Parameter-specific Morphing Reveals Contributions of Timbre to the Perception of Emotions in Voices in Cochlear Implant Users

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Supplemental Material

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1 Abbreviations

ANOVA	analysis of variance
AP	aperiodicity
CI	cochlear implant
dB	decibel
FF	formant frequencies
Full	full morph type
F0	fundamental frequency
Hz	Hertz
i.e.	id est
LGroup	listener group
LSex	listener sex
ML	morph level
ms	milliseconds
MType	morph type
NH	normal-hearing
PerfGroup	performance subgroup
SL	spectrum level
SpSex	speaker sex
T	time morph type
Timbre	timbre morph type
Time	timing morph type

2 Stimuli

2.1 Used morph types

Morph types (MType: F0, Full, Timbre, Time) used in the experiment and their relation to TANDEM-STRAIGHT acoustic parameters which were systematically manipulated (x) or kept constant at an intermediate morph level (50/50)

Note. AP = aperiodicity, FF = formant frequencies; SL = spectrum level; T = Time

Morph type	**TANDEM-STRAIGHT parameters**				
	AP	**F0**	**FF**	**SL**	**T**
Full	x	x	x	x	x
F0	50/50	x	50/50	50/50	50/50
Timbre	x	50/50	x	x	50/50
Time	50/50	50/50	50/50	50/50	x

2.2 Acoustic measurements

Filename	**Duration in ms**	**F0 Median in Hz**	**F0 Mean in Hz**	**F0 SD in Hz**	**Int. in dB**
nf01_w01_f0_00.wav	910	250.3	245.4	28.91	77.95
nf01_w01_f0_100.wav	909	357.6	354.4	91.8	79.83
nf01_w01_f0_20.wav	915	275.8	269.4	35.67	78.12
nf01_w01_f0_40.wav	907	301.8	297.3	45.55	78.83
nf01_w01_f0_60.wav	908	340.3	327.8	59.85	78.94
nf01_w01_f0_80.wav	911	384.3	362.4	77.18	79.5
nf01_w01_full_00.wav	967	248.3	242.5	30.59	77.21
nf01_w01_full_100.wav	854	397	391.3	73.19	78.36
nf01_w01_full_20.wav	939	276.8	268.3	36.98	76.47
nf01_w01_full_40.wav	920	302.9	296.9	46.93	77.93
nf01_w01_full_60.wav	898	341.3	329.2	58.74	78.7
nf01_w01_full_80.wav	869	386.8	367.1	73.51	78.24
nf01_w01_tbr_00.wav	909	323.5	312.8	52.76	77.99
nf01_w01_tbr_100.wav	909	328.2	317.5	48.7	77.17
nf01_w01_tbr_20.wav	909	321.8	312.1	52.59	77.64
nf01_w01_tbr_40.wav	909	321.7	312.1	52.42	78.46
nf01_w01_tbr_60.wav	909	321	312.3	52.22	78.56

nf01_w01_tbr_80.wav	909	323.5	314.3	50.49	78.5
nf01_w01_tmg_00.wav	964	320.2	308.4	56.44	78.73
nf01_w01_tmg_100.wav	853	321.3	313.7	50.72	78.85
nf01_w01_tmg_20.wav	941	318.3	310.2	54.16	78.91
nf01_w01_tmg_40.wav	922	322	312	53.49	78.98
nf01_w01_tmg_60.wav	898	322.5	313.4	51.36	79.14
nf01_w01_tmg_80.wav	878	323	313.7	50.66	78.91
nf01_w02_f0_00.wav	839	232.8	235.5	18.71	76.64
nf01_w02_f0_100.wav	850	381.5	366.3	70.64	76.98
nf01_w02_f0_20.wav	849	246.3	255.9	18.97	76.99
nf01_w02_f0_40.wav	849	279.8	278.9	25.98	77.65
nf01_w02_f0_60.wav	848	316.1	306.3	37.92	78.15
nf01_w02_f0_80.wav	850	354.1	334.8	52.76	78.1
nf01_w02_full_00.wav	916	233.9	237.3	19.66	79.72
nf01_w02_full_100.wav	770	382.9	375.3	62.73	76.01
nf01_w02_full_20.wav	883	248.4	256.7	20.21	80.79
nf01_w02_full_40.wav	864	280.5	280.2	26.88	79.31
nf01_w02_full_60.wav	826	316.6	306.7	37.03	76.55
nf01_w02_full_80.wav	800	355.9	336.9	50.41	75.02
nf01_w02_tbr_00.wav	849	299	293.1	31.42	79.76
nf01_w02_tbr_100.wav	849	298.6	293.6	30.53	75.12
nf01_w02_tbr_20.wav	849	299.6	293.2	31.76	80.35
nf01_w02_tbr_40.wav	849	299.4	292.8	31.76	79.68
nf01_w02_tbr_60.wav	849	298.9	291.7	31.72	76.42
nf01_w02_tbr_80.wav	849	296.6	292.5	30.66	74.46
nf01_w02_tmg_00.wav	930	295.6	288.3	33.53	78.21
nf01_w02_tmg_100.wav	763	297.3	292	30.38	78.04
nf01_w02_tmg_20.wav	888	295.6	289.1	33.4	78.21
nf01_w02_tmg_40.wav	863	299.8	291.3	31.95	77.82
nf01_w02_tmg_60.wav	826	296.8	292.1	31.12	78.37
nf01_w02_tmg_80.wav	794	296.4	291.6	31.19	77.97
nf01_w03_f0_00.wav	851	220.8	219.8	12.91	76.95
nf01_w03_f0_100.wav	852	373.7	364.8	92.79	77.91
nf01_w03_f0_20.wav	851	249.2	242.5	20.6	77.47
nf01_w03_f0_40.wav	854	284.4	268.4	33.52	78.38
nf01_w03_f0_60.wav	850	314.4	298.7	49.77	78.09
nf01_w03_f0_80.wav	853	343	331.1	69.46	78.19
nf01_w03_full_00.wav	688	221.9	220.9	12.54	80.35
nf01_w03_full_100.wav	1009	364	359.2	90.98	75.17
nf01_w03_full_20.wav	750	251	242.8	20.82	80.37
nf01_w03_full_40.wav	815	283.9	268.6	33.89	79.42
nf01_w03_full_60.wav	881	311.1	297.1	50.09	76.2
nf01_w03_full_80.wav	951	344.3	332.5	66.31	75.23
nf01_w03_tbr_00.wav	853	300.4	283.5	41.1	80.75
nf01_w03_tbr_100.wav	853	295.2	281.5	41.76	73.75

nf01_w03_tbr_20.wav	853	298.9	283.6	41.22	80.42
nf01_w03_tbr_40.wav	853	298.3	282.8	41.09	79.07
nf01_w03_tbr_60.wav	853	296.6	283.1	41.4	77.07
nf01_w03_tbr_80.wav	853	296.4	282.5	41.06	74.52
nf01_w03_tmg_00.wav	681	300.1	281.4	43.71	78.57
nf01_w03_tmg_100.wav	1017	295.9	283.3	39.36	78.57
nf01_w03_tmg_20.wav	753	298	281.6	43.63	78.86
nf01_w03_tmg_40.wav	817	298.8	283	42.05	78.68
nf01_w03_tmg_60.wav	881	295.5	282.1	41.64	78.12
nf01_w03_tmg_80.wav	950	298.1	283.8	39.4	78.58
nf01_w05_f0_00.wav	805	237.2	236.5	11.37	75.44
nf01_w05_f0_100.wav	824	373.8	367.5	89.04	78.31
nf01_w05_f0_20.wav	813	272.6	266.8	18.94	76.02
nf01_w05_f0_40.wav	819	312.1	301.8	30	76.86
nf01_w05_f0_60.wav	822	353.2	340.5	45.08	77.33
nf01_w05_f0_80.wav	824	400.6	389	60.61	76.69
nf01_w05_full_00.wav	641	232.9	235.1	12.11	81.72
nf01_w05_full_100.wav	984	398.8	382.5	83.2	79.12
nf01_w05_full_20.wav	720	271.4	265.8	19.53	78.2
nf01_w05_full_40.wav	786	312.9	302.9	28.86	76.35
nf01_w05_full_60.wav	853	356.7	341.6	44.2	78.89
nf01_w05_full_80.wav	918	408.8	392.6	57.4	78.22
nf01_w05_tbr_00.wav	820	333.6	319.9	37.33	82.96
nf01_w05_tbr_100.wav	820	334.1	325.4	32.55	78.3
nf01_w05_tbr_20.wav	820	334	321.2	36.77	78.79
nf01_w05_tbr_40.wav	820	334	321.3	36.71	76.9
nf01_w05_tbr_60.wav	820	333.9	323.2	34.66	77.79
nf01_w05_tbr_80.wav	820	334	325.3	32.56	76.55
nf01_w05_tmg_00.wav	662	333.5	320	38.2	77.04
nf01_w05_tmg_100.wav	980	334.3	324.1	33.86	77.87
nf01_w05_tmg_20.wav	724	333.6	320.9	36.84	77.36
nf01_w05_tmg_40.wav	786	334.4	320.5	37.55	77.34
nf01_w05_tmg_60.wav	853	333.1	320.9	36.73	77.57
nf01_w05_tmg_80.wav	919	335.1	323.9	33.76	77.78
nf03_w01_f0_00.wav	719	340.9	340.9	7.53	73.6
nf03_w01_f0_100.wav	716	354.8	348.7	70.74	74.96
nf03_w01_f0_20.wav	720	342.3	341	14.85	74.29
nf03_w01_f0_40.wav	718	349.5	343.2	26.76	74.42
nf03_w01_f0_60.wav	715	347.7	341.8	41.21	75.17
nf03_w01_f0_80.wav	718	351.5	345.5	55.45	75.21
nf03_w01_full_00.wav	750	339.6	341.3	8.11	76.04
nf03_w01_full_100.wav	685	374.9	359	64.39	73.94
nf03_w01_full_20.wav	732	340.2	340.2	14.72	75.97
nf03_w01_full_40.wav	723	347.1	342	27.11	74.46
nf03_w01_full_60.wav	707	351.2	344.5	39.16	74.92

nf03_w01_full_80.wav	697	364	352.2	53.34	74.42
nf03_w01_tbr_00.wav	716	341.8	340.1	34.89	77.43
nf03_w01_tbr_100.wav	716	351.9	345.2	33.27	73.17
nf03_w01_tbr_20.wav	716	347.9	342.8	34.11	76.11
nf03_w01_tbr_40.wav	716	348.1	342.7	34.19	75.07
nf03_w01_tbr_60.wav	716	350.3	344.1	33.2	74.61
nf03_w01_tbr_80.wav	716	350	344	33.19	74.01
nf03_w01_tmg_00.wav	750	337.2	338.8	34.53	74.22
nf03_w01_tmg_100.wav	689	351.6	345.5	32.44	75.41
nf03_w01_tmg_20.wav	732	341.6	340.4	34.96	74.42
nf03_w01_tmg_40.wav	721	349.4	342.3	33.46	74.95
nf03_w01_tmg_60.wav	709	348.8	344.1	33.11	74.98
nf03_w01_tmg_80.wav	697	350.7	345.1	33.2	75.25
nf03_w02_f0_00.wav	780	330.7	333.3	14.18	79.54
nf03_w02_f0_100.wav	778	297	276.3	44.33	79.57
nf03_w02_f0_20.wav	783	320.6	320.5	7.21	79.74
nf03_w02_f0_40.wav	779	312.2	308	15.76	79.44
nf03_w02_f0_60.wav	779	309.3	296.6	26.24	79.5
nf03_w02_f0_80.wav	781	302.1	286.5	35.06	79.74
nf03_w02_full_00.wav	680	330.3	332.7	14.26	80.86
nf03_w02_full_100.wav	881	294.2	275.9	43.3	73.25
nf03_w02_full_20.wav	723	320	320.4	7.1	80.4
nf03_w02_full_40.wav	760	312.2	308	15.78	79.86
nf03_w02_full_60.wav	800	308	296	26.61	78.37
nf03_w02_full_80.wav	843	301.5	285.7	35.54	76.8
nf03_w02_tbr_00.wav	780	312.3	303.1	19.95	80.58
nf03_w02_tbr_100.wav	780	312.2	305.6	17.66	74.06
nf03_w02_tbr_20.wav	780	312	303.1	20.02	80.2
nf03_w02_tbr_40.wav	780	311.8	302.1	21.09	80.09
nf03_w02_tbr_60.wav	780	311.8	302.2	21.14	78.82
nf03_w02_tbr_80.wav	780	312	303.3	20.16	76.47
nf03_w02_tmg_00.wav	682	311	302.4	20.7	79.31
nf03_w02_tmg_100.wav	879	310.9	301.6	21.26	79.43
nf03_w02_tmg_20.wav	719	311.2	302.5	20.46	79.48
nf03_w02_tmg_40.wav	760	311.4	302.1	21.15	79.76
nf03_w02_tmg_60.wav	800	311.4	302.6	20.44	79.39
nf03_w02_tmg_80.wav	840	311.4	301.9	21.19	79.63
nf03_w03_f0_00.wav	863	350.3	353.4	30	80.67
nf03_w03_f0_100.wav	854	347.4	344.8	83.17	80.93
nf03_w03_f0_20.wav	862	346.4	352.1	29.45	80.36
nf03_w03_f0_40.wav	862	333.3	351.1	39.24	80.43
nf03_w03_f0_60.wav	864	334.2	351.4	52.91	80.51
nf03_w03_f0_80.wav	851	341.7	352.2	67.27	80.87
nf03_w03_full_00.wav	764	360.1	354.9	30.92	81.35
nf03_w03_full_100.wav	966	344.1	342.4	81.51	77.94

nf03_w03_full_20.wav	804	349.6	352.8	29.59	81.91
nf03_w03_full_40.wav	842	332	351.1	39.16	81.11
nf03_w03_full_60.wav	874	334.3	349.7	53.42	80.6
nf03_w03_full_80.wav	919	341.1	351.5	66.05	79.27
nf03_w03_tbr_00.wav	861	336.2	351.5	45.06	82
nf03_w03_tbr_100.wav	861	330.9	349.2	48.95	78.83
nf03_w03_tbr_20.wav	861	333.6	350.8	45.21	82.04
nf03_w03_tbr_40.wav	861	333.5	351.1	45.54	81.01
nf03_w03_tbr_60.wav	861	333.4	351.4	45.88	80.47
nf03_w03_tbr_80.wav	861	332.7	351.4	46.2	79.27
nf03_w03_tmg_00.wav	763	335.5	354	46.22	80.5
nf03_w03_tmg_100.wav	967	330.1	348.5	44.62	80.26
nf03_w03_tmg_20.wav	799	334.3	352.7	46.04	80.57
nf03_w03_tmg_40.wav	841	333.9	351.1	45.72	80.89
nf03_w03_tmg_60.wav	882	332.7	351.1	45.34	80.62
nf03_w03_tmg_80.wav	924	330.7	349.9	45	80.55
nf03_w05_f0_00.wav	802	334.9	345.3	21.69	75.61
nf03_w05_f0_100.wav	810	339.7	326.2	48.84	75.11
nf03_w05_f0_20.wav	793	334.2	340.6	16.57	75.55
nf03_w05_f0_40.wav	804	334.6	336	20.86	75.51
nf03_w05_f0_60.wav	808	336.2	332.5	29.42	75.53
nf03_w05_f0_80.wav	809	337.8	329	39.19	75.02
nf03_w05_full_00.wav	676	334.5	344.7	21.12	78.82
nf03_w05_full_100.wav	930	335.7	328.2	41.36	74.83
nf03_w05_full_20.wav	732	334	340.5	16	78.55
nf03_w05_full_40.wav	783	335.1	335.7	21.32	76.49
nf03_w05_full_60.wav	826	333.6	330.9	30.47	74.81
nf03_w05_full_80.wav	879	334.8	326.9	39.54	74.46
nf03_w05_tbr_00.wav	810	335.4	333.4	26.69	79.1
nf03_w05_tbr_100.wav	810	336.5	337.4	22.83	75.36
nf03_w05_tbr_20.wav	810	333.6	332.2	27.04	79.05
nf03_w05_tbr_40.wav	810	335.1	334.1	24.91	76.66
nf03_w05_tbr_60.wav	810	336	334.4	25.15	74.95
nf03_w05_tbr_80.wav	810	336.2	334.8	24.84	75.08
nf03_w05_tmg_00.wav	687	336.4	336.3	22.67	75.76
nf03_w05_tmg_100.wav	930	333.2	331.5	26.76	75.3
nf03_w05_tmg_20.wav	732	335.3	336.2	23.05	75.75
nf03_w05_tmg_40.wav	782	334.7	333.9	25.51	75.59
nf03_w05_tmg_60.wav	825	334.6	333	25.68	75.63
nf03_w05_tmg_80.wav	877	334.1	332.4	26.28	75.36
nm03_w01_f0_00.wav	709	204.2	206.7	17.77	73.65
nm03_w01_f0_100.wav	697	290.9	270	41.21	75.24
nm03_w01_f0_20.wav	709	217.3	217.9	16.96	74.26
nm03_w01_f0_40.wav	707	234.7	230	18.61	74.96
nm03_w01_f0_60.wav	709	249.8	240.9	25.33	75.25

nm03_w01_f0_80.wav	707	271.6	257.3	29.6	75.49
nm03_w01_full_00.wav	643	202.5	205.4	17.56	77.83
nm03_w01_full_100.wav	772	294.1	278.2	30.66	74.65
nm03_w01_full_20.wav	667	217.9	216.1	18.51	78.26
nm03_w01_full_40.wav	694	235.1	228.6	20.38	76.52
nm03_w01_full_60.wav	713	251	242.1	23.8	74.89
nm03_w01_full_80.wav	741	271	257.8	28.12	74.54
nm03_w01_tbr_00.wav	709	243.7	234.7	22.17	78.14
nm03_w01_tbr_100.wav	709	244.7	238	18.39	73.66
nm03_w01_tbr_20.wav	709	243.2	234.7	22.65	77.91
nm03_w01_tbr_40.wav	709	243	234.4	22.58	76.31
nm03_w01_tbr_60.wav	709	243.8	236.5	20.64	74.56
nm03_w01_tbr_80.wav	709	244.6	238	18.51	73.3
nm03_w01_tmg_00.wav	642	243.6	232.9	24.86	75.44
nm03_w01_tmg_100.wav	774	243.6	237.8	18.35	75.03
nm03_w01_tmg_20.wav	666	244.6	232.8	24.58	75.86
nm03_w01_tmg_40.wav	689	244.8	236	21.26	75.57
nm03_w01_tmg_60.wav	715	244.2	235.8	20.98	75.4
nm03_w01_tmg_80.wav	741	243.2	236	20.89	75.41
nm03_w02_f0_00.wav	945	227.7	226.4	29.99	78.1
nm03_w02_f0_100.wav	944	269.4	242.5	57.03	78.32
nm03_w02_f0_20.wav	944	236.8	229.1	33.84	77.31
nm03_w02_f0_40.wav	944	246.2	232.1	39.05	76.17
nm03_w02_f0_60.wav	943	255.2	235.1	44.1	76.05
nm03_w02_f0_80.wav	937	261.9	239.1	49.83	76.59
nm03_w02_full_00.wav	980	222.6	226.4	30.57	78.48
nm03_w02_full_100.wav	904	275.8	255	45.91	73.15
nm03_w02_full_20.wav	965	233.7	229	34.76	77.37
nm03_w02_full_40.wav	949	244.7	233.7	37.49	76.21
nm03_w02_full_60.wav	940	255.2	236.2	43.04	75.11
nm03_w02_full_80.wav	918	263.8	243.3	45.79	73.71
nm03_w02_tbr_00.wav	945	247.7	232.1	41.74	79
nm03_w02_tbr_100.wav	945	253.7	239	35.22	75.53
nm03_w02_tbr_20.wav	945	249.3	232.7	41.58	78.37
nm03_w02_tbr_40.wav	945	249.9	233.4	41.52	76.14
nm03_w02_tbr_60.wav	945	251.5	235.5	39.78	74.82
nm03_w02_tbr_80.wav	945	252.3	235.3	39.49	75.09
nm03_w02_tmg_00.wav	980	251.9	236.6	38.51	75.95
nm03_w02_tmg_100.wav	914	250.3	232.8	41.41	76.69
nm03_w02_tmg_20.wav	964	251.2	235.8	39.17	75.83
nm03_w02_tmg_40.wav	947	249	235.3	39.56	76.04
nm03_w02_tmg_60.wav	939	250.1	234.5	40.18	76.04
nm03_w02_tmg_80.wav	923	251	232.8	42.02	76.29
nm03_w03_f0_00.wav	873	215.4	211.3	17.29	75.12
nm03_w03_f0_100.wav	862	264.3	239.9	50.59	75.14

nm03_w03_f0_20.wav	873	223.2	216.3	22.05	74.16
nm03_w03_f0_40.wav	869	231.8	220.7	28.88	75.93
nm03_w03_f0_60.wav	872	241.5	225.7	37.22	75.76
nm03_w03_f0_80.wav	871	252	231.7	44.67	75.8
nm03_w03_full_00.wav	804	212.7	208	19.48	79.78
nm03_w03_full_100.wav	930	266.9	254	39.86	74.2
nm03_w03_full_20.wav	827	222.3	213.2	24.68	79.44
nm03_w03_full_40.wav	853	231.4	220.1	29.23	77.05
nm03_w03_full_60.wav	876	242.7	228	34.62	74.7
nm03_w03_full_80.wav	906	253.2	236.3	40.25	73.93
nm03_w03_tbr_00.wav	871	236.3	222.6	33.58	80.57
nm03_w03_tbr_100.wav	871	237.4	223.9	31.69	73.23
nm03_w03_tbr_20.wav	871	236.3	222.7	33.68	80.16
nm03_w03_tbr_40.wav	871	237.2	222.8	33.52	77.1
nm03_w03_tbr_60.wav	871	237.3	224.6	31.42	74.39
nm03_w03_tbr_80.wav	871	238	224.6	31.36	73.04
nm03_w03_tmg_00.wav	801	235.7	218.2	36.09	75.68
nm03_w03_tmg_100.wav	941	237.7	227	29.4	76.44
nm03_w03_tmg_20.wav	825	235	220.2	34.89	75.77
nm03_w03_tmg_40.wav	856	236.9	222	33.85	76.09
nm03_w03_tmg_60.wav	878	236.7	224.8	31.49	76.03
nm03_w03_tmg_80.wav	909	238.3	226.1	30.67	76.35
nm03_w05_f0_00.wav	829	202	216.5	32.38	75.86
nm03_w05_f0_100.wav	819	249.2	245.9	33.18	76.73
nm03_w05_f0_20.wav	830	215.8	221.3	26.74	76.03
nm03_w05_f0_40.wav	828	224.6	225.8	24.02	76.6
nm03_w05_f0_60.wav	828	224.9	231.3	25.02	76.49
nm03_w05_f0_80.wav	821	237.3	238.9	27.19	76.47
nm03_w05_full_00.wav	839	211.1	218	31.31	75.91
nm03_w05_full_100.wav	810	250.9	247	33.82	76.38
nm03_w05_full_20.wav	835	213.7	221.5	25.75	76.17
nm03_w05_full_40.wav	830	222.6	225.6	23.89	76.63
nm03_w05_full_60.wav	826	226.2	231.4	24.91	76.57
nm03_w05_full_80.wav	824	236.2	240.1	26.45	77.08
nm03_w05_tbr_00.wav	829	225.4	228.1	23.96	77.3
nm03_w05_tbr_100.wav	829	223.9	228.9	23.09	74.69
nm03_w05_tbr_20.wav	829	225.1	228.3	23.88	77.56
nm03_w05_tbr_40.wav	829	224.9	228.4	24.08	76.89
nm03_w05_tbr_60.wav	829	224.7	228.4	24.32	76.34
nm03_w05_tbr_80.wav	829	225.3	229.5	23.1	76.6
nm03_w05_tmg_00.wav	837	224	227.5	23.55	76.1
nm03_w05_tmg_100.wav	819	225.5	229.1	24.02	76.82
nm03_w05_tmg_20.wav	832	224.8	229	22.74	76.1
nm03_w05_tmg_40.wav	826	224.7	228.3	24.17	76.37
nm03_w05_tmg_60.wav	828	225.1	228.7	24.13	76.65

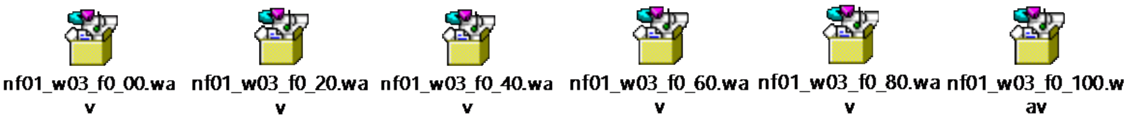
nm03_w05_tmg_80.wav	821	225.3	228.8	24.14	77.13
nm04_w01_f0_00.wav	707	149.8	158.6	22.36	73.99
nm04_w01_f0_100.wav	699	265.8	249.1	67.17	76.6
nm04_w01_f0_20.wav	708	171.1	175.5	27.07	74.68
nm04_w01_f0_40.wav	707	182.8	191.5	33.23	75.39
nm04_w01_f0_60.wav	702	208.3	210.6	40.57	75.07
nm04_w01_f0_80.wav	704	236.1	232	50.46	76.17
nm04_w01_full_00.wav	785	152.8	157.7	22.44	79.36
nm04_w01_full_100.wav	642	281.9	274.8	53.61	76.62
nm04_w01_full_20.wav	759	165.3	172.5	28.25	78.81
nm04_w01_full_40.wav	721	188.1	191.3	33.68	76.06
nm04_w01_full_60.wav	692	216.5	215	38.71	75.07
nm04_w01_full_80.wav	665	248.1	240.3	49.3	75.46
nm04_w01_tbr_00.wav	706	193.4	197.3	39.1	79.62
nm04_w01_tbr_100.wav	706	208.3	207.3	36.74	77.21
nm04_w01_tbr_20.wav	706	194.5	196.9	39.6	78.83
nm04_w01_tbr_40.wav	706	194.9	200.1	37.84	75.74
nm04_w01_tbr_60.wav	706	195.8	203.7	35.82	74.97
nm04_w01_tbr_80.wav	706	208.8	207.2	36.86	74.86
nm04_w01_tmg_00.wav	787	207.7	203.9	36.8	75.71
nm04_w01_tmg_100.wav	632	192.2	196.4	36.88	75.04
nm04_w01_tmg_20.wav	752	202.7	203.2	36.45	75.6
nm04_w01_tmg_40.wav	718	195.6	201.1	37.23	75.67
nm04_w01_tmg_60.wav	694	194.3	196.8	39.08	75.17
nm04_w01_tmg_80.wav	659	192.9	197.4	37.17	75.23
nm04_w02_f0_00.wav	706	222.7	213.4	30.1	76.99
nm04_w02_f0_100.wav	715	266.5	264.1	62.53	78.41
nm04_w02_f0_20.wav	720	229.8	221.2	29.93	77.77
nm04_w02_f0_40.wav	719	233.8	229.9	34.18	78.01
nm04_w02_f0_60.wav	712	242.3	238.8	41.88	77.22
nm04_w02_f0_80.wav	715	261	251.4	50.85	77.46
nm04_w02_full_00.wav	885	222.4	213.2	30.19	79.47
nm04_w02_full_100.wav	540	263.2	275.3	75.06	75.63
nm04_w02_full_20.wav	820	229.7	220.9	29.78	79.43
nm04_w02_full_40.wav	749	233.9	230.6	33.65	77.95
nm04_w02_full_60.wav	671	246.2	240.1	41.61	76.02
nm04_w02_full_80.wav	612	267.8	256.5	49.2	77.07
nm04_w02_tbr_00.wav	710	241.1	233	37.78	80.53
nm04_w02_tbr_100.wav	710	250.6	239.1	37.28	76.64
nm04_w02_tbr_20.wav	710	243.2	235.5	37.09	79.75
nm04_w02_tbr_40.wav	710	243.3	235.8	36.94	78.6
nm04_w02_tbr_60.wav	710	243.1	235.9	36.94	76.04
nm04_w02_tbr_80.wav	710	244.4	238.5	35.93	75.2
nm04_w02_tmg_00.wav	884	239.4	233	37.9	76.5
nm04_w02_tmg_100.wav	553	244.7	237.9	36.56	77.9

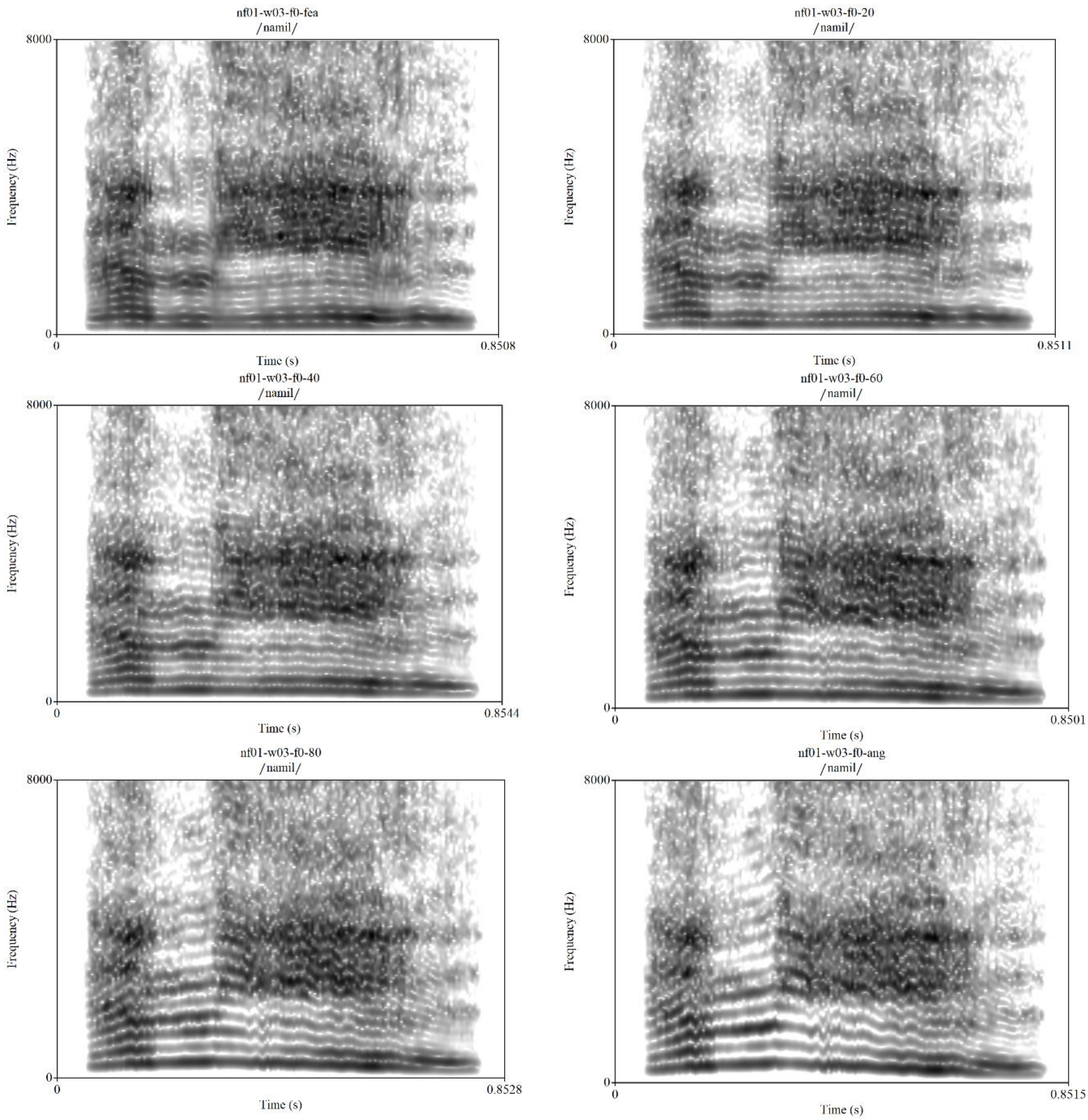
nm04_w02_tmg_20.wav	803	242.4	233.9	37.72	77.38
nm04_w02_tmg_40.wav	740	242.8	235.3	37.23	75.62
nm04_w02_tmg_60.wav	684	241.4	234.7	37.64	76.85
nm04_w02_tmg_80.wav	608	243.1	235.1	37.21	77.83
nm04_w03_f0_00.wav	800	211.3	214.1	37.03	74.13
nm04_w03_f0_100.wav	789	264.1	239.8	69.16	74.25
nm04_w03_f0_20.wav	798	216	217.9	33.89	74.49
nm04_w03_f0_40.wav	792	213.6	221.3	37.21	74.16
nm04_w03_f0_60.wav	797	230.7	226.9	45.29	74.7
nm04_w03_f0_80.wav	797	245.1	235.3	54.49	74.78
nm04_w03_full_00.wav	997	191.6	208.7	36.81	79.82
nm04_w03_full_100.wav	589	285.5	259.7	141.1	75.26
nm04_w03_full_20.wav	917	211.5	214.6	34.54	76.87
nm04_w03_full_40.wav	832	212.5	219.8	37.75	75.04
nm04_w03_full_60.wav	750	231.3	227.9	44.35	73.84
nm04_w03_full_80.wav	676	262.1	236.6	60.93	74.3
nm04_w03_tbr_00.wav	791	221	223.5	40.81	80.01
nm04_w03_tbr_100.wav	791	261.6	257.9	58.47	74.52
nm04_w03_tbr_20.wav	791	220.7	223.5	40.92	77.45
nm04_w03_tbr_40.wav	791	221.5	223.6	40.74	74.64
nm04_w03_tbr_60.wav	791	223.3	225.5	39.25	73.88
nm04_w03_tbr_80.wav	791	223.4	225.4	39.55	73.34
nm04_w03_tmg_00.wav	993	217.5	221.4	40.75	74.11
nm04_w03_tmg_100.wav	604	225	226.1	40.45	74.18
nm04_w03_tmg_20.wav	919	217.4	222.3	41.15	74.01
nm04_w03_tmg_40.wav	840	223.1	223.6	40.86	73.7
nm04_w03_tmg_60.wav	753	222.7	223.6	40.3	74.44
nm04_w03_tmg_80.wav	679	224.1	224.1	40.17	73.43
nm04_w05_f0_00.wav	770	218.2	209.6	25.74	75.08
nm04_w05_f0_100.wav	782	259.2	255	58.39	76.68
nm04_w05_f0_20.wav	775	217.6	216.9	22.81	75.69
nm04_w05_f0_40.wav	767	223.9	224.6	26.66	76.31
nm04_w05_f0_60.wav	781	228.7	233.6	35.17	76.21
nm04_w05_f0_80.wav	780	244.9	243.8	45.98	76.49
nm04_w05_full_00.wav	896	208.7	206.8	25.3	79.26
nm04_w05_full_100.wav	659	297.4	297.5	28.44	77.7
nm04_w05_full_20.wav	856	213.7	214.9	23.27	77.41
nm04_w05_full_40.wav	809	222.1	223.6	27.08	76.87
nm04_w05_full_60.wav	745	230.3	234.7	34.8	76.58
nm04_w05_full_80.wav	708	256.1	246.4	47.74	77.04
nm04_w05_tbr_00.wav	767	225.4	228.9	30.47	80.11
nm04_w05_tbr_100.wav	767	232.5	235.6	27.6	75.95
nm04_w05_tbr_20.wav	767	224.9	229	30.5	77.84
nm04_w05_tbr_40.wav	767	225	228.9	30.57	77.1
nm04_w05_tbr_60.wav	767	225.2	228.9	30.65	76.45

nm04_w05_tbr_80.wav	767	227.1	229.8	30.08	76.49
nm04_w05_tmg_00.wav	899	218.9	224.8	30.84	76.24
nm04_w05_tmg_100.wav	650	229.1	230.8	30.59	76.95
nm04_w05_tmg_20.wav	850	221.6	226.5	31.1	76.6
nm04_w05_tmg_40.wav	806	221.1	227.6	31.33	76.75
nm04_w05_tmg_60.wav	746	228.6	230	30.31	76.39
nm04_w05_tmg_80.wav	709	228.7	230.3	30.51	76.38

2.3 Examples of stimuli

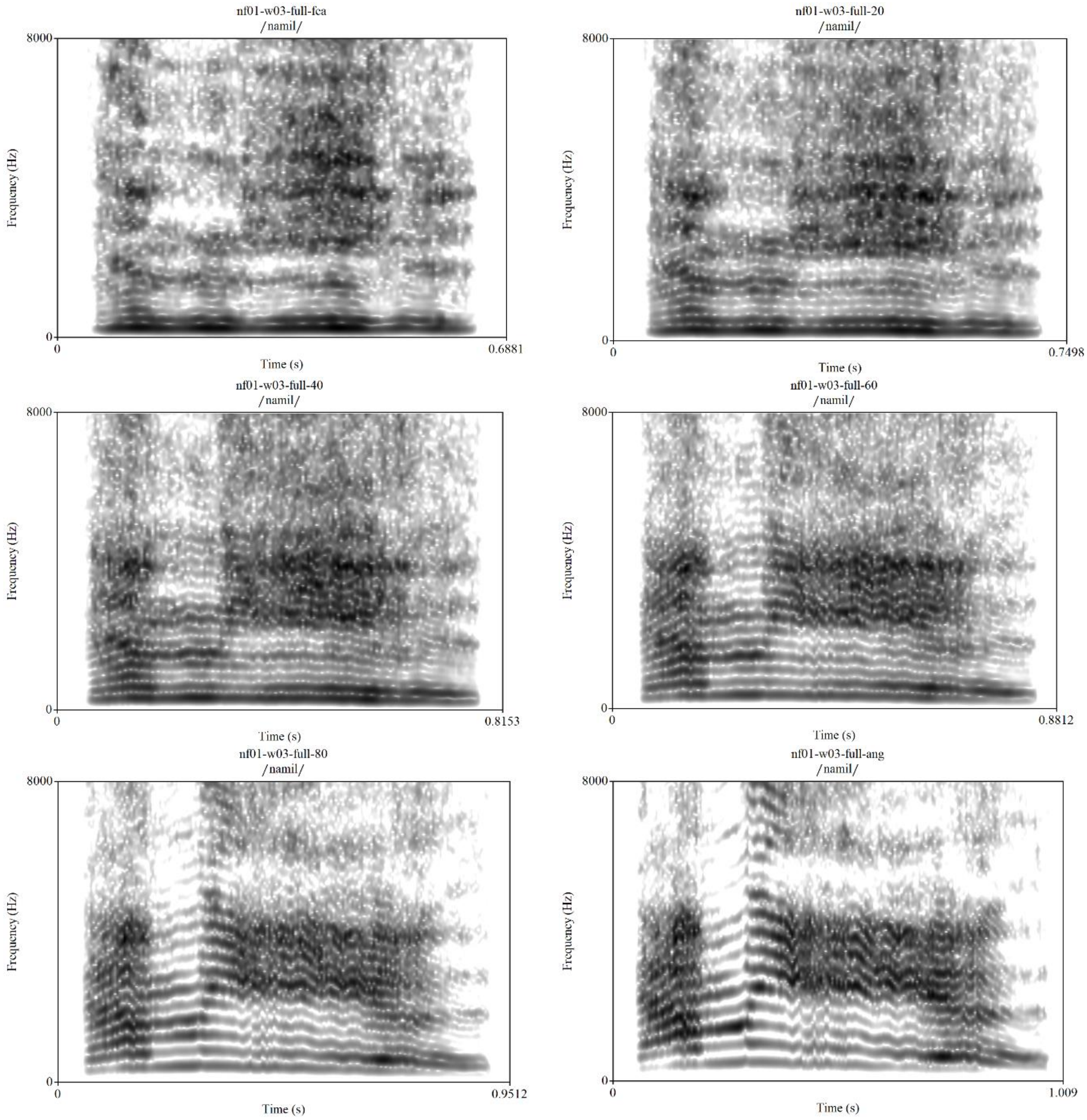
Female speaker (nf01), F0 morph type condition





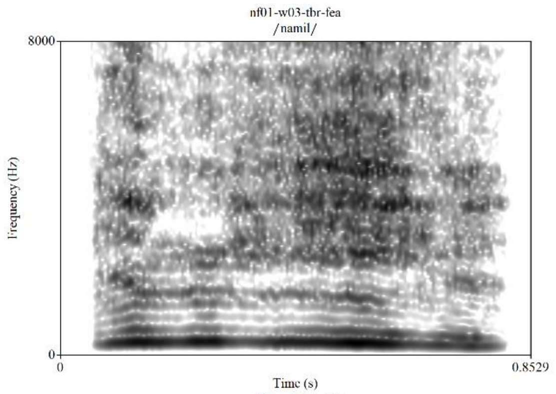
Female speaker (nf01), Full morph type condition

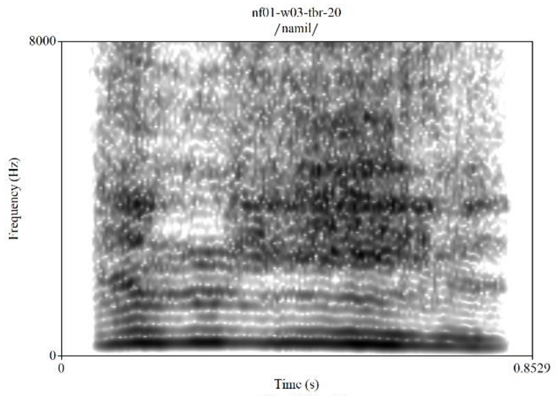
nf01_w03_full_00.wav nf01_w03_full_20.wav nf01_w03_full_40.wav nf01_w03_full_60.wav nf01_w03_full_80.wav nf01_w03_full_100.wav

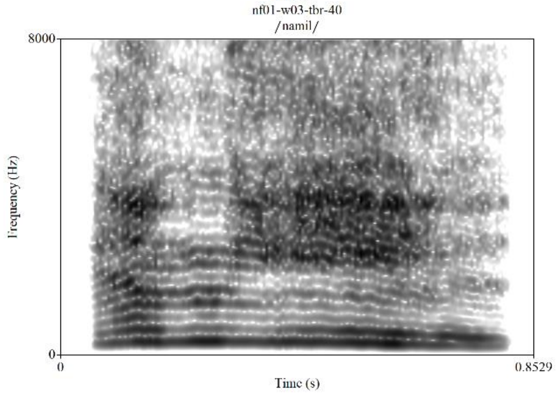


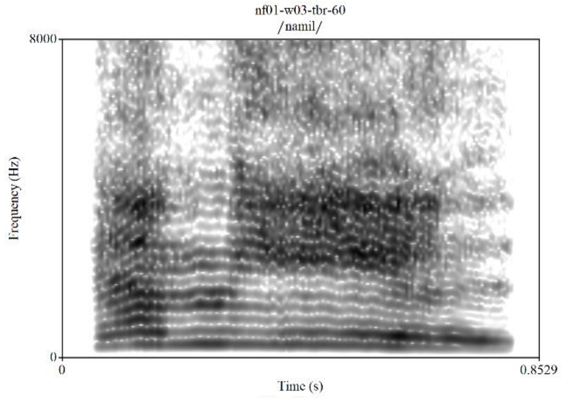
Female speaker (nf01), Timbre morph type condition

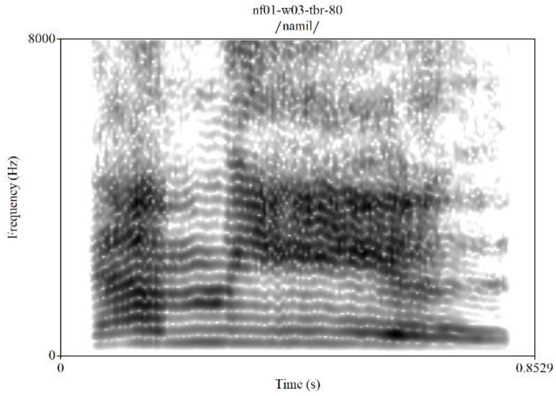
nf01_w03_tbr_00.wav nf01_w03_tbr_20.wav nf01_w03_tbr_40.wav nf01_w03_tbr_60.wav nf01_w03_tbr_80.wav nf01_w03_tbr_100.wav

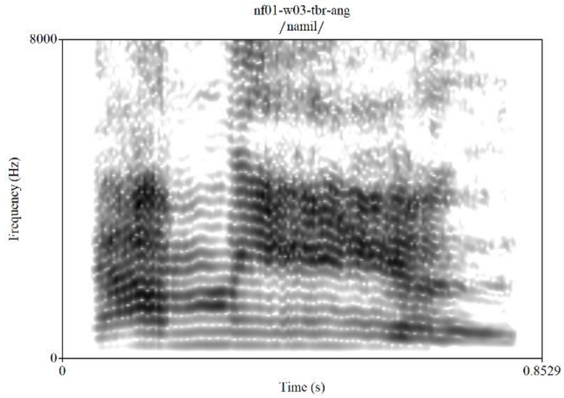






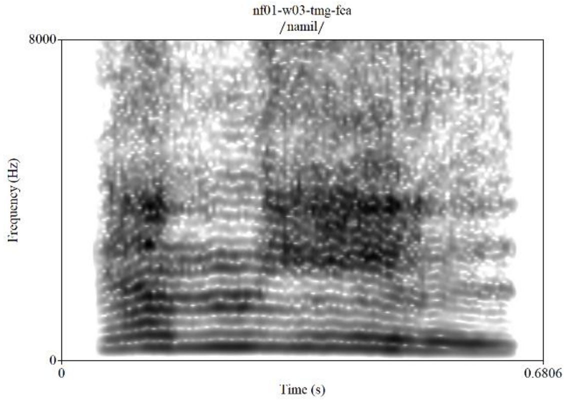


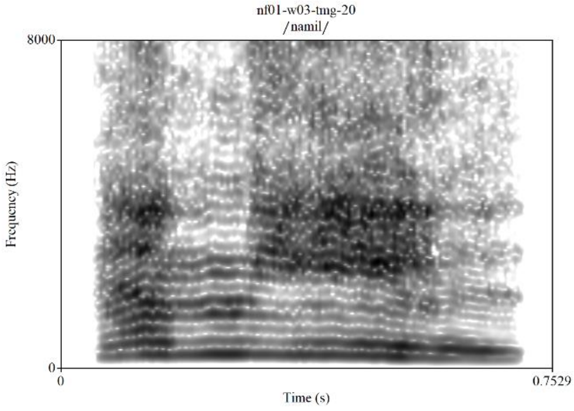


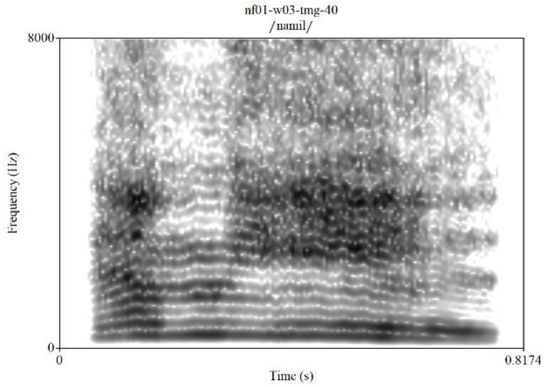


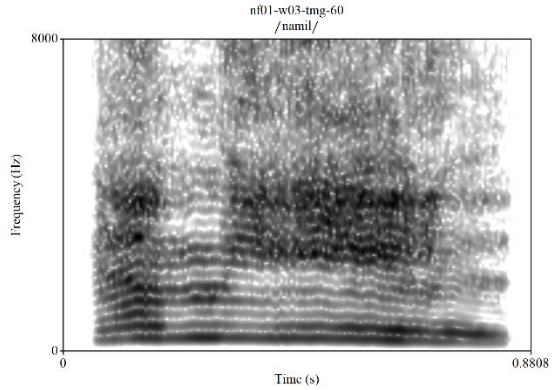
Female speaker (nf01), Timing morph type condition

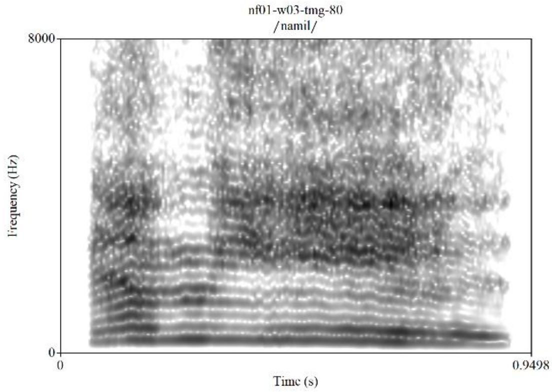
nf01_w03_tmg_00.wav nf01_w03_tmg_20.wav nf01_w03_tmg_40.wav nf01_w03_tmg_60.wav nf01_w03_tmg_80.wav nf01_w03_tmg_100.wav

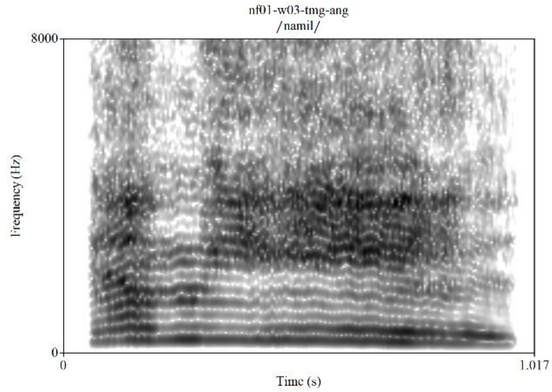




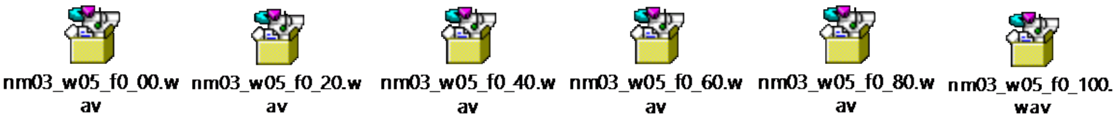


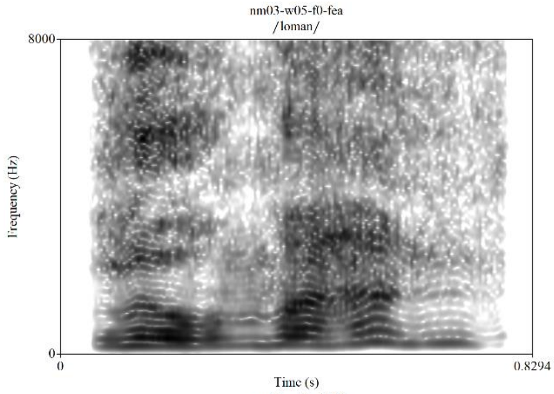


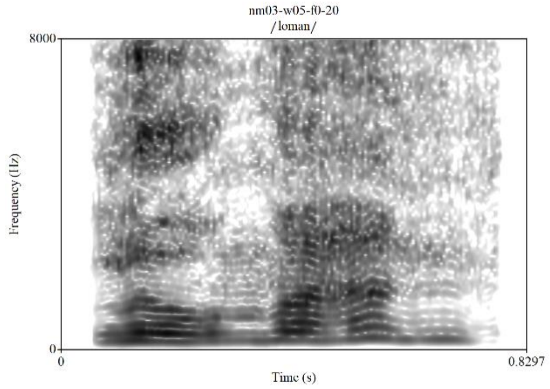


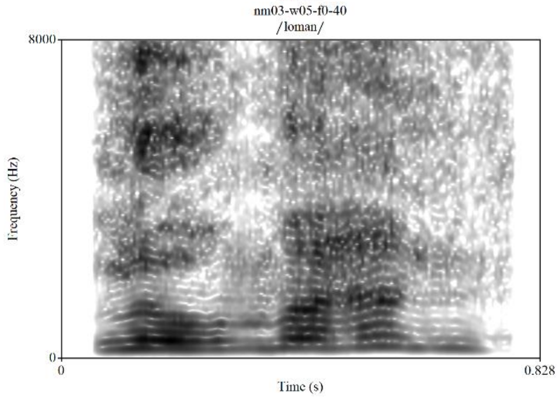


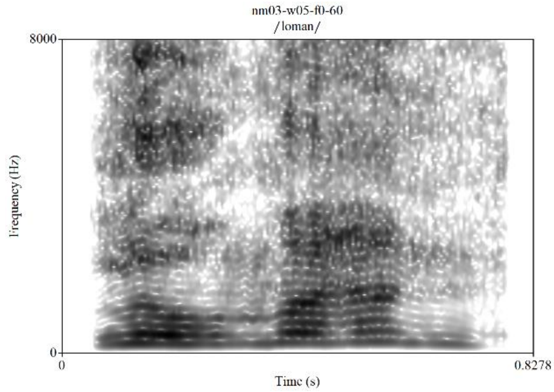
Male speaker (nm03), F0 morph type condition

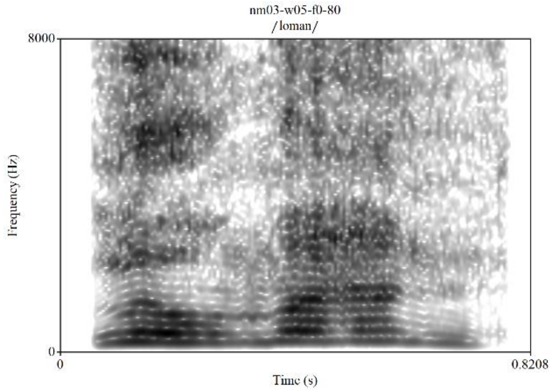


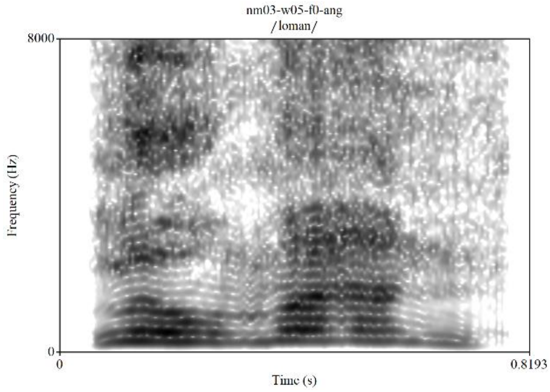












Male speaker (nm03), Full morph type condition


nm03_w05_full_00.wav

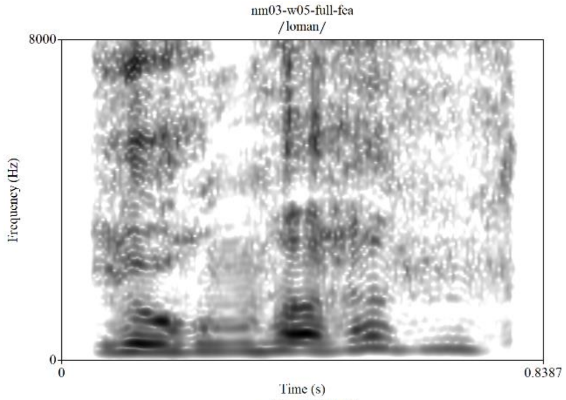

nm03_w05_full_20.wav

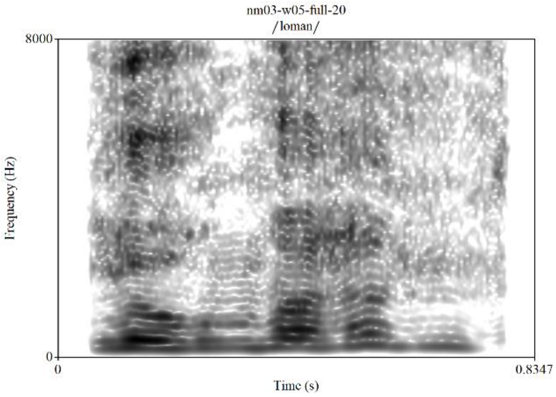

nm03_w05_full_40.wav

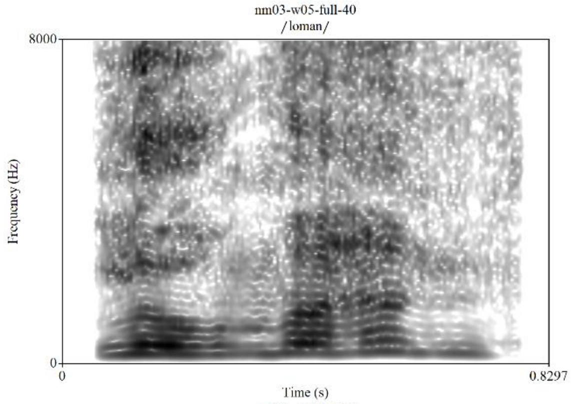

nm03_w05_full_60.wav

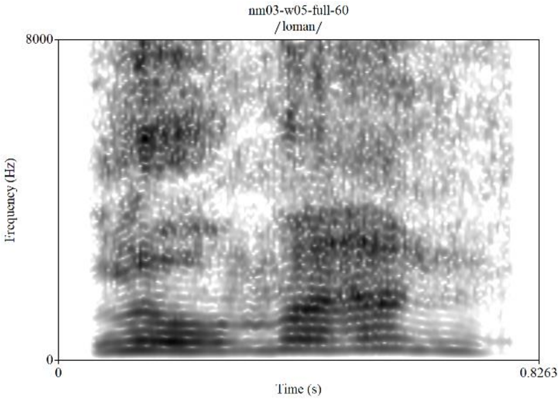

nm03_w05_full_80.wav

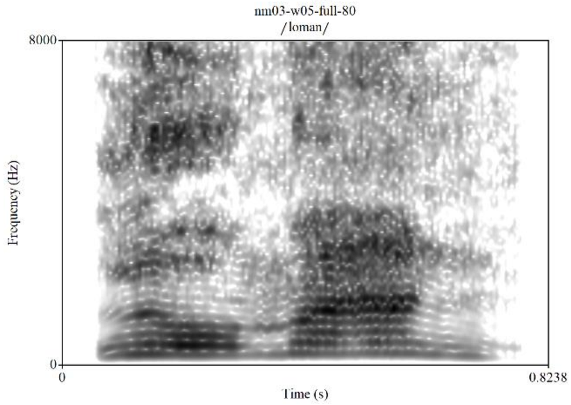

nm03_w05_full_100.wav

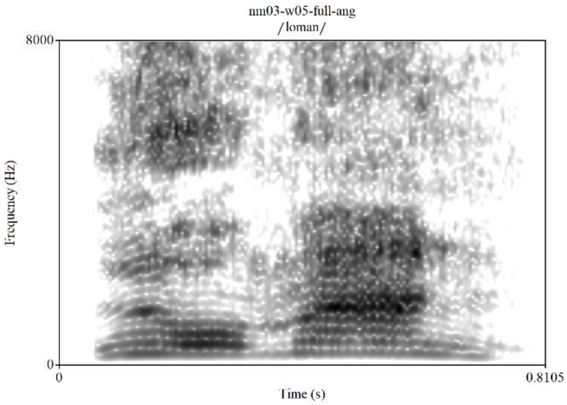






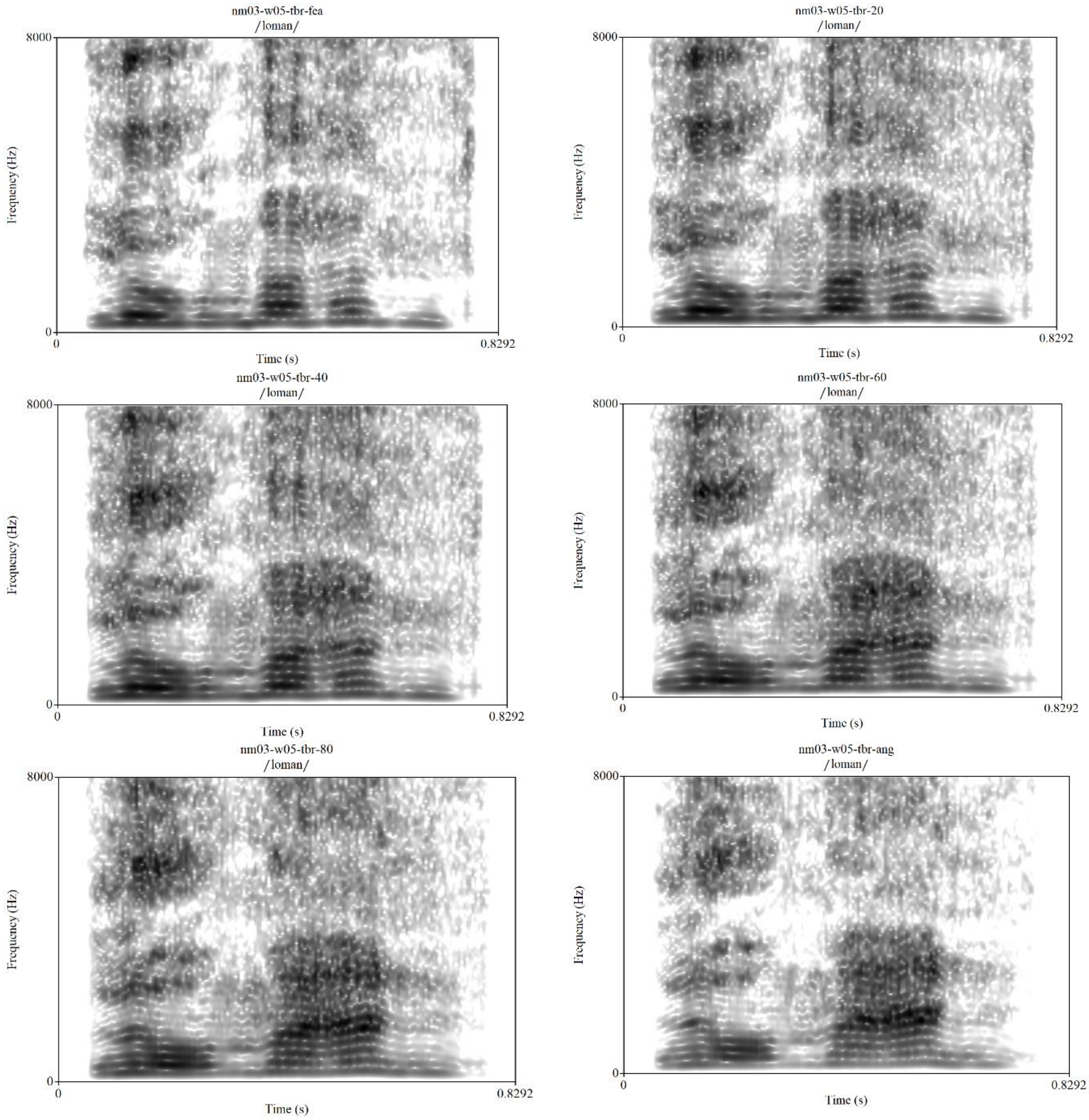






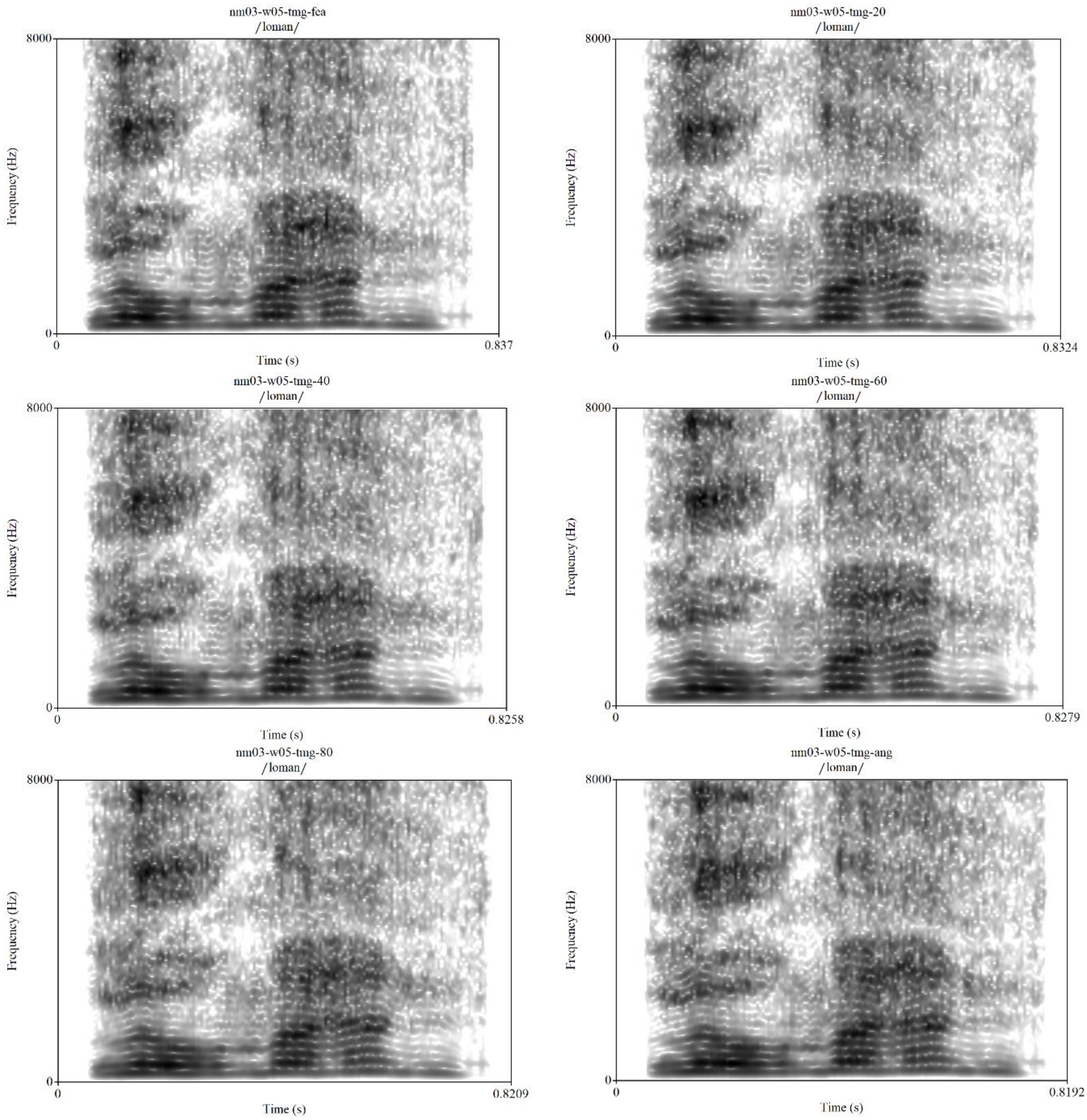
Male speaker (nm03), Timbre morph type condition

nm03_w05_tbr_00.wav nm03_w05_tbr_20.wav nm03_w05_tbr_40.wav nm03_w05_tbr_60.wav nm03_w05_tbr_80.wav nm03_w05_tbr_100.wav



Male speaker (nm03), Timing morph type condition

nm03_w05_tmg_00.wav nm03_w05_tmg_20.wav nm03_w05_tmg_40.wav nm03_w05_tmg_60.wav nm03_w05_tmg_80.wav nm03_w05_tmg_100.wav



3 Causes of hearing loss of CI users who participated in the experiment

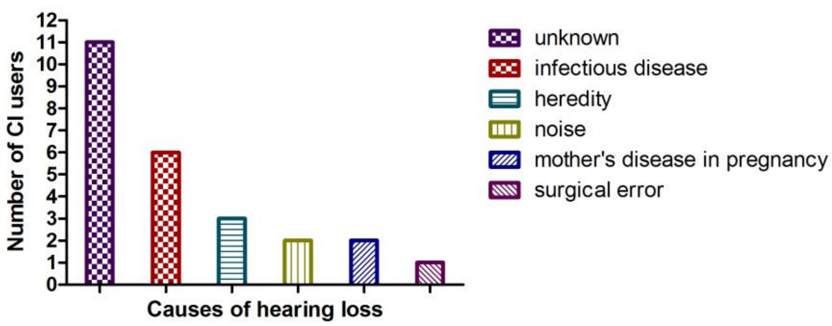


Figure S1. The CI users' causes of hearing loss.

4 Additional Data Analyses

4.1 Post hoc analysis of 3-way Interactions involving listener groups (LGroup)

4.1.1 Post-hoc analysis of the LGroup x MType x ML Interaction

4.1.1.1 CI users

In order to gain detailed knowledge about CI users' perceptual abilities and strategies while trying to recognize emotions in voices, we explicitly post-hoc tested the interaction of LGroup x MType x ML (cf. Figure 1). Thus, a 4 x 6 repeated-measures ANOVA with the factors MType and ML was performed within the group of CI users. It revealed a main effect of ML, $F(5,120) = 26.662$, $p < .001$, $\varepsilon_{HF} = .427$, $\eta_p^2 = .526$ and an interaction of MType x ML, $F(15,360) = 10.020$, $p < .001$, $\varepsilon_{HF} = .625$, $\eta_p^2 = .295$. To disentangle this interaction, separate one-way repeated-measures ANOVAs with factor MType were performed for each of the six MLs. Main effects of MType were significant for MLs 0, 20, 80 and 100, $F\text{s}(3,72) \geq 8.055$, $p\text{s} \leq .001$, $\eta_p^2 \geq .251$, but not for MLs 40 and 60, $F\text{s}(3,72) \leq 1.562$, $p\text{s} \geq .206$, $\eta_p^2 \leq .061$. Paired-sample t-tests for each MLs 0, 20, 80, and 100 were computed, such that a morph type was compared to the next morph type directly below it the scale. For example, the morph type for which the proportion of "angry"-responses had the highest value was compared with the morph type for which the proportion of "angry"-responses had the second highest value. Please note that corresponding means and standard errors of the mean (SEMs) can be found in Supplemental Material 4.5.1. For MLs 0 and 20, no significant differences between morph types Time and F0 were found, $|t\text{s}(24)| \leq 1.785$, $p\text{s} \geq .087$. However, there were significant differences between F0 and Timbre and between Timbre and Full for MLs 0 and 20, $|t\text{s}(24)| \geq 2.085$, $p\text{s} \leq .048$. For ML 80, there were significant differences between Full and Timbre and between F0 and Time, $|t\text{s}(24)| \geq 2.237$, $p\text{s} \leq .035$, but not between Timbre and F0, $|t(24)| = 1.509$, $p = .145$. In contrast to this, for ML 100, no significant differences between the in each case compared morph types were revealed, $|t\text{s}(24)| \leq 1.809$, $p\text{s} \geq .083$.

4.1.1.2 NH individuals

As we did within the group of CI users, we were moreover gaining detailed knowledge about the NH individuals' perceptual abilities and strategies while trying to recognize vocal emotion expression by explicitly post-hoc testing the interactions of LGroup x MType x ML. Thus, we conducted a 6 x 4 ANOVA with factors MType and ML within this group, too. Just as for the CI users, it revealed a main effect of ML, $F(5,120) = 303.155$, $p < .001$, $\varepsilon_{HF} = .655$, $\eta_p^2 = .927$ and an interaction of MType x ML, $F(15,360) = 75.006$, $p < .001$, $\varepsilon_{HF} = .851$, $\eta_p^2 = .758$ (cf. Figure 1). A further analysis of this interaction by computing separate one-way repeated-measures ANOVAs with factor MType for each of the six MLs revealed significant main effects of MType for all MLs, Fs(3,72) ≥ 13.340, ps ≤ .001, $\eta_p^2 \geq .357$. Paired-sample t-tests for all MLs were computed ─ a morph type was compared to the next morph type directly below it the scale, congruent with the analysis procedure for the CI group. Please note that corresponding means and standard errors of the mean (SEMs) can be found in Supplemental Material 4.5.2. For MLs 0, 20, and 40, significant differences between Time and F0 and between Timbre and Full, |ts(24)| ≥ 2.448, ps ≤ .022, but not between F0 and Timbre, |ts(24)| ≤ 1.670, ps ≥ .108, were found. For ML 60, there were significant differences between Timbre and Time, $|t(24)| = 4.023$, $p < .001$, but none between Full and F0 and between F0 and Timbre, |ts(24)| ≤ 1.087, ps ≥ .288. For MLs 80 and 100, however, significant differences between Full and F0 and between Timbre and Time, $|t(24)| \geq 5.763$, $p < .001$, were revealed; there were no significant differences between F0 and Timbre, |ts(24)| ≤ 0.591, ps ≥ .560. Consequently, as anticipated, F0 and Timbre did not differ significantly from one another at any morph levels.

4.1.2 Post-hoc analysis of the LGroup x ML x SpSex Interaction

4.1.2.1 CI users

To post-hoc test the interaction of LGroup x ML x SpSex (cf. Figure S5), for CI, a 6 x 2 repeated-measures ANOVA with the factors ML and SpSex was conducted. It revealed no significant main effects or interactions involving SpSex (all ps ≥ .232), indicating that female

(*M*s = .346 ± .025, .333 ± .024, .407 ± .023, .459 ± .021, .546 ± .023, .605 ± .022, for ML 0 to 100, respectively) and male voices (*M*s = .383 ± .025, .409 ± .025, .425 ± .020, .475 ± .021, .550 ± .021, .638 ± .024, for ML 0 to 100, respectively) were perceived as similar angry. Only a main effect of ML, $F(5,120) = 26.662$, $p < .001$, $\varepsilon_{HF} = .427$, $\eta_p^2 = .526$, was found.

4.1.2.2 NH individuals

In order to post-hoc test the interaction of LGroup x ML x SpSex (cf. Figure S5), for NH, a 6 x 2 repeated-measures ANOVA with the factors ML and SpSex was computed. It revealed main effects of ML, $F(5,120) = 303.155$, $p < .001$, $\varepsilon_{HF} = .655$, $\eta_p^2 = .927$, and SpSex, $F(1,24) = 19.663$, $p < .001$, $\eta_p^2 = .450$, and an interaction of ML x SpSex, $F(5,120) = 7.821$, $p < .001$, $\eta_p^2 = .246$. To disentangle this interaction, paired sample t-tests, comparing female and male speakers, were performed for each of the six MLs. Significant differences between female and male speakers were found for MLs 20, 40, 60, 80, and 100, $|ts(24)| \geq 2.626$, $ps \leq .015$, but not for ML 0, $|t(24)| = 1.960$, $p = .062$; at all MLs, female voices were perceived as less angry (*M*s = .205 ± .023, .194 ± .021, .262 ± .019, .407 ± .020, .571 ± .025, .668 ± .027, for ML 0 to 100, respectively) than male voices (*M*s = .252 ± .023, .261 ± .023, .390 ± .019, .582 ± .020, .710 ± .019, .820 ± .018, for ML 0 to 100, respectively).

4.2 Post hoc analysis of the 3-way interaction MType x ML x SpSex

The interaction of MType x ML x SpSex (cf. Figure S6) was post-hoc tested for exploring found differences between morph types used in the experiment. Thus, subsequent statistical analyses were performed separately for morph types Full, F0, Timbre, and Time.

Morph type Full

To post-hoc test the interaction of MType x ML x SpSex, for morph type Full, a 6 x 2 repeated-measures ANOVA with the factors ML and SpSex was performed. There were main effects of ML, $F(5,245) = 138.182$, $p < .001$, $\varepsilon_{HF} = .391$, $\eta_p^2 = .738$, and SpSex, $F(1,49) = 9.358$, $p = .004$, $\eta_p^2 = .160$. However, there was no significant interaction of ML x SpSex, $F(5,245) = 0.872$, $p = .492$, $\varepsilon_{HF} = .908$, $\eta_p^2 = .017$, indicating that voices of female (*M*s = .140

± .028, .158 ± .027, .273 ± .032, .479 ± .031, .717 ± .028, .793 ± .031, for ML 0 to 100, respectively) and male speakers (*M*s = .177 ± .035, .208 ± .034, .371 ± .027, .575 ± .029, .759 ± .025, .856 ± .028, for ML 0 to 100, respectively) were perceived as equally angry at the different morph levels.

Morph type F0

In analogy to morph type Full, first, a 6 x 2 ANOVA with factors ML and SpSex was computed. For F0, just as for Full, it revealed main effects of ML, $F(5,245) = 48.294$, $p < .001$, $\varepsilon_{HF} = .456$, $\eta_p^2 = .496$, and SpSex, $F(1,49) = 4.828$, $p = .033$, $\eta_p^2 = .090$, but no interaction of ML x SpSex, $F(5,245) = 2.223$, $p = .053$, $\eta_p^2 = .043$. Thus, it is indicated that here, at different morph levels, female (*M*s = .262 ± .030, .269 ± .033, .348 ± .036, .432 ± .025, .601 ± .029, .666 ± .031, for ML 0 to 100, respectively) and male speakers (*M*s = .341 ± .032, .364 ± .031, .402 ± .027, .527 ± .033, .599 ± .030, .694 ± .029, for ML 0 to 100, respectively) were perceived as equally angry.

Morph type Timbre

We post-hoc tested the interaction of MType x ML x SpSex, for morph type Timbre, by computing a 6 x 2 repeated-measures ANOVA with the factors ML and SpSex. Main effects of ML, $F(5,245) = 92.815$, $p < .001$, $\varepsilon_{HF} = .507$, $\eta_p^2 = .654$, and SpSex, $F(1,49) = 15.647$, $p < .001$, $\eta_p^2 = .242$, were found, but no interaction of ML x SpSex, $F(5,245) = 1.635$, $p = .173$, $\varepsilon_{HF} = .729$, $\eta_p^2 = .032$. Thus, for Timbre, female (*M*s = .201 ± .027, .188 ± .026, .333 ± .027, .462 ± .028, .563 ± .030, .637 ± .028, for ML 0 to 100, respectively) and male speakers (*M*s = .283 ± .030, .311 ± .036, .380 ± .028, .527 ± .029, .685 ± .028, .779 ± .032, for ML 0 to 100, respectively) seemed to be perceived as equally angry at the different morph levels.

Morph type Time

In analogy to the other morph types Full, F0 and Timbre, first, a 6 x 2 ANOVA with factors ML and SpSex was performed. In contrast to ANOVAs for the other morph types, for Time, the computed ANOVA revealed not only main effects of ML, $F(5,245) = 7.931$, $p < .001$, $\eta_p^2 = .139$, and SpSex, $F(1,49) = 7.455$, $p = .009$, $\eta_p^2 = .132$, but also an interaction of ML x SpSex, $F(5,245) = 4.943$, $p < .001$, $\eta_p^2 = .092$. To disentangle the interaction of ML x SpSex, paired sample t-tests, comparing female and male speakers, were performed for each of the six MLs. Significant differences between female and male speakers were found for MLs 40, 60, 80, and 100, $|ts(49)| \geq 2.604$, $ps \leq .012$, but not for MLs 0 and 20, $|t(49)| \leq 0.715$, $p \geq .478$. At all MLs, female voices were perceived as less angry (*M*s = .499 ± .033, .440 ± .032, .385 ± .027, .359 ± .028, .353 ± .028, .450 ± .031, for ML 0 to 100, respectively) than male voices (*M*s = .469 ± .032, .458 ± .031, .478 ± .027, .485 ± .026, .478 ± .026, .589 ± .030, for ML 0 to 100, respectively).

4.3 Exploratory Analysis

4.3.1 Analyses of slope values and points of subjective equality of the cumulative Gaussians

For detailed information on the calculation of cumulative Gaussians and related function scripts, the reader is kindly referred to Nussbaum, von Eiff, Skuk, & Schweinberger (2021). The slope of a cumulative Gaussian is represented by the standard deviation (SD). In this connection, a smaller SD value indicates a steeper slope. Points of subjective equality (PSEs) indicates how much the curve's shift towards the "angry sector" of the morph continuum. Fits in terms of R^2 were generally poor for low-performing CI users, for all Morph Types (e.g., Full: $M = .476$, $SD = .225$, range: .045 - .768, $n = 8$) or did not converge, such that this analysis could not be performed for the low-performing CI group.

For the high-performing CI users, however, fits in terms of R^2 were excellent for MType Full ($M = .917$, $SD = .072$, range: .759 - .997, $n = 13$) and good for Timbre ($M = .810$, $SD = .252$, range: .047 - .976, $n = 13$). For F0, however, they were less optimal ($M = .651$, $SD = .351$, range: .018 - .986, $n = 12$). One fit for F0 did not converge for this group and was excluded. Fits in terms of R^2 for Time ($M = .141$, $SD = .164$, range: .022 - .429, $n = 6$) for the high-performing CI users were poor. For this morph type, seven fits did not converge for this group and were consequently not included.

In contrast to these results, for the NH, fits in terms of R^2 for Full ($M = .974$, $SD = .035$, range: .829 - .998, $n = 25$) were excellent and for both F0 ($M = .888$, $SD = .077$, range: .699 - .989, $n = 24$) and Timbre ($M = .864$, $SD = .172$, range: .261 - .986, $n = 23$) generally good. For the NH, one fit for F0 and two fits for Timbre were excluded because they did not converge. Fits for Time ($M = .271$, $SD = .285$, range: .001 - .749, $n = 10$), however, were poor for this group, too. Fifteen fits for this morph type did not converge for this group and were excluded.

Furthermore, PSEs – and, consequently, their corresponding SDs – which did not lay in the morphing interval [0:100] were excluded from analysis. Doing so resulted in exclusion of one CI user for Full morphs, two CI users for F0 morphs, two CI users and two NH individuals for Timbre morphs and eight CI users and eighteen normal-hearing individuals for Time morphs. Due to a lack of power, analysis of resulting data for Time morphs was not possible.

The analysis of the slope values confirmed our earlier findings, that high-performing CI users and NH did not differ regarding their slopes for Timbre (Ms_{Timbre} = 59.397 ± 25.676, 51.995 ± 43.807, for CI and NH, respectively), $|t(32)| = 0.517$, $p = .609$. However, in line with our expectations, we found trends for steeper slopes for NH than for high-performing CI users for both F0 (Ms_{F0} = 117.569 ± 140.267, 52.339 ± 16.709, for CI and NH, respectively), $|t(34)| = 2.331$, $p = .026$, and Full (Ms_{Full} = 39.410 ± 15.287, 26.789 ± 12.634, for CI and NH, respectively), $|t(35)| = 2.657$, $p = .012$.

Importantly, analyzing PSEs, we found no significant differences between high-performing CI users and NH for any of the four morph types (Ms_{Full} = 57.524 ± 10.277, 56.691 ± 7.550, Ms_{F0} = 57.562 ± 13.402, 58.926 ± 14.975, Ms_{Timbre} = 62.914 ± 10.069, 61.515 ± 11.044, for CI and NH, respectively), $|t(35)| = 0.279$, $p = .782$, $|t(34)| = 0.260$, $p = .797$, $|t(32)| = 0.355$, $p = .725$, for MType Full, F0, and Timbre, respectively.

Altogether, high-performing CI users, in contrast to low-performing CI users, exhibited a pattern of results similar to the normal-hearing individuals' pattern in the present computer experiment. While low-performing CI users were close to guessing level, the group of high-performing CI users and the normal-hearing individuals did not differ significantly from one another in the extent in which they used Timbre. Moreover, both CI users and normal-hearing individuals were close to guessing level for Time. However, normal-hearing individuals outperformed high-performing CI users overall (in terms of performance with Full Morphs). Of note, high-performing CI users also used F0 information to a smaller extent than normal-hearing individuals.

4.3.2 Individual cumulative Gaussian fits

4.3.2.1 CI users

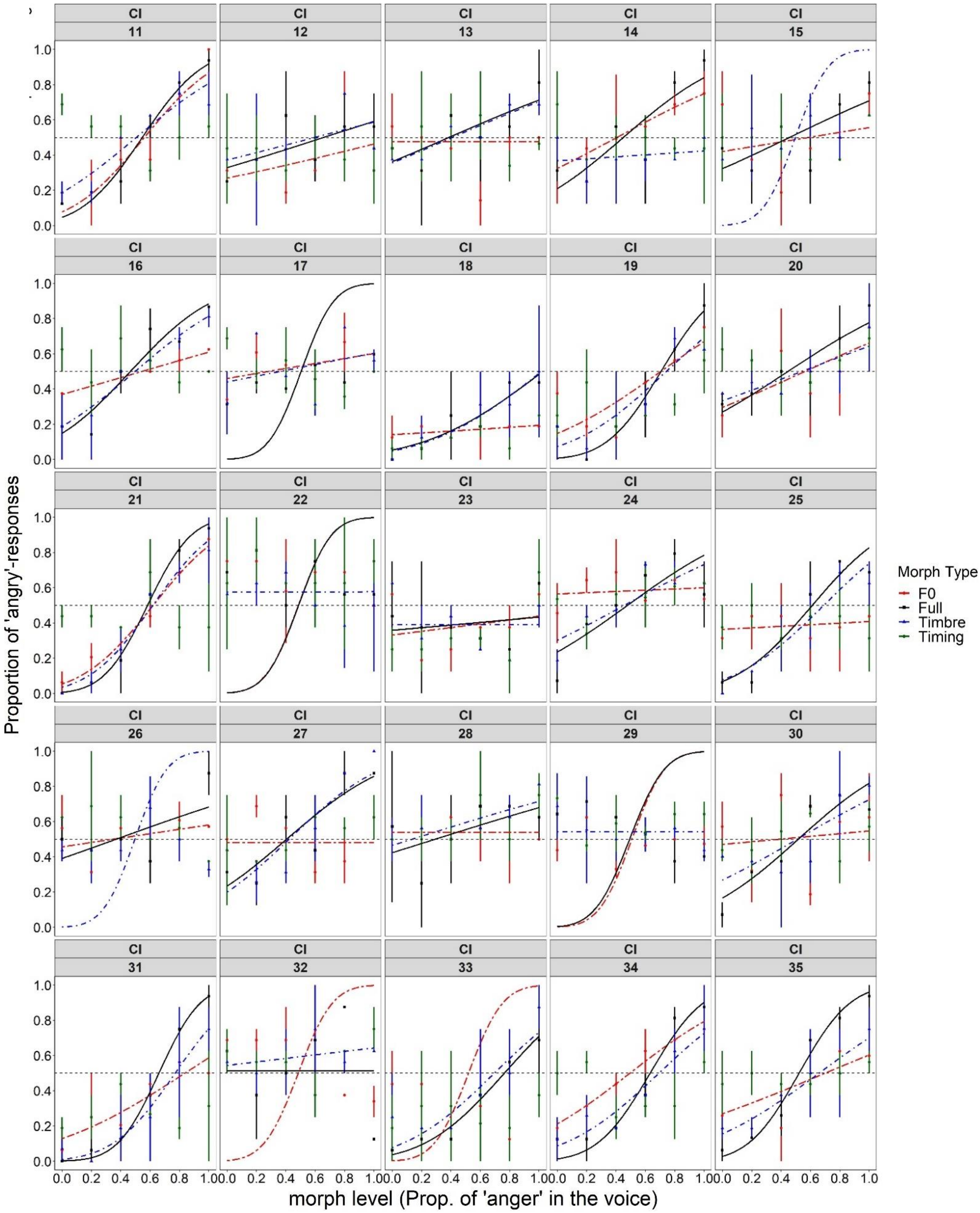


Figure S2. Individual cumulative Gaussian fits on the proportion of "angry"-responses for CI users, for each morph type used in the computer experiment.

4.3.2.2 NH individuals

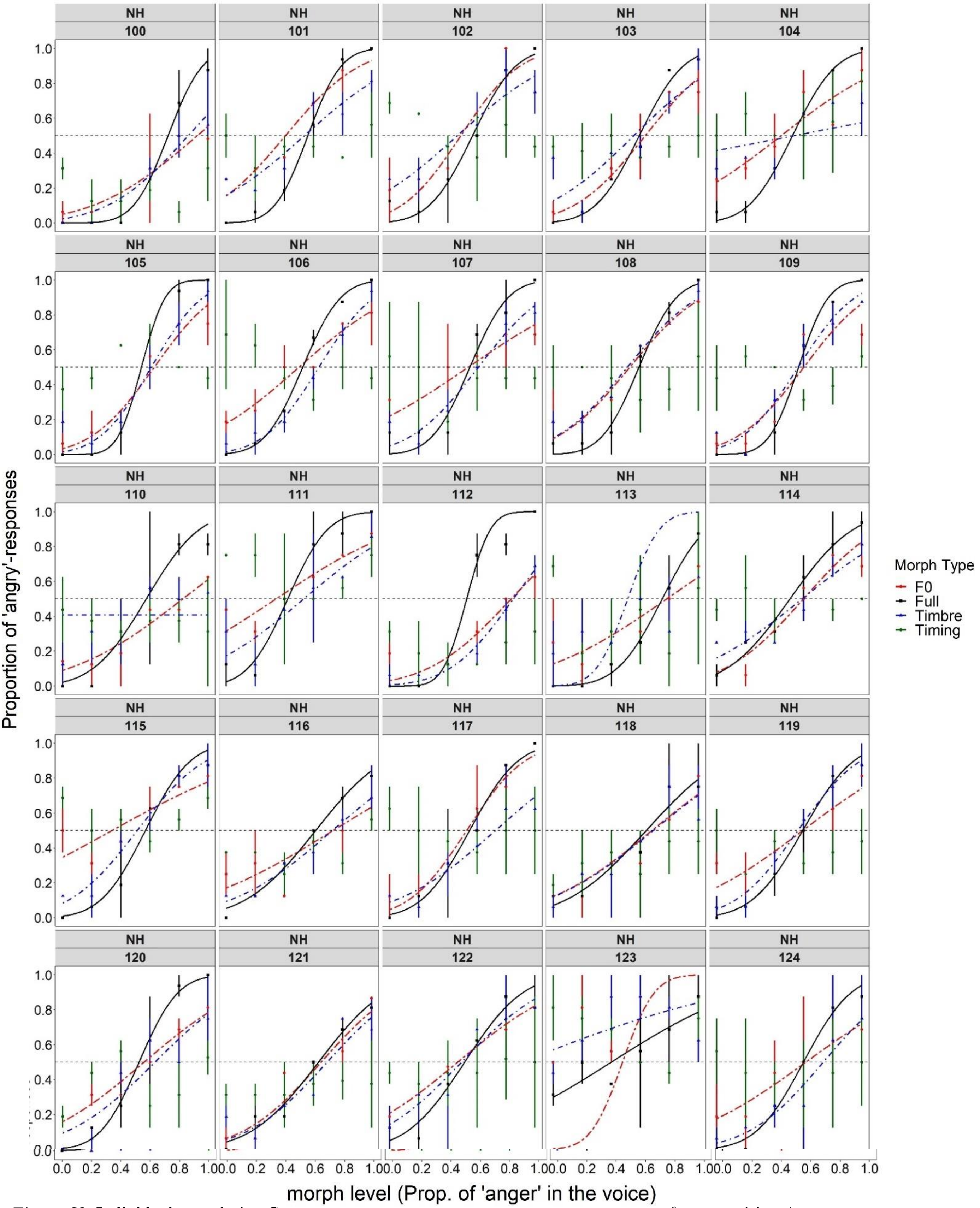


Figure S3. Individual cumulative Gaussian fits on the proportion of "angry"-responses for normal-hearing individuals, for each morph type used in the computer experiment.

4.3.3 Cumulative Gaussian fits, separately for five subgroups of CI users

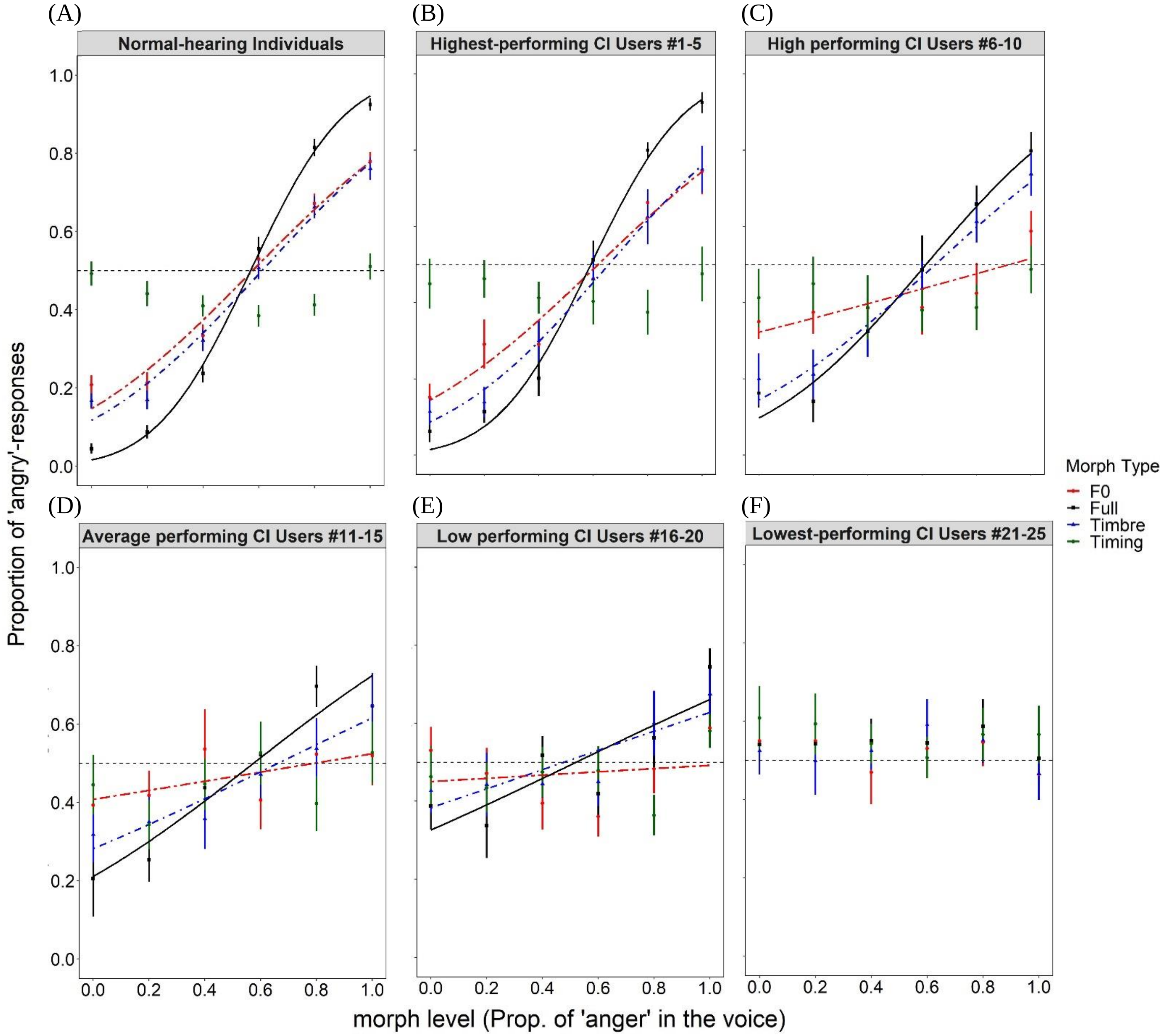


Figure S4. The proportion of "angry"-responses for different morph levels and morph types used in the experiment, separately for normal-hearing individuals (A) and five subgroups of CI users (CI) divided by performance (n = 5 per subgroup): the highest-performing (B), the high performing (C), the average performing (D), the low performing (E), and the lowest-performing (F) CI users. Note that steeper slopes represent better performance. Error bars represent standard errors of the mean (SEM). Best-fitting cumulative Gaussian functions are also shown.

4.4 Quality of Life

4.4.1 Correlation between the mean deviation from the NH individuals' performance and all domains of the NCIQ

One-tailed Pearson correlation coefficient between the mean deviation (including all MTypes or only MType F0, MType Full, MType Timbre, MType Time) from the normal-hearing individuals' performance and all domains of the NCIQ, all CI users included

Variables	DEV_{all}	F0 Mean Deviation DEV_{F0}	Full Mean Deviation DEV_{Full}	Timbre Mean Deviation DEV_{Timbre}	Time Mean Deviation DEV_{Time}
Total Score	**-.390***	**-.320**	**-.375***	**-.404***	**-.319**
BSP	-.249	-.169	-.282	-.281	-.124
ASP	-.395*	-.329	-.429*	-.371*	-.273
SP	-.407*	-.333	-.373*	-.434*	-.356*
SE	-.178	-.138	-.170	-.191	-.147
AL	-.405*	-.373*	-.367*	-.392*	-.368*
SI	-.321	-.260	-.253	-.364*	-.331

* $p < .05$. ** $p < .01$. *** $p < .001$.

Note: BSP – basic sound perception; ASP – advanced sound perception; SP – speech production; SE – self-esteem; AL – activity limitations; SI – social interactions.

4.4.2 Individual scores on the NCIQ

All CI users' scores on the Nimjegen Cochlear Implant Questionnaire

CI user	BSP	ASP	SP	SE	AL	SI	Total Score
11	82.50	95.00	70.00	70.00	72.50	82.50	78.75
12	50.00	57.50	12.50	60.00	25.00	45.00	41.67
13	62.50	50.00	57.50	57.50	42.50	47.50	52.92
14	70.00	92.50	62.50	52.50	33.33	38.89	58.29
15	100.00	100.00	77.50	77.78	90.00	90.00	89.21

16	80.00	65.00	72.50	50.00	77.50	75.00	70.00
17	80.56	86.11	47.50	58.33	37.50	55.56	60.93
18	57.50	75.00	57.50	52.50	56.25	67.50	61.04
19	65.00	82.50	60.00	36.11	50.00	52.78	57.73
20	17.50	30.56	25.00	30.56	15.63	28.57	24.63
21	75.00	59.38	67.50	72.50	66.67	58.33	66.56
22	52.50	32.50	50.00	40.00	42.50	50.00	44.58
23	45.00	33.33	60.00	60.00	45.00	59.38	50.45
24	65.00	50.00	42.50	27.50	27.78	32.50	40.88
25	92.50	97.50	80.00	67.50	70.00	80.56	81.34
26	82.50	44.44	52.50	59.38	30.00	20.83	48.28
27	80.00	50.00	67.50	52.50	38.89	52.78	56.94
28	62.50	42.50	45.00	50.00	27.50	45.00	45.42
29	55.00	44.44	52.78	42.50	32.50	62.50	48.29
30	50.00	47.50	25.00	30.00	27.78	22.50	33.80
31	72.50	75.00	55.00	45.00	47.50	62.50	59.58
32	92.50	80.00	67.50	57.50	67.50	47.22	68.70
33	87.50	72.50	82.50	83.33	65.00	87.50	79.72
34	94.44	80.56	85.00	67.50	80.00	75.00	80.42
35	62.50	57.50	65.00	42.50	35.00	33.33	49.31
M	69.40	64.05	57.61	53.72	48.15	54.93	57.98
SD	18.87	21.52	18.02	14.80	20.27	19.68	16.10
MIN	17.50	30.56	12.50	27.50	15.63	20.83	24.63
MAX	100.00	100.00	85.00	83.33	90.00	90.00	89.21
N	25	25	25	25	25	25	25

4.5 Resulting means and corresponding SEMs

4.5.1 CI users

From the computer experiment resulting means and corresponding SEMs for CI users, separately for used morph types and morph levels

Morph type	**Morph level**	**Mean**	**SEM**
F0	0	.395	.032
F0	20	.421	.030
F0	40	.415	.035
F0	60	.429	.027
F0	80	.528	.030
F0	100	.581	.028
Full	0	.272	.036
Full	20	.278	.036
Full	40	.406	.031
Full	60	.497	.031
Full	80	.661	.027
Full	100	.724	.034
Timbre	0	.317	.033
Timbre	20	.329	.036
Timbre	40	.390	.028
Timbre	60	.483	.030
Timbre	80	.585	.030
Timbre	100	.655	.032
Time	0	.476	.034
Time	20	.457	.030
Time	40	.453	.028
Time	60	.459	.028
Time	80	.418	.029
Time	100	.527	.030

4.5.2 NH individuals

From the computer experiment resulting means and corresponding SEMs for normal-hearing individuals, separately for used morph types and morph levels

Morph type	**Morph level**	**Mean**	**SEM**
F0	0	.208	.024
F0	20	.213	.028
F0	40	.334	.028
F0	60	.530	.031
F0	80	.673	.024
F0	100	.779	.024
Full	0	.045	.013
Full	20	.088	.017
Full	40	.238	.024
Full	60	.557	.030
Full	80	.815	.022
Full	100	.925	.016
Timbre	0	.168	.019
Timbre	20	.170	.024
Timbre	40	.322	.027
Timbre	60	.506	.028
Timbre	80	.663	.029
Timbre	100	.761	.029
Time	0	.493	.031
Time	20	.441	.032
Time	40	.410	.027
Time	60	.385	.028
Time	80	.413	.028
Time	100	.511	.034

4.6 Deviation Scores (DEV_{all}) of the CI users and Median Split in subgroups

Subject	Sex	Age	meanDeviationScore	subgroup[1]	rank
21	male	64	0.2776	High-performing	1
31	female	72	0.2808	High-performing	2
34	male	77	0.2837	High-performing	3
11	female	61	0.2859	High-performing	4
35	female	54	0.3016	High-performing	5
19	female	57	0.3328	High-performing	6
16	female	50	0.3405	High-performing	7
33	male	20	0.3501	High-performing	8
25	female	76	0.3666	High-performing	9
20	female	81	0.3961	High-performing	10
18	male	67	0.4059	High-performing	11
14	male	68	0.4120	High-performing	12
30	male	76	0.4121	High-performing	13
28	male	27	0.4166	Low-performing	14
24	male	67	0.4194	Low-performing	15
27	female	80	0.4222	Low-performing	16
17	male	68	0.4325	Low-performing	17
23	female	69	0.4437	Low-performing	18
15	female	56	0.4556	Low-performing	19
13	female	76	0.4563	Low-performing	20
12	female	47	0.4678	Low-performing	21
32	male	83	0.4756	Low-performing	22
26	female	51	0.4820	Low-performing	23
22	male	41	0.5108	Low-performing	24
29	female	36	0.5195	Low-performing	25

[1] group of participants divided by median split

5 Further Visualizations of the Analyses

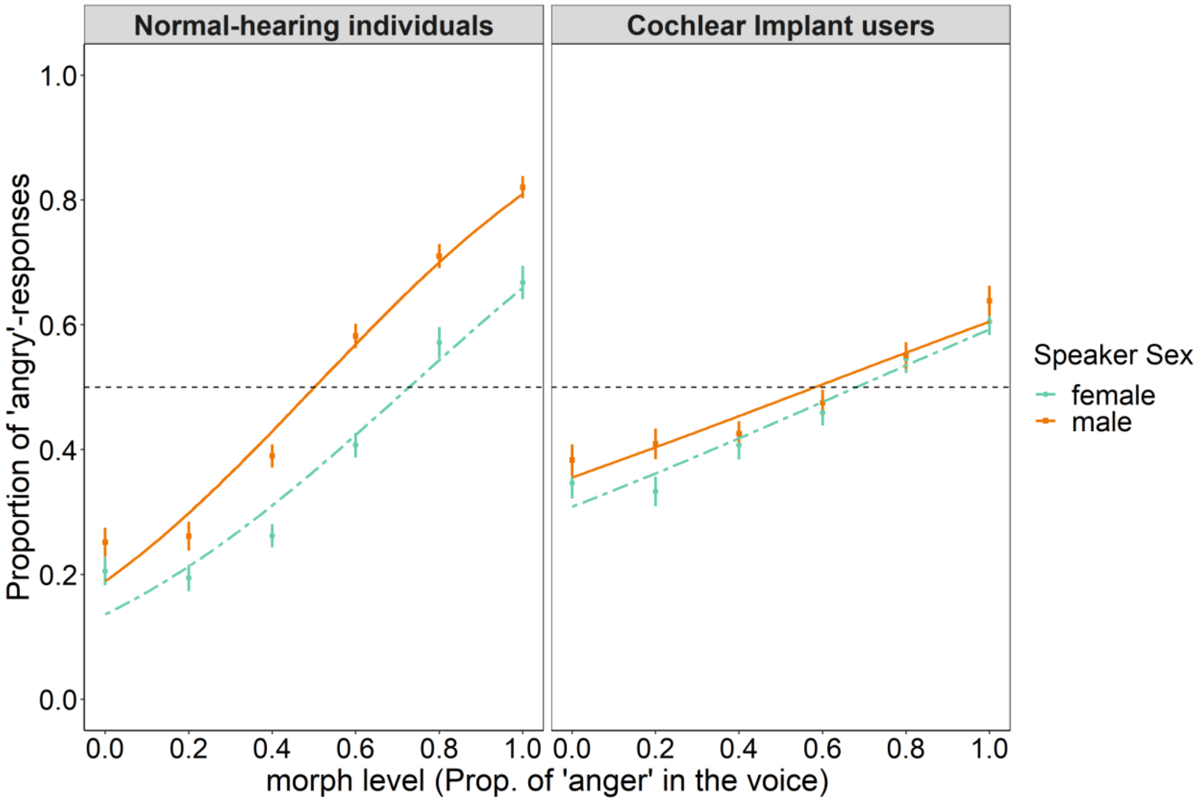


Figure S5. The proportion of "angry"-responses for different morph levels and speaker sex, separately for CI users and normal-hearing individuals. Note that steeper slopes represent better performance. Error bars represent standard errors of the mean (SEM). Best-fitting cumulative Gaussian functions are also shown.

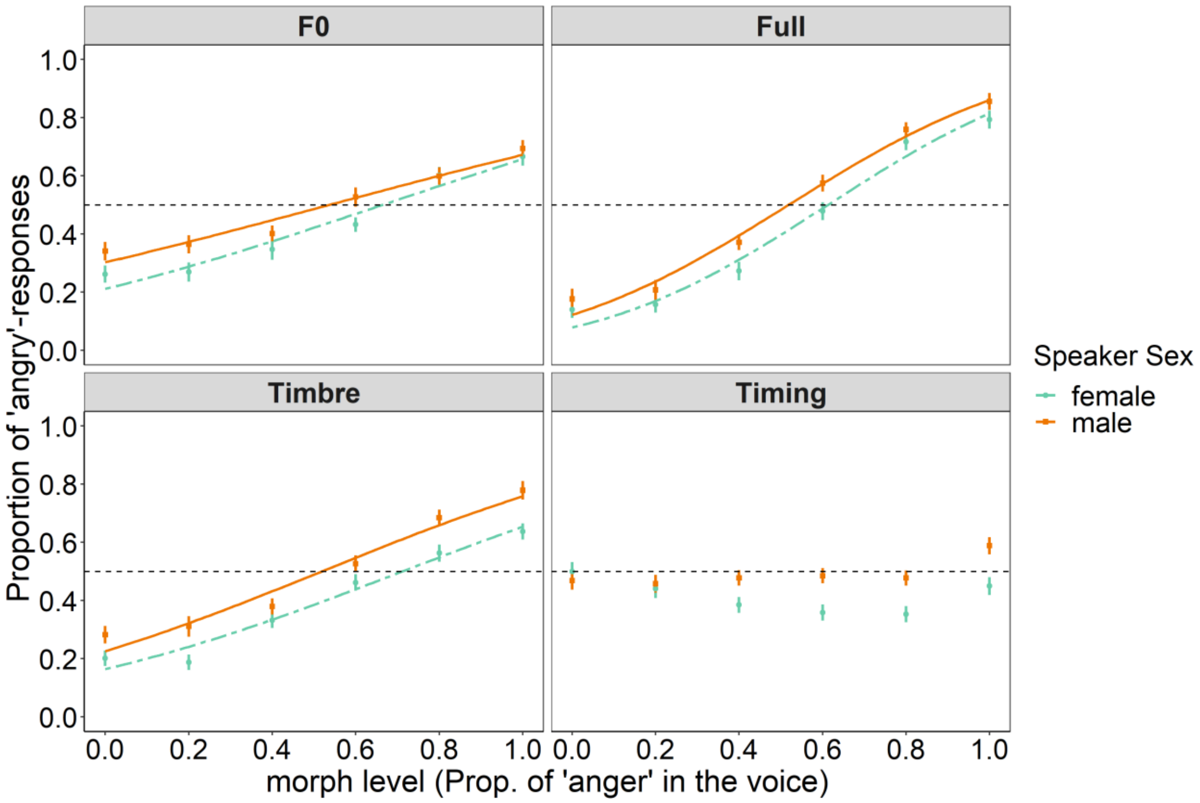


Figure S6. The proportion of “angry”-responses for different morph levels and speaker sex for all participants, both CI users and normal-hearing individuals, separately for morph types used in the experiment. Note that steeper slopes represent better performance. Error bars represent standard errors of the mean (SEM). Best-fitting cumulative Gaussian functions are also shown.

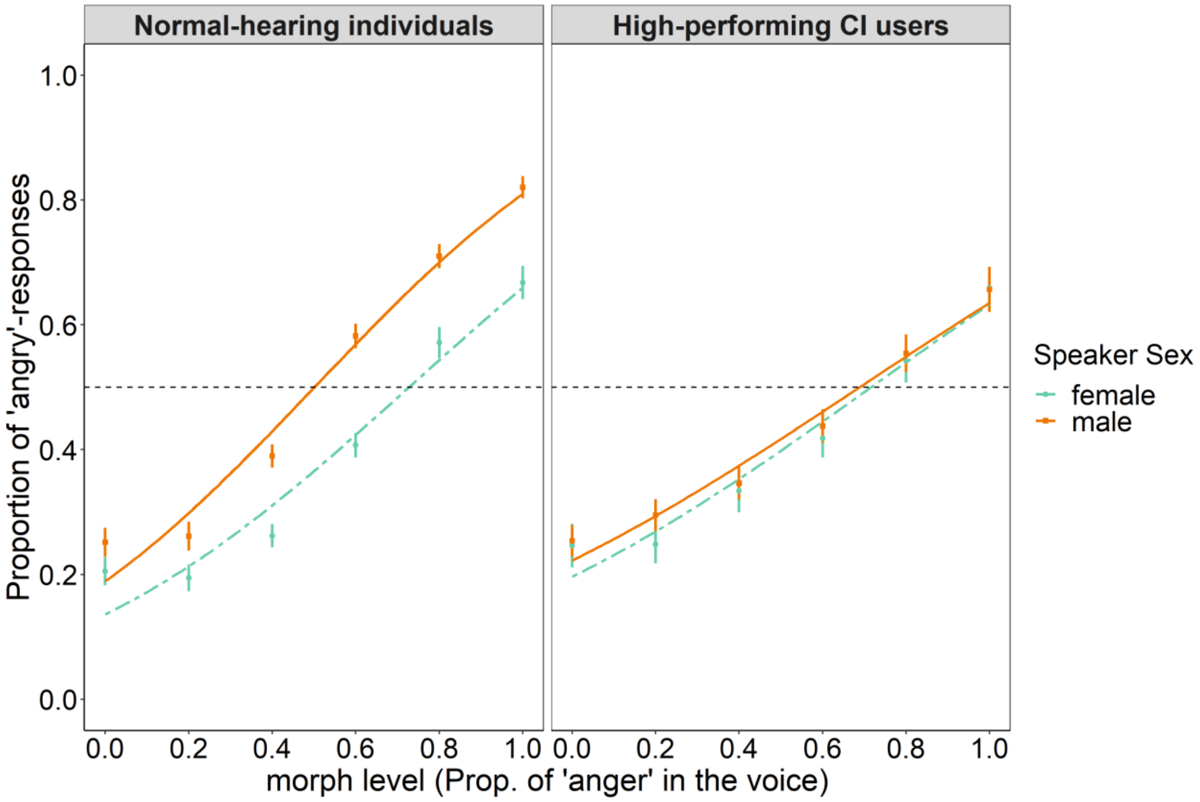


Figure S7. The proportion of "angry"-responses for different morph levels and speaker sex, separately for high-performing CI users and normal-hearing individuals. Note that steeper slopes represent better performance. Error bars represent standard errors of the mean (SEM). Best-fitting cumulative Gaussian functions are also shown.

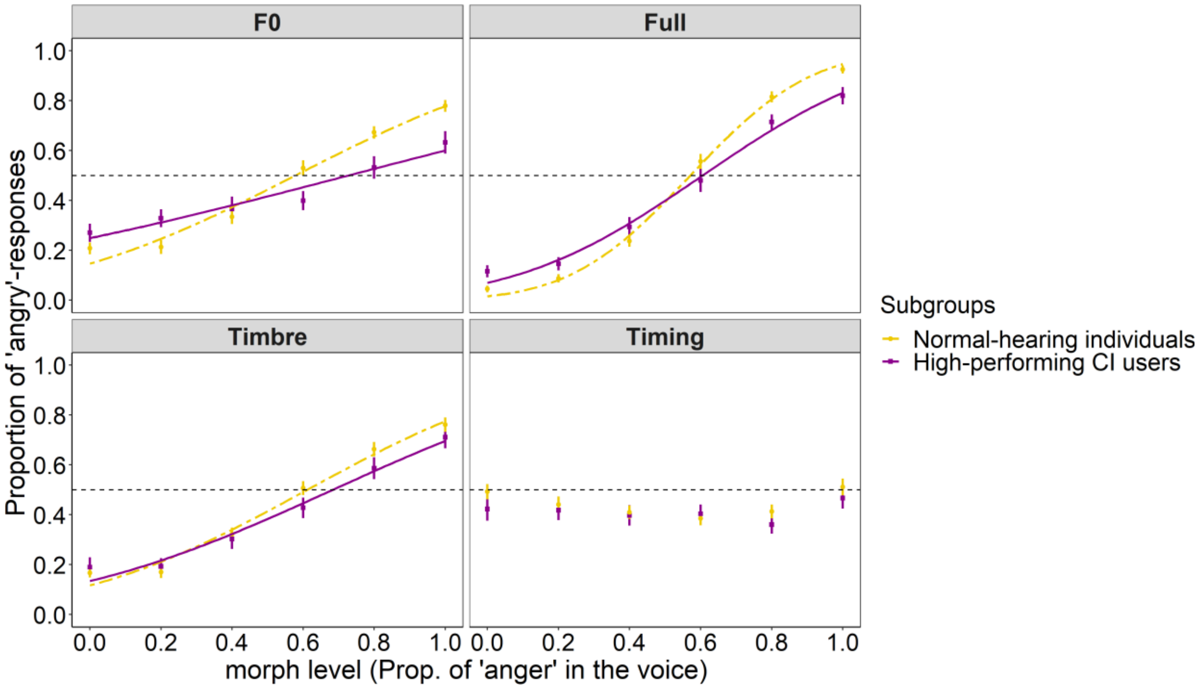


Figure S8. The proportion of "angry"-responses for different morph levels and for the subgroups of high-performing CI users and normal-hearing individuals, separately for morph types used in the experiment. Note that steeper slopes represent better performance. Error bars represent standard errors of the mean (SEM). Best-fitting cumulative Gaussian functions are also shown.

References to Supplemental Material

Nussbaum, C., von Eiff, C. I., Skuk, V. G., & Schweinberger, S. R. (2021, March 17). Vocal emotion adaptation aftereffects within and across speaker genders: Roles of timbre and fundamental frequency. *PsyArXiV*, https://doi.org/10.31234/osf.io/zcypa