

Modeling Human Color Perception under Extended Luminance Levels

Supplemental Material B

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1 Color Appearance Data

This document provides the psychophysical experimental data which was used to develop our model. The data comprises two main parts: (1) physical measurements of color stimuli (absolute XYZ coordinates measured with a spectroradiometer; Y in [cd/m^2]) and (2) perceptual attribute estimates (averaged over six participants) of the stimuli in terms of lightness J , colorfulness M , and hue quadrature H .

In each phase, 40 main color patches were observed on a high-luminance display under different viewing conditions (different peak luminance level, background, ambient surround, and color temperature, see Table 1). Six observers who passed the Ishihara and City University vision tests for normal color vision participated in the experiments. Each participant completed a total of 2,280 estimations (19 phases with 40 patches and 3 estimates each), which took about 10 hours per participant. The averaged repeatability in terms of CV was 11.83% for lightness, 22.82% for colorfulness, and 11.42% for hue. Note that our experimental results are compatible with the LUTCHI data [Luo et al., 1991].

The lightness attribute has a scale of 0–100 relative to the brightness of reference white. The colorfulness attribute has an absolute scale of 0 to unlimited. The hue attribute varies from 0 to 400: redness (0) - yellowness (100) - greenness (200) - blueness (300) - redness (400); observers were allowed to judge a hue as undefined (denoted as 'N/A' below) if the shown patch was too dark, too bright, or neutral.

References

Luo, M. R., Clarke, A. A., Rhodes, P. A., Schappo, A., Scrivener, S. A. R., and Tait, C. J. 1991. Quantifying colour appearance. Part I. LUTCHI colour appearance data. *Color Res. Appl.*, 16(3):166–180.

Phase	Medium	CCT	Reference White (Abs.)			La(10°)	Background (Abs.)				Ambient
Number	Type	K	X	Y[cd/m ²]	Z	[cd/m ²]	%	X	Y[cd/m ²]	Z	Luminance
1	LCD	5935	32.51	43.88	25.72	12.06	24.52%	8.64	10.76	7.66	dark
2	LCD	6265	93.68	122.90	84.06	31.26	21.81%	21.94	26.81	20.98	dark
3	LCD	6265	376.08	493.60	348.19	30.07	0.34%	1.22	1.68	1.23	dark
4	LCD	6265	396.71	521.00	371.57	144.29	23.82%	103.97	126.90	104.31	dark
5	LCD	6197	419.38	562.60	373.03	466.17	87.11%	366.89	490.10	326.54	dark
6	LCD	6197	800.51	1067.00	714.78	70.00	0.32%	2.43	3.37	2.46	dark
7	LCD	6197	800.22	1051.00	736.81	269.90	22.06%	189.58	231.80	183.53	dark
8	LCD	6390	1712.46	2176.00	1689.59	136.44	0.22%	3.59	4.76	4.12	dark
9	LCD	6392	1721.81	2189.00	1697.69	367.61	12.16%	229.77	266.20	234.15	dark
10	LCD	6391	1726.31	2196.00	1702.69	576.71	22.90%	422.04	502.90	427.31	dark
11	LCD	6387	1732.94	2205.00	1708.66	1204.03	55.06%	1012.64	1214.00	1010.70	dark
12	LCD	6388	1758.09	2241.00	1729.44	2009.94	94.87%	1667.67	2126.00	1636.72	dark
13	LCD	7941	995.40	1274.00	1293.24	312.49	21.16%	228.16	269.55	314.68	dark
14	LCD	1803	1063.72	1233.00	356.61	284.36	19.17%	217.84	236.35	73.20	dark
15	LCD	6391	1730.32	2201.40	1705.62	604.76	22.90%	432.93	533.92	429.98	average
16	Trans.	5823	6890.34	8519.00	5936.19	941.70	5.61%	408.02	477.60	256.97	dark
17	Trans.	5823	6849.58	8458.00	5911.69	2120.66	21.41%	1499.62	1811.00	1062.72	dark
18	Trans.	5921	13676.05	16860.00	12201.60	1860.80	5.49%	791.12	926.00	523.38	dark
19	Trans.	5937	13295.61	16400.00	11918.19	4183.52	21.81%	2963.80	3577.00	2194.24	dark

Table 1: Summary of viewing conditions for all 19 phases.

Color	Phase 1						Phase 2					
	X	Y[cd/m ²]	Z	J	M	H	X	Y[cd/m ²]	Z	J	M	H
1	0.61	0.56	0.30	8.67	12.44	0.25	2.03	1.79	0.99	10.83	17.88	9.00
2	0.44	0.50	0.30	2.00	2.33	N/A	1.35	1.61	0.87	2.83	4.47	50.00
3	1.31	0.85	4.93	32.50	64.28	305.00	4.48	2.79	17.89	33.67	68.77	304.17
4	0.69	0.79	0.35	6.67	6.75	77.50	2.17	2.53	0.94	8.00	11.74	74.17
5	1.98	1.42	0.37	43.00	50.84	1.33	6.63	4.61	1.30	40.33	54.01	2.50
6	2.60	1.56	8.57	41.33	64.26	325.83	9.05	5.25	30.85	46.17	68.51	334.17
7	0.62	0.94	0.50	15.83	30.28	179.17	1.94	3.13	1.59	23.67	35.88	200.33
8	3.36	2.04	14.17	52.00	61.81	305.83	11.45	6.74	49.71	60.33	71.36	267.83
9	1.00	1.79	0.41	39.50	55.77	207.50	3.16	6.01	1.17	43.67	58.28	210.00
10	4.64	3.07	0.59	55.00	60.54	10.50	15.26	9.99	1.87	57.17	65.50	4.17
11	1.80	2.00	0.51	31.17	27.80	127.00	5.95	6.69	1.62	43.17	34.53	126.17
12	1.51	2.90	0.48	42.67	55.22	190.00	4.86	9.63	1.50	51.83	55.61	191.67
13	3.03	2.37	2.02	46.17	48.29	372.50	10.14	7.86	7.24	47.33	46.51	375.00
14	2.90	4.18	5.21	47.33	34.51	275.33	9.75	14.17	18.62	51.83	39.92	275.67
15	8.58	5.52	0.70	68.33	52.87	6.67	28.02	17.81	2.24	72.33	62.82	12.00
16	6.56	4.27	0.85	52.83	57.80	3.83	21.27	13.69	2.90	63.67	57.17	9.00
17	4.06	3.44	11.91	53.33	52.41	320.33	14.13	11.83	42.42	62.00	51.86	327.67
18	6.53	5.48	10.96	55.17	39.94	349.17	21.82	18.18	38.37	60.00	48.68	349.17
19	10.06	6.78	0.84	61.83	62.88	36.17	32.85	22.11	2.52	67.83	70.82	44.17
20	3.43	4.62	6.41	49.00	38.09	283.67	11.81	15.83	23.14	53.83	35.68	278.67
21	3.34	6.58	1.15	59.50	50.56	187.50	10.88	21.90	3.94	62.33	61.04	190.33
22	9.63	7.34	0.89	58.67	57.49	54.50	31.73	24.31	2.79	59.50	60.09	52.50
23	12.91	9.54	15.52	62.33	42.42	363.67	42.90	31.55	54.69	68.67	46.60	365.00
24	12.88	10.57	2.40	57.83	38.24	52.00	42.19	34.80	8.60	68.50	63.93	50.83
25	4.98	7.59	5.42	54.83	24.06	232.00	16.77	25.49	19.44	58.17	31.24	239.50
26	6.70	8.31	16.89	63.83	37.24	296.67	23.01	28.32	60.21	74.17	50.83	300.83
27	16.90	15.00	13.88	67.83	44.30	369.50	55.72	49.57	49.14	73.83	35.20	359.50
28	5.20	10.39	1.00	65.83	51.39	181.33	16.71	33.71	3.38	67.33	64.72	188.33
29	16.57	17.14	5.95	66.17	35.76	72.50	53.72	55.68	20.54	68.83	34.82	57.83
30	15.79	17.06	1.45	69.17	61.28	91.17	51.81	56.58	5.15	71.17	72.14	92.50
31	19.50	20.00	18.41	73.67	27.74	374.50	64.64	66.23	65.07	72.33	24.89	361.17
32	18.31	19.75	9.07	76.00	29.21	60.83	60.30	65.35	32.24	76.33	25.63	60.33
33	16.15	17.81	1.56	69.00	63.58	91.67	52.93	58.99	5.31	73.17	72.06	81.17
34	9.05	17.46	2.71	77.83	57.62	180.83	29.44	57.45	9.58	83.83	60.51	178.33
35	20.65	25.84	15.39	82.00	3.09	N/A	68.72	86.00	54.73	83.17	3.87	100.40
36	18.55	27.94	9.15	85.50	27.74	167.83	61.10	92.38	32.47	83.83	26.46	187.00
37	21.31	28.42	2.29	90.00	70.67	103.17	69.41	93.51	7.78	87.67	74.78	119.17
38	24.41	30.88	16.30	88.17	4.65	82.83	80.86	102.40	58.25	88.67	6.54	92.00
39	21.22	30.34	2.84	92.83	64.35	111.67	68.30	98.26	9.56	87.50	71.09	138.33
40	27.32	33.76	24.28	100.00	1.44	N/A	90.04	111.20	85.51	99.67	1.63	N/A

Table 2: Phase 1 & 2. Physical measurements vs. perceptual estimates.

Color	Phase 3						Phase 4					
	X	Y[cd/m^2]	Z	J	M	H	X	Y[cd/m^2]	Z	J	M	H
1	3.98	3.11	1.23	28.71	59.45	12.00	9.16	7.98	4.02	15.57	38.10	6.71
2	2.00	2.25	1.20	22.71	23.45	94.86	6.06	7.32	3.85	6.71	6.87	66.00
3	12.12	6.55	54.72	44.71	78.01	308.00	20.51	12.82	85.04	36.43	80.24	301.86
4	4.29	4.70	1.37	31.14	38.64	126.43	10.82	12.83	4.38	19.00	31.57	129.14
5	19.38	12.55	2.66	46.71	59.89	7.71	30.53	20.90	6.19	39.57	55.90	7.43
6	26.96	14.53	100.40	55.71	78.48	336.14	41.56	24.10	142.99	48.71	78.74	330.14
7	3.25	5.83	2.84	40.86	51.77	193.14	9.07	15.38	8.09	25.29	49.74	195.00
8	37.60	20.32	174.31	61.57	87.33	306.14	50.87	30.70	224.51	58.86	74.69	299.57
9	6.73	13.78	2.10	44.71	63.39	189.43	14.56	28.62	5.81	43.86	64.39	195.00
10	50.34	31.42	4.80	58.71	68.92	11.43	66.86	42.69	8.51	57.57	79.69	5.29
11	14.94	15.70	2.91	46.14	46.81	100.71	27.09	30.92	7.31	36.71	41.42	119.00
12	11.84	24.79	3.19	57.43	72.34	185.00	22.76	46.24	7.43	48.71	60.89	192.29
13	29.48	20.84	19.49	53.29	49.26	373.29	47.16	36.61	36.23	45.14	51.02	369.43
14	26.67	38.05	57.55	55.71	52.99	277.43	45.42	66.68	89.77	54.71	43.16	262.00
15	101.12	62.46	7.03	78.29	72.72	16.43	117.67	73.41	9.99	79.71	78.48	9.71
16	73.91	45.77	7.46	72.00	62.62	7.43	92.49	58.18	13.58	66.14	68.11	7.00
17	42.31	32.35	142.31	64.00	63.65	327.57	64.20	55.26	192.04	59.43	59.16	323.14
18	69.73	54.11	130.56	70.86	44.53	347.14	101.07	85.40	179.74	59.00	57.92	354.57
19	118.82	75.96	7.02	83.57	75.80	30.00	135.23	90.72	10.80	76.43	87.41	34.29
20	32.51	42.52	72.61	57.14	35.65	278.14	52.89	71.18	106.59	53.86	38.63	294.29
21	29.90	62.32	10.42	64.86	59.75	185.86	48.97	99.74	20.43	64.00	70.25	188.71
22	111.26	79.33	8.23	77.14	69.29	45.86	134.40	104.00	12.86	67.29	78.35	47.14
23	150.53	104.20	192.87	80.57	53.88	358.57	186.12	138.80	247.22	65.43	73.81	358.86
24	152.22	116.60	25.10	78.71	44.39	48.14	177.17	148.90	43.04	68.29	54.41	44.86
25	47.64	72.60	59.87	64.43	29.76	230.71	76.86	116.30	94.50	50.14	33.23	221.43
26	72.33	83.96	212.76	74.71	56.58	284.29	100.83	126.80	267.11	75.29	46.65	296.00
27	196.50	163.40	167.20	82.43	31.64	369.86	234.65	212.30	222.34	74.00	44.30	380.71
28	50.02	103.90	10.61	78.29	78.02	198.57	75.81	154.20	17.66	71.14	83.62	186.00
29	189.77	185.10	65.43	79.57	28.18	49.71	229.05	242.10	101.05	70.00	31.80	57.86
30	181.71	185.00	15.76	71.71	83.53	88.00	215.15	239.60	23.68	78.43	91.76	89.29
31	224.22	216.50	231.01	86.57	12.34	372.17	271.71	281.80	287.69	76.71	36.49	374.29
32	209.32	213.70	104.63	85.71	24.45	52.71	252.87	277.50	150.11	75.14	24.60	54.71
33	185.40	192.70	16.70	82.14	89.69	94.29	219.63	249.40	24.63	74.71	84.26	91.43
34	90.14	181.00	28.83	87.00	49.99	181.71	128.48	250.80	49.00	85.00	72.98	184.57
35	230.13	279.00	188.02	95.57	2.44	90.00	284.65	356.70	242.66	86.57	5.59	78.33
36	199.61	300.90	107.13	91.29	19.57	173.86	259.59	389.50	153.34	88.57	32.13	176.71
37	240.67	310.60	26.70	95.14	75.00	103.29	285.73	388.40	37.88	92.29	92.38	102.57
38	277.13	338.40	201.47	98.29	4.15	77.00	334.78	424.90	260.98	92.43	12.43	98.57
39	235.29	330.50	32.61	94.57	75.78	105.43	282.70	408.60	46.24	93.43	68.66	111.71
40	316.13	374.50	320.99	100.00	1.97	N/A	369.89	460.90	365.11	99.14	1.77	N/A

Table 3: Phase 3 & 4. Physical measurements vs. perceptual estimates.

Color	Phase 5						Phase 6					
	X	Y[cd/m ²]	Z	J	M	H	X	Y[cd/m ²]	Z	J	M	H
1	14.89	16.22	9.01	9.83	15.28	6.67	15.20	11.17	3.08	26.86	64.01	7.57
2	12.06	15.74	8.90	3.67	3.16	31.25	8.93	10.66	3.32	23.29	27.38	95.00
3	25.48	20.64	85.85	31.50	58.73	300.83	37.50	21.34	169.15	46.14	76.47	304.29
4	16.32	20.73	9.20	15.00	17.32	109.17	19.32	22.96	4.60	32.00	45.66	91.00
5	35.58	28.81	10.75	36.00	38.44	7.50	60.24	38.53	7.29	50.86	69.41	14.43
6	46.06	31.81	141.97	35.83	62.00	339.50	80.85	44.77	282.50	53.00	78.11	332.86
7	14.52	23.07	12.53	18.83	24.46	202.50	15.05	28.34	12.34	37.57	52.78	207.57
8	55.27	38.40	221.08	53.00	60.07	300.83	97.79	58.54	442.85	61.86	82.53	302.14
9	20.22	36.53	10.59	40.67	45.20	189.17	27.57	58.63	7.38	49.14	84.07	190.00
10	71.85	50.93	13.17	49.17	60.73	1.67	136.63	84.80	12.76	67.71	66.28	10.86
11	32.85	39.25	11.94	29.67	26.00	100.50	56.31	64.76	10.90	49.86	42.75	111.43
12	28.17	53.75	12.23	48.33	54.98	194.17	44.64	95.72	10.66	53.86	76.70	186.29
13	51.71	44.18	39.47	39.17	42.09	374.50	96.36	74.20	70.82	57.71	53.88	376.00
14	49.94	73.59	90.45	49.50	27.44	275.67	91.58	139.00	180.29	58.57	56.73	279.86
15	122.11	81.54	14.72	59.33	58.98	6.67	240.78	148.10	15.66	80.14	70.87	19.14
16	97.09	66.34	18.08	53.83	55.17	1.67	188.73	116.40	22.76	78.86	74.39	15.86
17	68.03	62.18	189.32	50.50	55.52	336.33	128.63	113.40	379.68	60.29	57.98	326.00
18	104.13	92.00	177.24	53.33	49.39	346.67	206.42	177.80	355.38	68.00	62.94	350.00
19	140.51	99.33	15.44	66.33	56.42	23.33	279.91	187.80	17.06	83.00	78.74	33.43
20	58.77	80.35	110.11	52.33	33.29	279.00	110.76	153.60	218.66	59.71	43.45	277.00
21	53.88	106.80	24.09	59.00	46.59	188.33	100.13	209.10	39.16	68.00	67.01	189.71
22	138.44	111.50	17.32	60.83	49.50	52.00	276.80	216.10	21.50	73.71	61.72	57.14
23	188.69	145.60	243.26	67.00	51.97	N/A	380.63	288.30	486.59	83.00	55.65	356.86
24	180.66	156.20	45.98	61.50	44.48	56.50	362.81	309.20	84.16	82.14	54.70	49.00
25	80.60	122.60	94.44	57.33	23.51	240.00	158.12	243.60	187.83	64.43	36.95	241.71
26	103.80	132.70	260.87	63.00	38.39	294.83	202.69	263.80	527.10	74.57	50.48	302.29
27	236.88	219.00	218.80	69.50	37.34	369.67	479.49	441.70	438.30	82.86	36.43	369.86
28	79.58	159.60	21.22	67.00	55.48	180.00	155.84	323.00	31.27	81.29	83.74	186.71
29	231.19	248.20	101.06	64.00	27.21	58.17	468.16	502.30	198.77	83.71	34.57	61.71
30	218.04	245.90	27.47	62.50	60.27	86.67	440.76	497.70	43.19	80.14	99.45	92.00
31	273.64	288.50	282.17	72.00	38.28	363.67	555.70	586.10	565.95	89.43	23.80	362.43
32	254.64	283.40	148.32	68.83	30.49	60.67	517.18	575.70	297.02	89.43	24.11	52.57
33	222.32	255.50	28.02	64.83	59.71	103.67	450.83	518.60	45.04	82.57	88.78	95.29
34	131.98	256.40	50.96	74.50	50.20	176.67	261.57	517.90	94.47	87.43	44.58	186.14
35	290.17	368.20	240.55	77.50	9.37	55.60	587.85	747.40	481.91	97.43	3.38	70.00
36	262.18	396.30	151.46	84.50	21.22	173.67	531.05	804.10	301.86	93.57	27.05	178.29
37	288.47	395.50	41.19	88.17	65.07	99.67	582.80	801.40	70.25	91.86	77.91	99.57
38	336.41	431.80	255.25	84.67	13.81	68.40	682.66	877.20	511.94	97.86	3.08	82.40
39	290.00	422.40	49.36	85.67	46.69	115.83	587.93	856.40	91.54	96.00	70.57	110.00
40	371.86	468.30	357.84	97.00	5.89	361.60	747.91	946.50	712.76	99.86	2.12	N/A

Table 4: Phase 5 & 6. Physical measurements vs. perceptual estimates.

Color	Phase 7						Phase 8					
	X	Y[cd/m ²]	Z	J	M	H	X	Y[cd/m ²]	Z	J	M	H
1	18.47	15.90	7.26	19.29	21.64	8.43	26.96	19.66	6.83	32.17	75.63	16.67
2	12.62	15.32	7.36	8.14	8.97	81.67	15.28	17.79	7.17	28.17	41.67	119.17
3	40.05	25.76	165.02	36.86	87.75	300.86	69.17	38.91	315.77	46.17	83.51	304.67
4	21.82	26.05	8.53	18.29	18.92	120.71	32.56	37.24	9.03	38.00	59.22	122.00
5	62.15	42.48	11.43	42.71	63.50	8.57	110.87	69.29	14.86	54.17	79.89	16.83
6	81.19	47.98	274.36	52.14	75.84	329.43	150.90	82.11	546.02	57.33	75.05	337.50
7	18.14	31.33	15.63	27.29	37.83	197.29	25.41	46.37	23.81	37.17	58.34	204.17
8	99.06	61.58	434.33	63.43	87.47	301.43	194.29	111.30	904.19	59.83	85.83	318.33
9	29.71	59.26	11.17	44.57	72.48	195.14	45.04	94.48	14.53	49.33	79.65	191.67
10	136.99	87.83	16.74	67.14	82.87	0.86	266.28	160.80	26.01	67.83	79.34	18.00
11	57.26	65.64	14.54	41.29	40.55	118.57	97.35	106.80	20.31	49.83	56.45	123.00
12	46.04	94.62	14.35	54.14	72.20	194.43	73.59	156.40	20.82	53.67	77.93	190.83
13	93.91	73.67	68.92	57.29	55.51	370.29	173.95	127.80	127.11	53.83	53.38	376.50
14	90.40	135.60	174.35	53.14	46.84	259.71	157.95	231.40	337.18	55.50	52.65	273.33
15	241.14	150.90	18.90	89.14	91.10	11.14	506.80	303.00	34.45	80.50	94.61	27.50
16	187.31	118.20	25.95	72.00	83.08	5.43	381.79	229.10	44.99	72.67	73.38	15.00
17	127.49	112.60	372.54	61.43	63.47	324.29	238.64	196.90	757.07	67.17	57.00	319.33
18	201.15	173.00	345.78	61.57	61.43	343.57	382.49	310.00	698.89	73.17	55.02	347.50
19	281.05	189.70	21.72	79.71	88.22	35.00	597.45	381.00	37.28	78.33	86.80	34.67
20	108.00	148.50	211.22	56.57	49.82	271.43	192.48	256.90	412.99	57.17	51.13	288.17
21	98.40	202.50	40.18	72.43	72.75	189.00	169.12	351.40	72.06	61.00	69.89	185.83
22	275.22	213.80	24.93	76.86	96.82	47.14	573.77	417.30	45.18	70.67	83.39	60.83
23	374.15	281.80	475.78	75.71	62.69	365.00	776.34	550.20	1004.81	79.67	59.94	362.50
24	360.18	303.50	83.12	75.29	52.10	43.57	761.52	596.70	156.64	83.00	62.71	47.17
25	153.28	234.80	181.96	55.29	38.79	236.71	274.64	414.30	351.75	66.33	41.15	246.67
26	197.16	253.40	514.03	74.71	53.47	298.29	381.07	461.60	1102.55	77.00	66.00	298.83
27	472.12	429.70	428.10	75.57	47.73	367.57	985.09	836.70	885.98	85.17	58.61	375.33
28	150.99	309.70	33.72	84.00	84.56	188.71	269.18	556.10	62.21	73.17	86.53	180.00
29	463.43	491.60	194.92	76.43	40.24	55.71	950.59	939.70	377.88	78.83	48.02	64.17
30	436.86	486.90	45.97	76.14	92.39	91.00	901.72	933.90	91.14	83.00	88.81	97.00
31	549.70	574.80	560.14	83.29	32.51	360.29	1126.00	1099.00	1192.29	88.83	32.11	382.83
32	506.39	556.30	286.24	76.14	34.68	52.14	1043.65	1076.00	576.42	84.83	38.30	49.83
33	445.04	505.00	47.59	80.29	96.37	94.57	920.98	972.70	95.48	82.83	89.43	90.33
34	255.79	503.90	94.37	89.00	66.75	187.29	467.24	921.90	183.53	81.83	64.72	181.33
35	579.74	732.10	476.38	88.00	7.35	70.86	1157.77	1394.00	989.90	96.50	5.00	63.67
36	519.82	785.10	296.01	90.57	32.00	173.71	1003.61	1486.00	592.74	92.67	37.07	170.83
37	572.08	778.80	71.85	92.00	88.34	115.86	1175.48	1518.00	151.34	92.50	87.71	118.33
38	666.43	849.30	498.26	92.86	6.37	88.33	1365.29	1658.00	1053.42	97.83	4.88	80.00
39	578.88	837.90	92.68	94.00	78.35	103.57	1164.67	1619.00	189.70	91.67	80.02	103.67
40	741.05	930.00	711.74	99.43	2.60	388.33	1541.92	1824.00	1635.45	100.00	3.71	2.50

Table 5: Phase 7 & 8. Physical measurements vs. perceptual estimates.

Color	Phase 9						Phase 10					
	X	Y[cd/m^2]	Z	J	M	H	X	Y[cd/m^2]	Z	J	M	H
1	32.10	25.53	11.73	29.17	52.39	27.67	36.36	30.91	16.09	19.00	22.33	19.43
2	20.32	23.68	12.25	18.83	22.08	144.50	24.46	28.85	16.45	7.86	8.24	81.00
3	73.89	44.56	320.57	47.33	96.64	303.33	78.02	49.80	324.49	37.00	81.31	301.86
4	37.54	43.11	14.00	28.00	48.33	128.67	42.02	48.66	18.49	17.00	19.68	120.00
5	116.75	75.50	19.71	51.67	76.07	9.67	120.75	80.69	23.88	47.86	64.99	6.43
6	156.41	88.25	552.54	54.17	80.61	337.83	160.77	93.70	557.49	54.29	77.22	325.57
7	30.34	52.27	28.84	39.83	63.45	195.33	34.72	57.82	33.30	24.29	40.71	198.29
8	200.54	118.90	910.13	63.33	87.69	317.00	204.71	123.70	916.05	72.29	93.24	302.29
9	50.03	100.70	19.43	54.67	80.99	190.00	54.39	106.30	23.67	46.86	66.75	194.00
10	270.63	166.10	30.76	64.50	86.03	9.67	276.38	172.30	35.18	65.14	80.75	4.86
11	102.81	113.10	25.55	50.00	57.01	128.33	107.70	119.10	29.99	45.86	38.79	109.29
12	78.53	162.30	26.11	56.50	78.77	189.50	82.91	168.10	30.33	55.14	72.14	192.71
13	180.15	134.60	133.17	55.50	53.13	372.50	184.94	140.30	137.80	52.14	50.83	371.57
14	162.87	238.30	340.50	57.33	43.58	277.00	167.62	244.20	345.62	55.00	52.80	270.00
15	512.09	309.10	40.05	80.83	94.49	24.50	516.69	314.30	44.01	83.00	91.86	13.00
16	385.79	234.10	49.54	75.50	78.92	9.83	392.10	240.90	54.89	77.14	91.05	5.43
17	244.90	204.00	764.67	62.17	54.20	322.00	249.67	209.80	771.03	66.29	64.57	310.71
18	389.97	318.40	706.11	65.50	56.78	357.50	394.28	323.40	711.39	63.00	62.43	342.57
19	601.81	386.60	42.80	84.17	94.76	40.33	607.33	392.60	47.01	85.00	101.32	38.29
20	199.16	265.40	420.99	52.50	38.42	284.17	203.55	270.80	425.92	60.14	46.52	279.57
21	174.30	357.80	77.13	66.67	69.88	188.83	179.38	364.90	81.62	62.43	69.54	190.43
22	577.72	422.50	49.99	72.50	85.50	46.17	583.19	428.50	53.70	79.29	93.64	50.57
23	781.73	557.10	1010.82	80.17	75.93	365.83	790.41	565.60	1020.46	79.29	63.02	358.86
24	770.86	606.60	164.88	77.50	58.56	47.50	773.39	611.10	168.50	79.00	73.20	51.43
25	279.60	420.30	356.39	60.17	40.90	232.50	285.66	428.00	363.07	60.71	41.95	237.86
26	386.74	469.70	1104.73	75.17	57.75	295.00	390.95	475.50	1109.04	77.86	69.25	298.29
27	991.40	844.00	894.23	81.00	54.22	380.83	995.20	849.50	899.16	78.29	55.88	370.43
28	272.45	559.00	66.25	76.67	95.12	N/A	278.72	568.00	72.23	74.00	72.94	187.14
29	957.74	948.80	386.90	76.17	48.42	55.83	963.83	956.20	392.42	76.71	44.94	59.29
30	909.49	942.80	95.64	79.00	84.88	87.00	912.69	946.80	100.76	77.14	101.34	89.00
31	1134.49	1109.00	1201.68	82.83	42.70	382.50	1140.21	1117.00	1207.43	81.43	46.06	365.29
32	1054.31	1089.00	588.07	82.33	47.62	70.83	1059.86	1097.00	593.89	79.00	40.18	48.00
33	926.32	979.50	100.94	78.00	91.94	106.67	931.38	986.20	105.40	79.57	96.27	91.43
34	471.99	928.90	186.70	82.83	70.23	180.00	479.58	939.80	194.29	84.86	75.31	199.29
35	1164.59	1403.00	996.03	89.17	7.83	51.17	1172.12	1413.00	1004.82	88.57	8.15	76.43
36	1014.08	1499.00	603.34	84.83	42.73	156.17	1021.02	1508.00	608.72	91.57	32.91	167.43
37	1176.79	1519.00	153.58	91.33	83.09	102.00	1186.78	1531.00	162.75	91.43	83.53	101.86
38	1372.22	1668.00	1062.09	92.67	9.02	101.00	1377.69	1674.00	1069.43	91.86	10.09	88.86
39	1170.06	1626.00	195.66	93.83	82.02	105.67	1173.43	1632.00	195.67	93.86	92.63	122.86
40	1553.40	1840.00	1643.56	99.50	3.35	355.00	1559.29	1849.00	1647.77	100.00	2.48	362.50

Table 6: Phase 9 & 10. Physical measurements vs. perceptual estimates.

Color	Phase 11						Phase 12					
	X	Y[cd/m ²]	Z	J	M	H	X	Y[cd/m ²]	Z	J	M	H
1	49.58	47.11	29.37	14.83	23.00	4.17	64.47	68.09	43.88	9.17	9.78	17.50
2	37.73	45.13	29.66	6.17	3.68	133.33	52.69	66.23	44.25	2.50	2.18	N/A
3	91.19	65.99	337.87	39.00	72.28	320.83	106.44	87.19	354.74	32.17	70.68	301.67
4	54.88	64.50	31.39	12.83	21.77	132.83	70.16	85.91	46.17	6.33	7.19	106.00
5	134.07	96.98	37.30	42.00	52.69	12.33	149.33	118.10	51.59	35.17	50.71	8.00
6	174.42	110.20	571.64	44.17	66.81	325.33	190.11	131.60	589.65	39.17	75.21	326.33
7	47.75	73.75	46.27	20.83	30.61	206.67	62.76	95.13	60.95	21.67	35.23	202.50
8	216.29	138.90	926.17	60.50	86.00	300.83	232.62	160.80	946.58	53.00	75.73	302.50
9	67.25	121.90	36.76	45.17	58.39	198.33	82.17	143.30	51.11	33.67	48.20	192.50
10	288.80	188.00	48.19	53.67	68.32	7.50	304.82	209.60	62.67	49.50	71.04	10.17
11	119.97	134.20	43.00	39.33	37.62	135.67	135.93	156.40	57.56	28.00	30.11	113.83
12	96.10	184.40	43.07	53.83	66.32	192.83	111.05	206.00	57.49	50.17	67.57	192.33
13	197.85	156.30	150.70	51.00	53.14	367.17	214.36	178.50	166.53	40.33	52.44	364.50
14	180.39	260.10	357.36	47.67	50.74	271.67	196.07	282.30	373.73	48.67	48.16	269.33
15	529.04	330.10	56.79	80.17	86.06	4.50	545.97	352.40	71.90	68.50	77.26	3.67
16	404.24	256.10	67.63	66.00	71.27	4.67	420.25	277.80	81.63	55.50	73.06	2.50
17	261.43	224.70	780.50	63.17	64.33	317.00	278.14	247.50	800.73	56.17	59.00	330.17
18	407.67	339.80	724.80	61.83	59.50	345.00	425.59	363.50	744.02	56.67	63.01	350.00
19	620.04	408.50	60.21	70.50	75.24	36.50	634.39	429.30	73.83	66.50	72.85	24.67
20	216.13	286.60	438.18	54.50	45.12	293.17	232.35	309.30	455.13	49.00	47.12	276.00
21	192.17	380.60	94.48	63.83	57.59	191.67	207.44	403.30	108.79	59.83	63.42	192.50
22	593.58	442.40	66.71	63.83	68.51	50.00	611.09	465.50	81.66	59.17	62.76	40.67
23	801.97	580.70	1032.89	77.33	57.85	355.00	816.35	601.60	1047.62	63.67	63.67	358.33
24	785.28	625.90	181.03	70.33	59.68	71.00	800.25	647.70	195.95	63.17	55.26	44.83
25	297.68	443.00	374.63	61.33	41.39	225.83	315.06	467.60	392.51	54.33	47.49	247.50
26	403.71	491.10	1118.72	73.67	54.82	300.00	419.86	515.10	1135.37	68.00	56.71	295.00
27	1009.22	866.40	913.82	75.17	45.63	371.33	1025.71	890.70	932.00	69.00	41.73	367.17
28	290.08	581.30	84.08	71.33	76.95	186.33	307.56	606.00	100.16	71.17	70.58	185.83
29	973.73	969.50	404.23	70.50	46.23	61.33	991.90	996.00	421.38	69.00	42.27	58.00
30	923.96	961.50	111.43	68.33	82.90	87.50	939.85	984.60	128.08	60.83	63.02	86.00
31	1151.32	1131.00	1220.32	78.50	35.66	363.50	1170.49	1158.00	1241.17	68.33	44.30	363.17
32	1071.39	1111.00	606.96	75.33	35.55	59.67	1086.37	1133.00	623.79	69.17	41.58	56.00
33	943.27	1001.00	117.52	75.83	80.91	88.33	958.30	1024.00	130.35	61.67	76.98	85.83
34	492.78	954.60	207.90	79.17	54.22	203.33	511.26	983.20	222.32	71.17	65.95	185.83
35	1183.60	1427.00	1016.75	77.83	11.72	94.17	1203.23	1454.00	1035.93	71.67	17.30	92.17
36	1029.10	1518.00	619.36	82.50	36.14	178.50	1052.80	1551.00	637.58	76.67	34.76	173.33
37	1196.33	1545.00	171.57	89.33	70.59	117.83	1216.31	1574.00	187.93	70.83	71.30	115.50
38	1387.22	1687.00	1077.89	88.00	11.94	88.33	1411.07	1722.00	1103.10	78.00	22.07	91.50
39	1186.33	1646.00	211.88	92.33	67.91	104.33	1205.44	1675.00	227.17	74.00	51.51	123.00
40	1568.55	1861.00	1656.54	98.17	2.34	N/A	1586.78	1889.00	1672.76	87.00	14.33	361.33

Table 7: Phase 11 & 12. Physical measurements vs. perceptual estimates.

Color	Phase 13						Phase 14					
	X	Y[cd/m ²]	Z	J	M	H	X	Y[cd/m ²]	Z	J	M	H
1	18.12	15.64	12.15	17.50	43.53	17.00	28.46	21.50	3.35	25.67	57.75	42.83
2	12.63	14.82	12.55	9.50	12.15	105.00	17.35	17.63	3.89	10.17	9.15	100.00
3	56.36	28.96	254.19	42.83	91.79	300.83	22.33	23.80	62.90	39.17	83.97	300.83
4	20.63	24.11	13.04	25.83	37.65	131.17	30.84	29.89	4.38	22.17	28.94	113.33
5	59.75	40.71	18.30	46.33	74.97	10.17	102.99	65.38	4.78	50.00	69.31	11.83
6	109.20	53.76	435.71	50.67	85.90	327.83	64.61	52.80	106.70	55.17	87.03	338.33
7	17.93	29.17	22.82	32.67	50.53	193.33	19.32	30.00	7.65	28.83	45.20	198.67
8	148.27	72.66	701.15	64.33	89.17	301.67	50.89	56.43	171.21	64.17	101.03	299.67
9	28.21	55.57	16.58	49.33	77.53	191.67	32.40	55.43	7.58	52.33	64.68	195.83
10	134.69	85.58	27.14	57.17	86.24	3.00	233.44	141.60	6.84	61.00	83.11	10.17
11	53.16	60.29	21.40	48.00	57.18	141.17	82.19	75.65	7.80	45.67	49.11	122.50
12	43.33	89.14	20.90	55.33	75.06	189.17	49.35	87.51	10.63	57.33	65.23	187.50
13	96.94	71.49	106.11	56.00	41.31	365.83	139.25	100.30	27.98	59.33	43.53	378.33
14	103.47	133.70	267.55	55.50	50.30	257.50	75.50	124.40	72.85	57.33	61.96	264.83
15	243.20	151.00	32.47	71.50	90.61	9.17	418.33	248.60	7.15	81.33	100.21	37.83
16	187.93	117.10	40.50	68.83	75.71	5.83	322.52	193.70	10.00	68.67	84.98	10.67
17	163.13	115.90	592.40	65.17	60.39	320.17	102.69	111.90	148.02	55.50	56.06	317.00
18	232.08	174.30	551.84	61.50	67.27	350.00	232.54	200.00	138.40	60.33	53.35	356.67
19	283.22	187.70	34.20	74.33	91.78	39.17	483.43	298.80	9.50	79.83	94.36	45.00
20	124.58	147.60	328.79	57.67	58.32	269.00	95.33	140.90	88.35	56.67	42.94	267.83
21	96.41	198.20	57.50	62.33	55.87	205.83	103.49	188.20	26.16	61.67	58.29	190.00
22	274.80	209.40	39.03	70.33	91.59	70.00	460.25	309.70	12.52	78.33	105.61	53.33
23	426.50	290.50	774.27	73.83	73.88	358.67	503.33	368.20	190.79	75.33	81.58	373.67
24	369.77	303.10	125.60	67.17	66.80	46.67	579.82	415.40	37.59	73.17	71.43	47.50
25	163.89	233.00	278.67	59.67	35.87	213.00	158.49	227.70	80.50	64.17	41.15	238.67
26	252.86	265.20	837.77	69.67	58.77	298.17	147.83	234.80	214.67	71.50	62.48	294.17
27	523.31	442.30	690.95	70.00	55.15	370.33	657.96	533.90	177.46	80.17	52.79	374.50
28	147.56	308.70	48.90	70.83	99.22	185.33	167.00	292.50	29.23	68.00	101.57	192.17
29	482.56	496.10	298.96	71.50	47.56	57.00	679.57	591.10	90.37	74.67	38.93	57.50
30	440.94	489.00	69.24	70.33	92.85	95.00	670.89	587.80	33.47	75.83	89.74	86.33
31	609.87	588.60	907.43	76.67	33.96	365.00	710.51	656.50	235.77	76.33	31.41	379.17
32	539.69	571.10	451.72	71.67	41.21	56.67	715.61	655.60	129.02	77.00	34.59	55.33
33	449.89	508.50	71.58	71.67	84.80	90.33	678.30	603.80	36.53	72.83	70.57	89.83
34	258.43	512.40	139.13	79.50	73.67	184.00	281.14	479.90	61.97	76.17	65.58	182.33
35	624.66	750.10	755.00	88.17	4.65	106.00	729.03	787.80	211.55	86.67	8.50	64.17
36	541.65	804.90	455.34	85.00	26.66	178.83	639.23	809.50	148.55	80.17	34.96	160.83
37	583.99	802.70	107.27	82.83	96.21	105.00	821.76	868.80	58.23	81.83	81.27	102.33
38	727.91	889.00	805.43	95.83	6.40	88.67	863.08	933.40	230.01	91.50	10.23	59.17
39	582.57	856.10	132.44	90.50	80.71	107.17	796.50	902.10	70.22	81.50	66.96	106.67
40	831.79	977.10	1181.01	100.00	2.64	390.00	919.57	1004.00	322.02	99.17	3.23	N/A

Table 8: Phase 13 & 14. Physical measurements vs. perceptual estimates.

Color	Phase 15						Phase 16					
	X	Y[cd/m ²]	Z	J	M	H	X	Y[cd/m ²]	Z	J	M	H
1	41.90	38.26	21.58	22.50	35.59	398.00	12.36	12.02	6.71	6.67	26.18	395.00
2	30.09	36.34	21.96	7.17	6.12	166.67	14.21	15.49	6.33	6.83	25.88	87.50
3	83.74	57.29	330.69	45.83	90.83	301.83	51.61	28.08	234.05	21.33	101.00	301.17
4	47.43	55.88	23.82	17.67	20.02	114.50	159.01	71.32	13.59	33.33	117.14	2.50
5	126.35	88.11	29.47	48.00	64.74	7.00	511.93	135.80	2169.70	40.00	94.91	327.67
6	166.52	101.17	563.47	56.33	93.13	328.00	418.63	212.50	12.62	48.50	121.52	399.50
7	40.19	65.07	38.63	25.33	57.90	200.50	585.45	233.60	2808.28	48.67	89.46	305.33
8	209.69	130.72	920.62	64.00	91.60	299.83	264.38	256.10	6.70	38.17	54.78	98.33
9	59.78	113.34	29.10	49.50	78.23	213.17	119.30	325.00	99.72	44.67	94.71	195.67
10	281.38	179.36	40.56	57.00	80.12	3.33	957.14	609.00	74.48	64.17	85.15	12.83
11	112.75	125.92	35.28	42.50	47.60	130.33	211.41	708.70	39.54	58.33	96.46	199.17
12	88.44	175.44	35.56	57.83	81.15	209.00	657.73	808.80	138.87	43.33	68.82	148.67
13	190.25	147.50	143.06	53.17	58.10	368.83	965.47	890.40	904.20	53.50	66.49	360.00
14	172.98	251.26	350.88	51.50	51.35	272.83	1431.62	928.80	464.40	60.67	91.11	5.17
15	522.12	321.78	49.44	80.83	100.67	10.83	439.37	972.10	1256.21	58.50	78.05	247.50
16	396.83	247.60	59.74	64.67	66.22	7.50	1128.14	1053.00	2896.00	62.33	60.79	309.83
17	254.56	216.58	774.80	60.50	62.18	318.00	337.86	1084.00	63.89	60.00	97.23	196.67
18	400.00	331.02	717.04	59.50	63.74	348.33	1548.81	1519.00	2556.04	60.17	47.17	334.17
19	612.21	399.60	52.22	79.67	94.68	40.50	2090.34	1573.00	16.19	63.33	105.80	51.17
20	208.73	277.80	430.64	54.33	42.87	286.33	2207.29	1598.00	3118.45	61.50	79.90	370.33
21	184.48	371.60	86.82	63.67	69.23	187.50	2223.13	1882.00	34.78	64.17	95.39	52.00
22	587.87	435.24	59.45	70.00	92.74	50.50	1498.01	2092.00	1956.12	61.50	44.62	253.33
23	793.36	571.04	1023.32	72.33	69.33	365.50	2477.33	2169.00	697.35	66.83	57.64	39.17
24	778.26	617.60	173.40	76.33	69.86	48.50	1096.26	2361.00	320.34	69.17	82.15	190.83
25	290.53	434.64	367.67	55.00	45.46	240.83	2971.35	2735.00	2586.56	69.67	51.42	387.83
26	396.47	482.60	1114.08	75.00	64.08	295.83	1996.49	2798.00	3759.46	73.00	66.34	288.50
27	1001.32	857.46	905.04	72.83	63.14	378.83	1999.92	2992.00	1854.77	73.33	44.31	231.00
28	283.60	574.08	76.99	81.83	88.61	186.67	3451.11	3706.00	1282.88	74.33	30.81	59.33
29	967.56	962.04	396.56	67.33	55.46	59.00	3511.12	3739.00	3300.11	78.50	20.09	393.33
30	917.54	953.92	105.41	69.83	88.32	86.67	3543.47	3909.00	53.29	77.17	107.60	92.00
31	1144.50	1122.80	1212.58	73.50	35.22	378.33	2040.48	3922.00	247.14	76.67	101.35	190.33
32	1063.12	1101.20	597.83	71.33	33.85	54.17	3806.31	4037.00	1768.59	77.67	32.40	53.33
33	936.05	992.68	109.94	74.50	86.41	93.83	3336.75	4281.00	2187.57	85.17	16.74	197.50
34	484.57	945.68	198.95	78.17	76.84	186.17	3723.35	4348.00	104.65	79.17	110.79	94.50
35	1176.26	1418.20	1008.69	87.00	7.88	97.50	2496.79	4348.00	466.46	77.67	78.83	172.50
36	1024.12	1512.40	612.35	81.67	42.10	166.17	3595.13	5319.00	1464.41	81.17	50.63	184.17
37	1190.34	1537.40	165.43	85.50	96.93	103.33	4016.11	5489.00	172.26	84.17	102.45	105.00
38	1382.70	1681.80	1073.19	91.00	8.05	87.00	4494.54	5512.00	2632.77	87.17	17.47	101.67
39	1179.99	1639.60	204.01	86.33	80.22	107.83	4762.91	5719.00	4159.67	96.50	2.99	N/A
40	1561.99	1852.60	1651.22	99.50	4.07	380.00	4116.73	5933.00	340.81	83.67	108.50	118.00

Table 9: Phase 15 & 16. Physical measurements vs. perceptual estimates.

Color	Phase 17						Phase 18					
	X	Y[cd/m ²]	Z	J	M	H	X	Y[cd/m ²]	Z	J	M	H
1	31.89	36.11	20.98	2.00	4.42	380.00	24.34	24.33	13.60	3.00	22.70	0.40
2	34.40	40.08	21.13	2.17	5.55	N/A	28.45	31.05	13.62	6.50	9.44	93.80
3	73.95	54.12	257.68	15.83	94.28	303.33	109.33	60.53	504.19	24.17	102.26	302.17
4	184.53	98.45	29.46	22.83	102.07	398.83	344.91	155.20	30.85	40.83	117.41	394.17
5	543.14	162.50	2238.20	32.00	91.97	299.33	1088.84	292.20	4631.31	44.50	94.88	329.67
6	450.86	242.70	27.47	38.83	101.58	398.00	898.29	451.00	25.71	56.17	120.77	N/A
7	623.63	267.00	2907.38	41.17	86.49	300.00	1237.86	503.00	5962.05	52.50	97.53	301.67
8	296.72	292.80	22.27	37.33	60.28	102.50	535.36	517.60	16.90	44.33	59.71	95.33
9	141.17	356.20	115.61	41.33	79.43	199.17	243.90	671.70	214.07	49.67	80.84	198.33
10	1006.43	653.20	92.51	55.67	76.72	10.17	2031.34	1278.00	160.66	61.17	93.70	11.33
11	241.28	763.10	57.11	55.50	86.23	213.33	439.42	1477.00	82.77	66.33	96.45	194.17
12	695.66	855.60	157.55	46.67	48.92	127.50	1352.83	1664.00	300.56	51.50	59.05	139.17
13	1026.10	953.90	955.07	50.33	54.12	356.67	2017.78	1849.00	1933.10	61.17	57.21	358.33
14	1510.38	993.00	501.16	61.17	78.35	2.83	3005.41	1926.00	992.92	68.17	84.73	399.17
15	472.89	1029.00	1309.59	53.00	74.05	264.33	927.66	2052.00	2704.55	62.67	81.95	293.83
16	1185.02	1115.00	3004.45	62.67	63.30	308.00	2369.41	2207.00	6178.95	70.00	58.46	310.33
17	362.11	1129.00	77.16	58.17	83.18	211.67	682.56	2210.00	135.66	69.67	99.43	211.33
18	1621.87	1596.00	2662.74	61.83	51.85	339.50	3249.59	3171.00	5487.03	69.17	58.52	341.00
19	2189.50	1655.00	28.66	68.67	109.71	50.00	4318.54	3210.00	27.96	76.33	117.69	55.33
20	2296.66	1676.00	3235.94	64.00	74.84	370.83	4625.45	3326.00	6649.08	68.33	87.31	370.33
21	2328.70	1978.00	44.38	66.00	92.75	50.00	4597.17	3850.00	72.42	66.50	104.67	51.67
22	1563.74	2183.00	2029.92	62.50	50.43	265.67	3082.79	4321.00	4168.25	73.17	43.88	271.00
23	2574.96	2262.00	731.73	68.83	56.87	33.67	5121.67	4448.00	1492.25	72.00	64.54	29.50
24	1154.15	2475.00	339.74	68.17	81.38	190.00	2231.99	4864.00	686.41	73.50	90.94	191.67
25	3091.92	2858.00	2681.91	67.83	59.53	374.17	6157.79	5637.00	5507.23	73.17	58.26	10.83
26	2094.67	2927.00	3899.40	70.50	54.51	294.17	4145.83	5802.00	8015.02	73.67	56.21	295.83
27	2083.35	3114.00	1920.36	72.17	40.21	223.50	4098.75	6146.00	3942.69	76.00	33.53	232.00
28	3600.76	3865.00	1342.36	80.33	27.05	55.00	7106.92	7600.00	2716.28	84.50	27.69	57.83
29	3635.44	3877.00	3417.92	76.67	26.87	384.50	7254.22	7705.00	7029.93	88.83	24.10	384.50
30	2109.65	4042.00	272.38	78.33	90.55	175.50	7217.23	7933.00	111.41	81.83	118.85	90.67
31	3670.72	4054.00	65.44	75.33	102.33	88.67	4139.24	8022.00	535.82	84.17	111.77	173.33
32	3981.29	4230.00	1857.74	74.83	34.38	53.00	7771.79	8212.00	3756.60	84.00	30.52	43.17
33	3437.79	4418.00	2249.42	80.33	17.46	155.00	7543.19	8791.00	236.97	82.33	125.17	86.67
34	3842.10	4495.00	120.09	75.00	96.35	93.00	6845.62	8796.00	4653.72	92.00	9.57	161.67
35	2596.52	4523.00	485.99	79.17	79.81	175.83	5157.02	9056.00	1017.39	79.00	84.54	173.17
36	3767.22	5573.00	1544.55	84.50	42.95	176.67	7377.39	10950.00	3168.49	85.17	40.51	177.50
37	4644.97	5701.00	2723.72	88.00	18.96	92.17	9256.02	11340.00	5617.57	93.00	12.21	80.00
38	4181.37	5707.00	201.80	86.67	97.32	102.50	8294.38	11350.00	366.19	85.17	113.10	101.67
39	4942.49	5924.00	4327.15	96.67	2.35	N/A	9756.02	11660.00	8853.97	96.83	2.67	N/A
40	4274.83	6157.00	360.46	81.67	93.56	109.17	8441.72	12200.00	724.31	88.83	120.79	105.00

Table 10: Phase 17 & 18. Physical measurements vs. perceptual estimates.

Phase 19						
Color	X	Y [cd/m ²]	Z	J	M	H
1	64.08	73.06	44.65	1.83	4.16	N/A
2	71.30	83.41	46.37	2.50	4.16	N/A
3	152.66	111.80	546.27	15.00	81.23	302.50
4	388.52	205.70	61.51	33.83	98.89	395.83
5	1131.57	340.70	4677.55	39.17	94.96	328.83
6	954.02	510.10	60.85	45.17	110.92	398.33
7	1302.90	561.80	6104.10	47.33	98.38	303.33
8	583.15	575.20	45.51	43.67	56.54	105.00
9	287.49	731.40	249.81	49.67	84.06	215.83
10	2091.48	1341.00	194.78	59.67	86.80	10.17
11	481.80	1540.00	113.83	55.50	90.28	198.83
12	1401.97	1725.00	338.97	53.17	54.50	131.67
13	2090.73	1930.00	1999.23	60.33	55.91	358.33
14	3088.20	2005.00	1043.93	65.17	75.58	2.17
15	973.04	2114.00	2764.06	55.00	77.41	285.50
16	2438.32	2284.00	6300.84	70.33	59.85	309.50
17	732.90	2286.00	167.61	60.67	97.59	192.50
18	3328.01	3255.00	5585.21	67.50	52.55	336.00
19	4394.58	3288.00	55.72	70.33	107.84	48.83
20	4719.83	3412.00	6780.75	64.00	80.81	386.67
21	4696.31	3954.00	103.29	75.00	105.80	50.00
22	3164.93	4429.00	4264.17	68.00	49.00	258.33
23	5199.51	4531.00	1523.84	71.17	68.21	28.00
24	2308.14	4988.00	732.18	69.50	87.77	223.33
25	6271.83	5753.00	5622.41	71.33	57.34	369.17
26	4267.48	5959.00	8199.61	76.83	64.17	295.17
27	4220.96	6311.00	4063.33	72.17	45.27	254.50
28	7198.48	7710.00	2791.25	82.67	41.86	59.17
29	7367.16	7823.00	7154.88	83.83	26.33	378.00
30	7378.83	8125.00	139.22	79.17	108.95	89.83
31	4219.20	8156.00	579.06	79.17	91.91	175.00
32	7984.78	8454.00	3873.57	81.17	43.10	52.50
33	6935.08	8903.00	4746.89	90.00	15.50	166.00
34	7696.87	8989.00	248.94	79.33	109.86	91.67
35	5183.23	9081.00	1057.18	80.33	79.04	181.33
36	7504.09	11150.00	3230.11	83.83	56.69	184.00
37	9299.93	11400.00	5682.85	93.33	18.16	89.17
38	8399.19	11490.00	418.34	85.00	99.65	101.67
39	9947.84	11880.00	9037.32	96.33	2.76	N/A
40	8604.66	12420.00	764.81	86.67	103.85	117.50

Table 11: Phase 19. Physical measurements vs. perceptual estimates.