Wilks' Lambda	.569	2.592	120.000	2041.906	.000	.131
	Hotelling's Trace	.612	2.609	120.000	2046.000	.000	.133
	Roy's Largest Root	.260	4.470 ^b	30.000	516.000	.000	.206

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept+DEGRAD+GENRE+SUB+DEGRAD * GENRE+DEGRAD * SUB+GENRE * SUB

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Basic Audio Quality	479283.205 ^a	155	3092.150	40.218	.000	.924
	Timbral Fidelity	511896.256 ^b	155	3302.556	45.422	.000	.932
	Frontal Spatial Fidelity	447577.629 ^c	155	2887.598	18.569	.000	.848
	Surround Spatial Fidelity	593511.250 ^d	155	3829.105	14.482	.000	.813
Intercept	Basic Audio Quality	2374290.381	1	2374290.381	30881.253	.000	.984
	Timbral Fidelity	2773544.024	1	2773544.024	38145.940	.000	.987
	Frontal Spatial Fidelity	3030963.037	1	3030963.037	19491.157	.000	.974
	Surround Spatial Fidelity	2596577.357	1	2596577.357	9820.281	.000	.950
DEGRAD	Basic Audio Quality	391601.348	6	65266.891	848.895	.000	.908
	Timbral Fidelity	426368.393	6	71061.399	977.343	.000	.919
	Frontal Spatial Fidelity	320484.307	6	53414.051	343.489	.000	.800
	Surround Spatial Fidelity	401829.205	6	66971.534	253.287	.000	.747
GENRE	Basic Audio Quality	509.440	2	254.720	3.313	.037	.013
	Timbral Fidelity	658.967	2	329.484	4.532	.011	.017
	Frontal Spatial Fidelity	207.271	2	103.635	.666	.514	.003
	Surround Spatial Fidelity	21751.241	2	10875.621	41.132	.000	.138
SUB	Basic Audio Quality	34411.571	15	2294.105	29.838	.000	.464
	Timbral Fidelity	32932.119	15	2195.475	30.195	.000	.467
	Frontal Spatial Fidelity	44768.701	15	2984.580	19.193	.000	.358
	Surround Spatial Fidelity	61075.929	15	4071.729	15.399	.000	.309
DEGRAD * GENRE	Basic Audio Quality	20438.205	12	1703.184	22.152	.000	.340
	Timbral Fidelity	22847.804	12	1903.984	26.186	.000	.378
	Frontal Spatial Fidelity	25840.167	12	2153.347	13.847	.000	.244
	Surround Spatial Fidelity	13781.321	12	1148.443	4.343	.000	.092
DEGRAD * SUB	Basic Audio Quality	26636.033	90	295.956	3.849	.000	.402
	Timbral Fidelity	25347.798	90	281.642	3.874	.000	.403
	Frontal Spatial Fidelity	46073.122	90	511.924	3.292	.000	.365
	Surround Spatial Fidelity	61069.509	90	678.550	2.566	.000	.309
GENRE * SUB	Basic Audio Quality	5686.607	30	189.554	2.465	.000	.125
	Timbral Fidelity	3741.176	30	124.706	1.715	.011	.091
	Frontal Spatial Fidelity	10204.062	30	340.135	2.187	.000	.113
	Surround Spatial Fidelity	34004.045	30	1133.468	4.287	.000	.200
Error	Basic Audio Quality	39672.414	516	76.885			
	Timbral Fidelity	37517.720	516	72.709			
	Frontal Spatial Fidelity	80240.333	516	155.505			
	Surround Spatial Fidelity	136435.393	516	264.410			
Total	Basic Audio Quality	2893246.000	672				
	Timbral Fidelity	3322958.000	672				
	Frontal Spatial Fidelity	3558781.000	672				
	Surround Spatial Fidelity	3326524.000	672				
Corrected Total	Basic Audio Quality	518955.619	671				
	Timbral Fidelity	549413.976	671				
	Frontal Spatial Fidelity	527817.963	671				
	Surround Spatial Fidelity	729946.643	671				

- a. R Squared = .924 (Adjusted R Squared = .901)
- b. R Squared = .932 (Adjusted R Squared = .911)
- c. R Squared = .848 (Adjusted R Squared = .802)
- d. R Squared = .813 (Adjusted R Squared = .757)

2.4 Condition 4

Multivariate Tests^c

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.992	15652.809 ^a	4.000	513.000	.000	.992
	Wilks' Lambda	.008	15652.809 ^a	4.000	513.000	.000	.992
	Hotelling's Trace	122.049	15652.809 ^a	4.000	513.000	.000	.992
	Roy's Largest Root	122.049	15652.809 ^a	4.000	513.000	.000	.992
DEGRAD	Pillai's Trace	2.293	115.478	24.000	2064.000	.000	.573
	Wilks' Lambda	.003	306.186	24.000	1790.853	.000	.759
	Hotelling's Trace	25.214	537.367	24.000	2046.000	.000	.863
	Roy's Largest Root	15.899	1367.285 ^b	6.000	516.000	.000	.941
GENRE	Pillai's Trace	.155	10.760	8.000	1028.000	.000	.077
	Wilks' Lambda	.846	11.200 ^a	8.000	1026.000	.000	.080
	Hotelling's Trace	.182	11.640	8.000	1024.000	.000	.083
	Roy's Largest Root	.180	23.078 ^b	4.000	514.000	.000	.152
SUB	Pillai's Trace	1.181	14.420	60.000	2064.000	.000	.295
	Wilks' Lambda	.226	15.478	60.000	2004.722	.000	.310
	Hotelling's Trace	1.940	16.539	60.000	2046.000	.000	.327
	Roy's Largest Root	1.053	36.237 ^b	15.000	516.000	.000	.513
DEGRAD * GENRE	Pillai's Trace	.348	4.102	48.000	2064.000	.000	.087
	Wilks' Lambda	.680	4.334	48.000	1978.168	.000	.092
	Hotelling's Trace	.429	4.569	48.000	2046.000	.000	.097
	Roy's Largest Root	.309	13.299 ^b	12.000	516.000	.000	.236
DEGRAD * SUB	Pillai's Trace	1.317	2.813	360.000	2064.000	.000	.329
	Wilks' Lambda	.198	2.845	360.000	2053.450	.000	.333
	Hotelling's Trace	2.024	2.876	360.000	2046.000	.000	.336
	Roy's Largest Root	.688	3.942 ^b	90.000	516.000	.000	.407
GENRE * SUB	Pillai's Trace	.496	2.436	120.000	2064.000	.000	.124
	Wilks' Lambda	.582	2.480	120.000	2041.906	.000	.126
	Hotelling's Trace	.592	2.524	120.000	2046.000	.000	.129
	Roy's Largest Root	.289	4.965 ^b	30.000	516.000	.000	.224

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept+DEGRAD+GENRE+SUB+DEGRAD * GENRE+DEGRAD * SUB+GENRE * SUB

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Basic Audio Quality	471536.545 ^a	155	3042.171	36.064	.000	.915
	Timbral Fidelity	506476.173 ^b	155	3267.588	31.358	.000	.904
	Frontal Spatial Fidelity	463531.007 ^c	155	2990.523	18.712	.000	.849
	Surround Spatial Fidelity	619356.921 ^d	155	3995.851	28.546	.000	.896
Intercept	Basic Audio Quality	2050438.095	1	2050438.095	24307.150	.000	.979
	Timbral Fidelity	2352466.667	1	2352466.667	22575.632	.000	.978
	Frontal Spatial Fidelity	3131719.680	1	3131719.680	19595.960	.000	.974
	Surround Spatial Fidelity	1936186.073	1	1936186.073	13831.814	.000	.964
DEGRAD	Basic Audio Quality	409318.113	6	68219.686	808.718	.000	.904
	Timbral Fidelity	429011.563	6	71501.927	686.174	.000	.889
	Frontal Spatial Fidelity	352558.476	6	58759.746	367.675	.000	.810
	Surround Spatial Fidelity	536211.042	6	89368.507	638.435	.000	.881
GENRE	Basic Audio Quality	990.646	2	495.323	5.872	.003	.022
	Timbral Fidelity	9035.414	2	4517.707	43.355	.000	.144
	Frontal Spatial Fidelity	872.824	2	436.412	2.731	.066	.010
	Surround Spatial Fidelity	1154.932	2	577.466	4.125	.017	.016
SUB	Basic Audio Quality	25170.667	15	1678.044	19.893	.000	.366
	Timbral Fidelity	25489.333	15	1699.289	16.307	.000	.322
	Frontal Spatial Fidelity	44443.963	15	2962.931	18.540	.000	.350
	Surround Spatial Fidelity	36143.903	15	2409.594	17.214	.000	.334
DEGRAD * GENRE	Basic Audio Quality	4489.021	12	374.085	4.435	.000	.093
	Timbral Fidelity	15532.982	12	1294.415	12.422	.000	.224
	Frontal Spatial Fidelity	4951.426	12	412.619	2.582	.002	.057
	Surround Spatial Fidelity	2536.923	12	211.410	1.510	.116	.034
DEGRAD * SUB	Basic Audio Quality	24383.792	90	270.931	3.212	.000	.359
	Timbral Fidelity	19740.437	90	219.338	2.105	.000	.269
	Frontal Spatial Fidelity	47482.714	90	527.586	3.301	.000	.365
	Surround Spatial Fidelity	35946.815	90	399.409	2.853	.000	.332
GENRE * SUB	Basic Audio Quality	7184.307	30	239.477	2.839	.000	.142
	Timbral Fidelity	7666.443	30	255.548	2.452	.000	.125
	Frontal Spatial Fidelity	13221.604	30	440.720	2.758	.000	.138
	Surround Spatial Fidelity	7363.307	30	245.444	1.753	.009	.093
Error	Basic Audio Quality	43527.360	516	84.355			
	Timbral Fidelity	53769.161	516	104.204			
	Frontal Spatial Fidelity	82464.312	516	159.815			
	Surround Spatial Fidelity	72230.006	516	139.981			
Total	Basic Audio Quality	2565502.000	672				
	Timbral Fidelity	2912712.000	672				
	Frontal Spatial Fidelity	3677715.000	672				
	Surround Spatial Fidelity	2627773.000	672				
Corrected Total	Basic Audio Quality	515063.905	671				
	Timbral Fidelity	560245.333	671				
	Frontal Spatial Fidelity	545995.320	671				
	Surround Spatial Fidelity	691586.927	671				

- a. R Squared = .915 (Adjusted R Squared = .890)
- b. R Squared = .904 (Adjusted R Squared = .875)
- c. R Squared = .849 (Adjusted R Squared = .804)
- d. R Squared = .896 (Adjusted R Squared = .864)