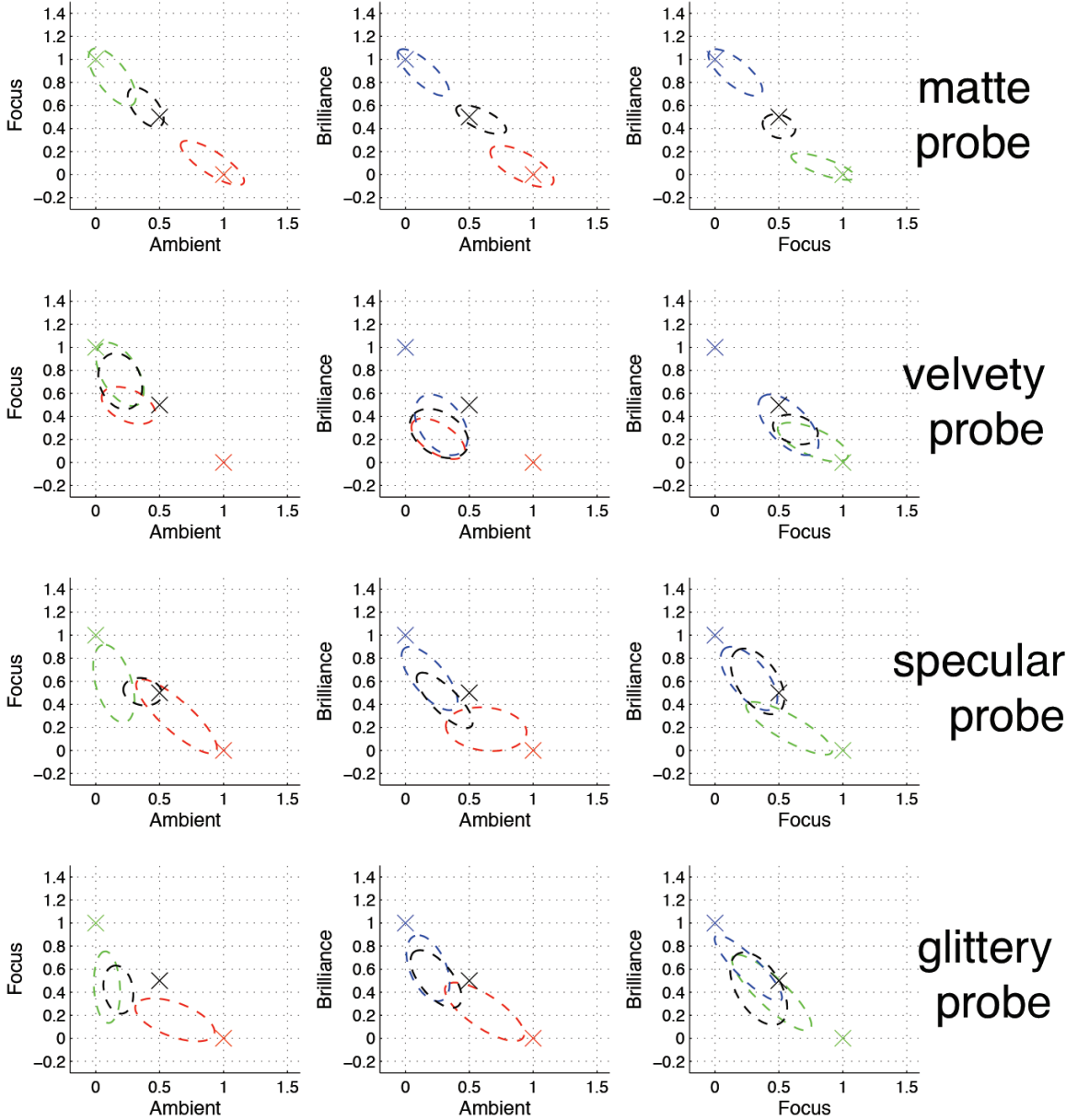
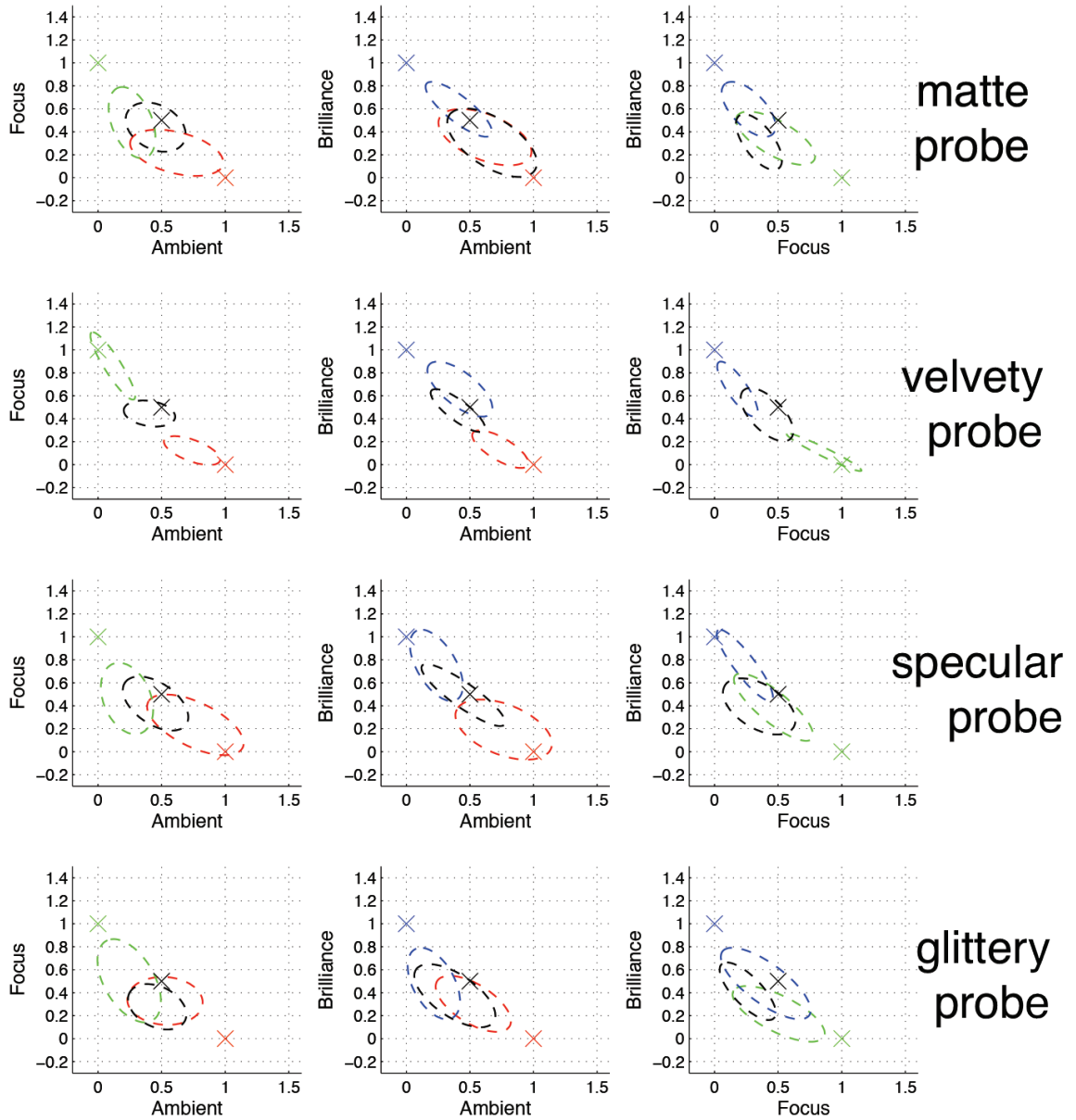


Supplements

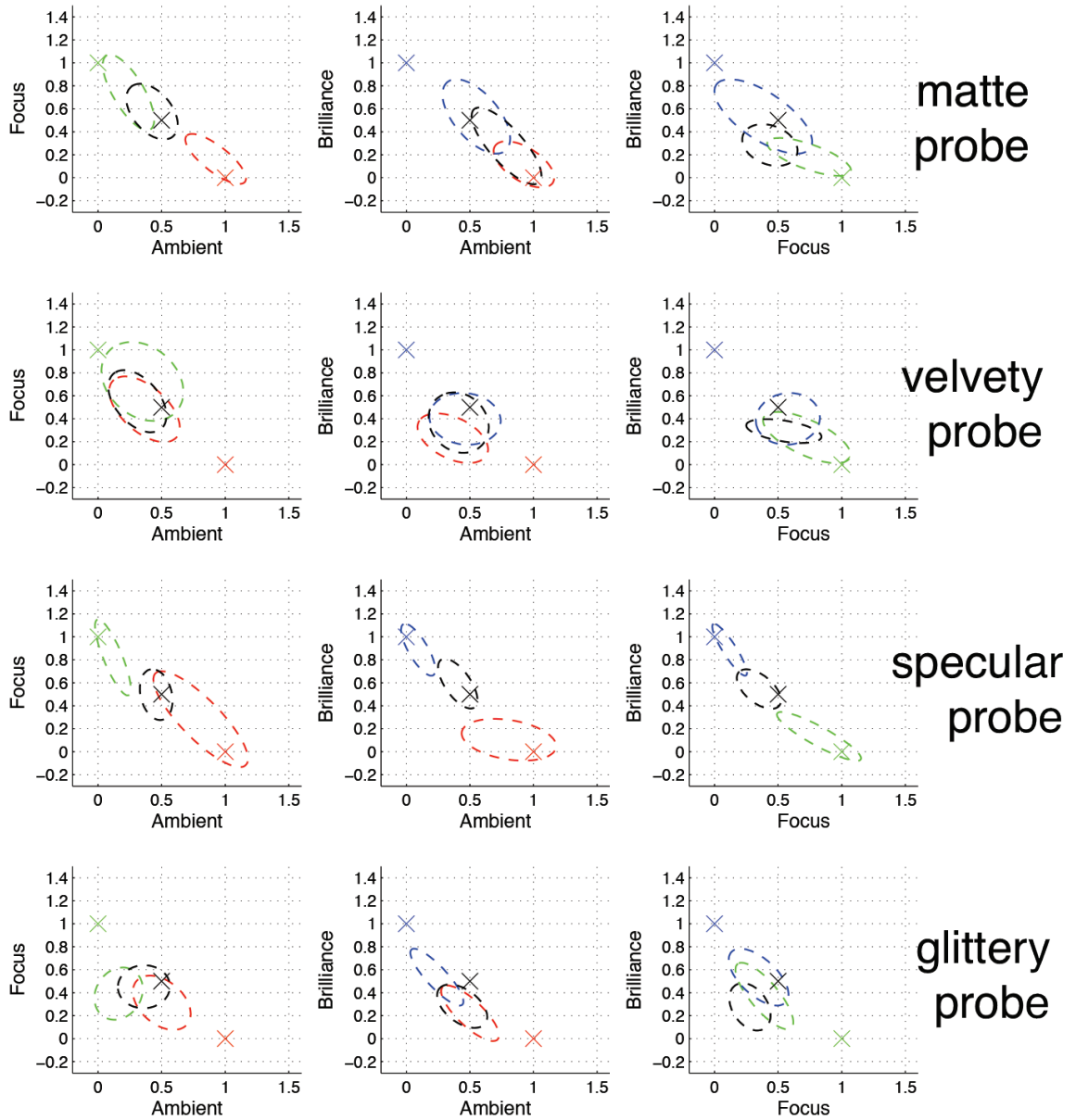
A) matte stimuli



B) velvety stimuli



C) specular stimuli



D) glittery stimuli

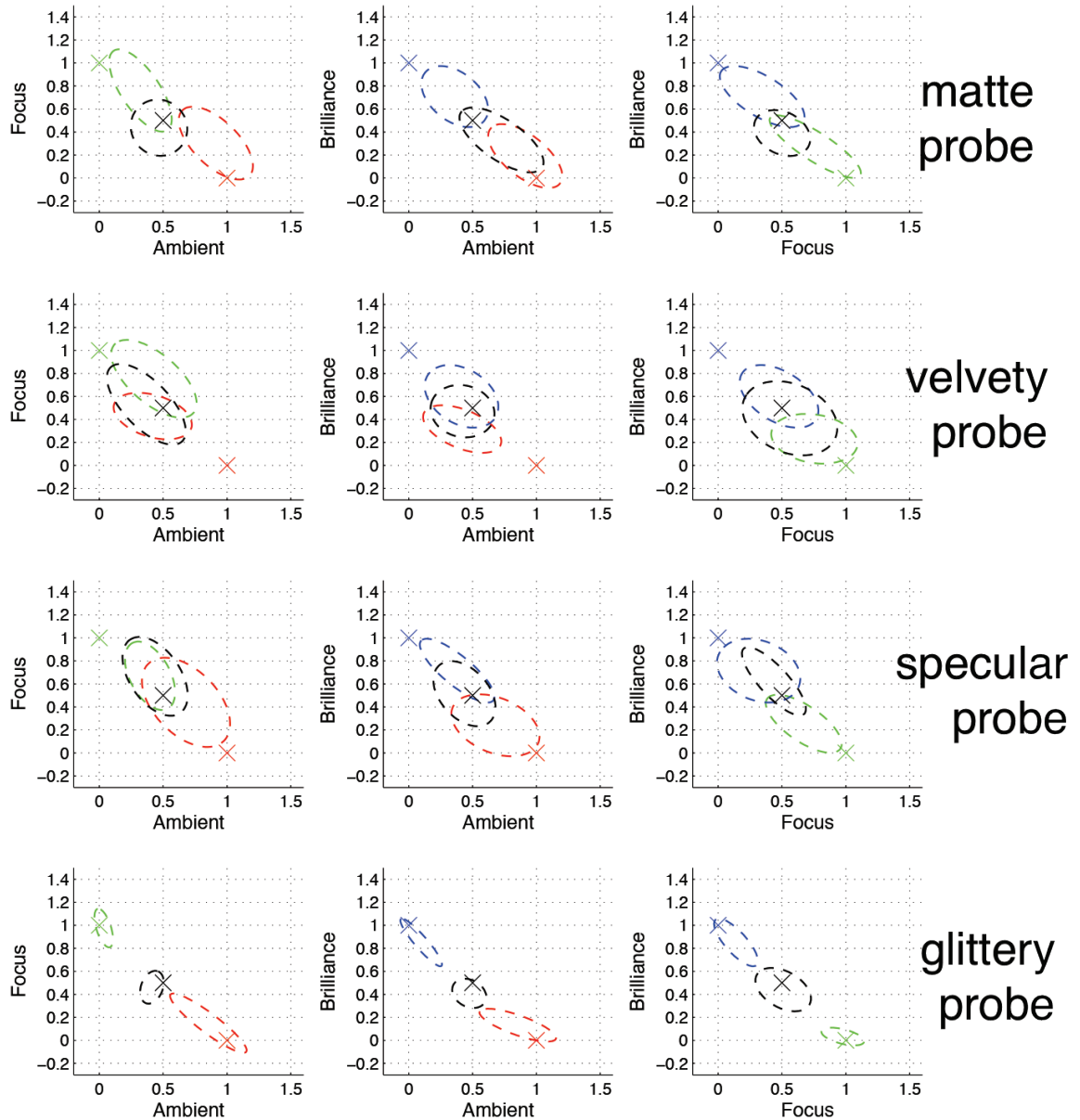


Figure S1. The bivariate plots for combinations of canonical material modes in Experiment 1, with A) matte mode in the stimuli, B) velvety mode in the stimuli, C) specular mode in the stimuli, D) glittery mode in the stimuli. The subplots in each row are results from one of the four material modes in the probe, specifically matte, velvety, specular, and glittery from top to bottom, respectively. Different colors correspond to different lighting weight combinations in the stimuli, which are depicted by the crosses. The ellipses represent one standard deviation of bivariate normal distributions fitted to the data. Specifically, the red color corresponds to the stimuli in which only ambient light was presented, the green color corresponds to the stimuli in which only focus light was presented, the blue color corresponds to the stimuli in which only brilliance light was presented, and the black color corresponds to the stimuli when two lighting modes were optically mixed (each 50% in the mixture). The ellipses represent one standard deviation of bivariate normal distributions fitted to the data.

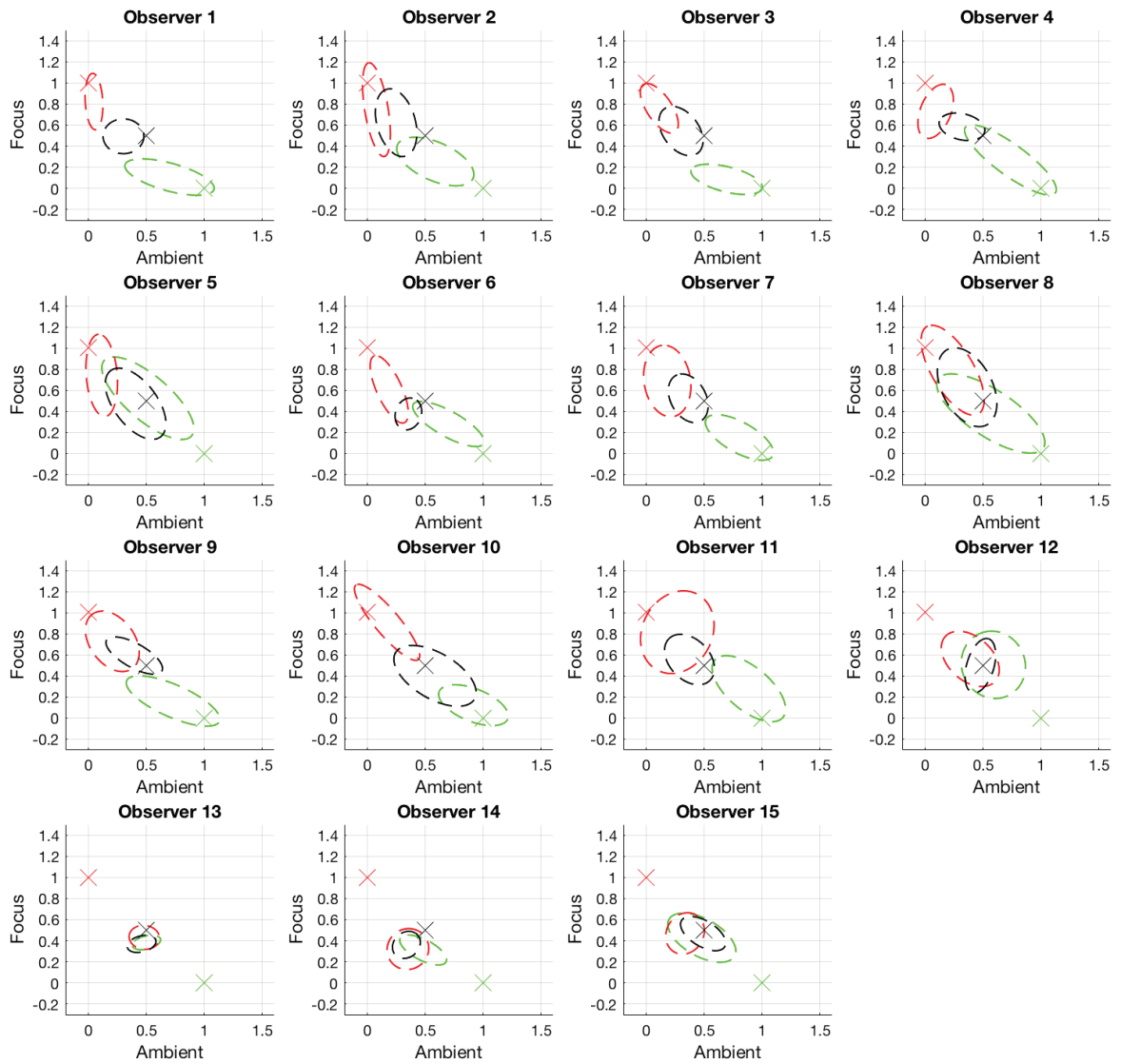


Figure S2. The bivariate plots for combination of ambient (green) and focus (red) lighting modes for each observer in Experiment 1. The subplots in each row are results for different lighting combinations. Different colors correspond to different lighting weight combinations in the stimuli, which are depicted by the crosses. The ellipses represent one standard deviation of bivariate normal distributions fitted to the data. Observer 1 to 4 are experienced observers. Observer 5 to 15 are inexperienced observers. Except for the last four observers, all performed well above chance if evaluated by the ratio r (Figure 4).

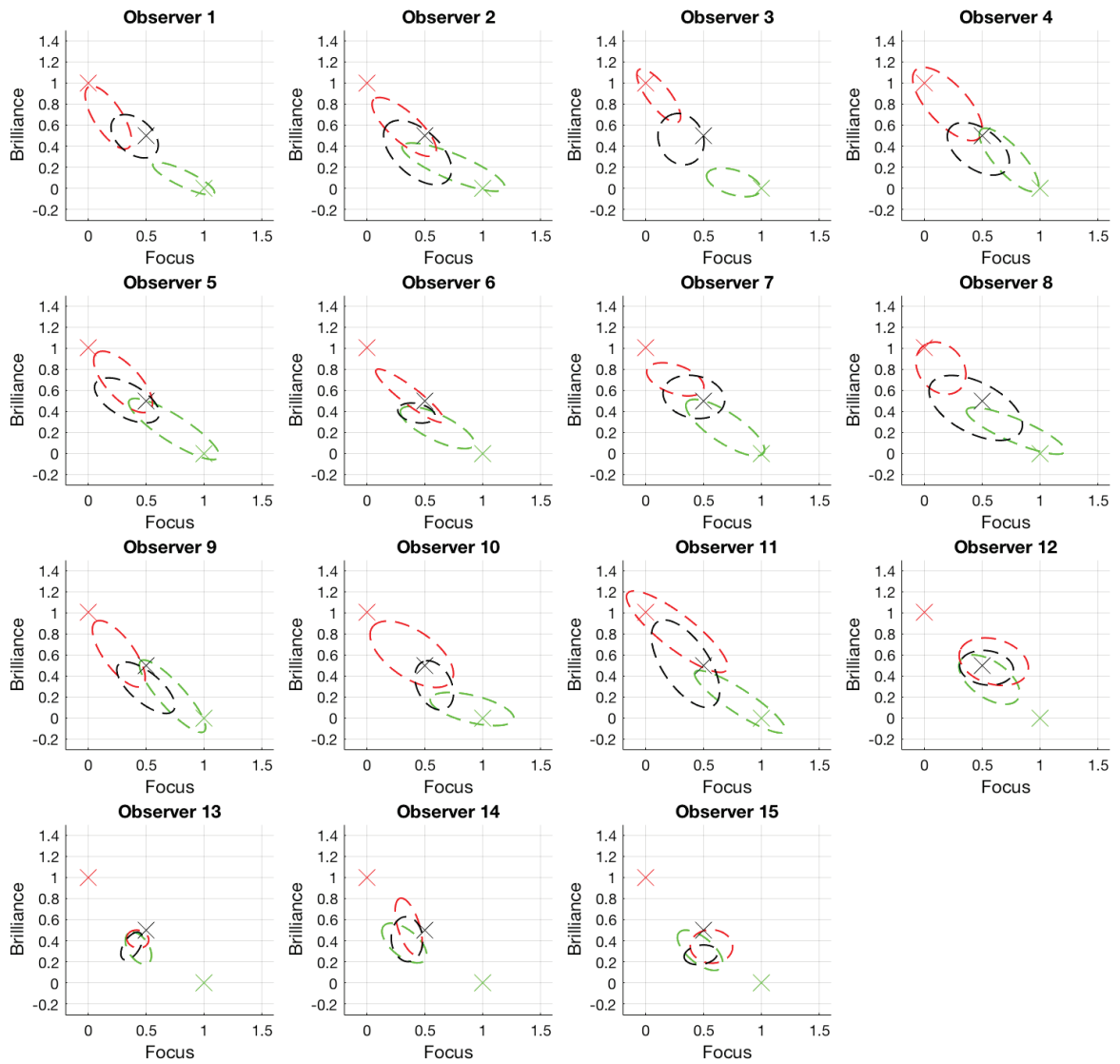


Figure S3. The bivariate plots for combination of focus (green) and brilliance (red) lighting modes for each observer in Experiment 1. The subplots in each row are results for different lighting combinations. Different colors correspond to different lighting weight combinations in the stimuli, which are depicted by the crosses. The ellipses represent one standard deviation of bivariate normal distributions fitted to the data. Observer 1 to 4 are experienced observers. Observer 5 to 15 are inexperienced observers. Except for the last four observers, all performed well above chance if evaluated by the ratio r (Figure 4).

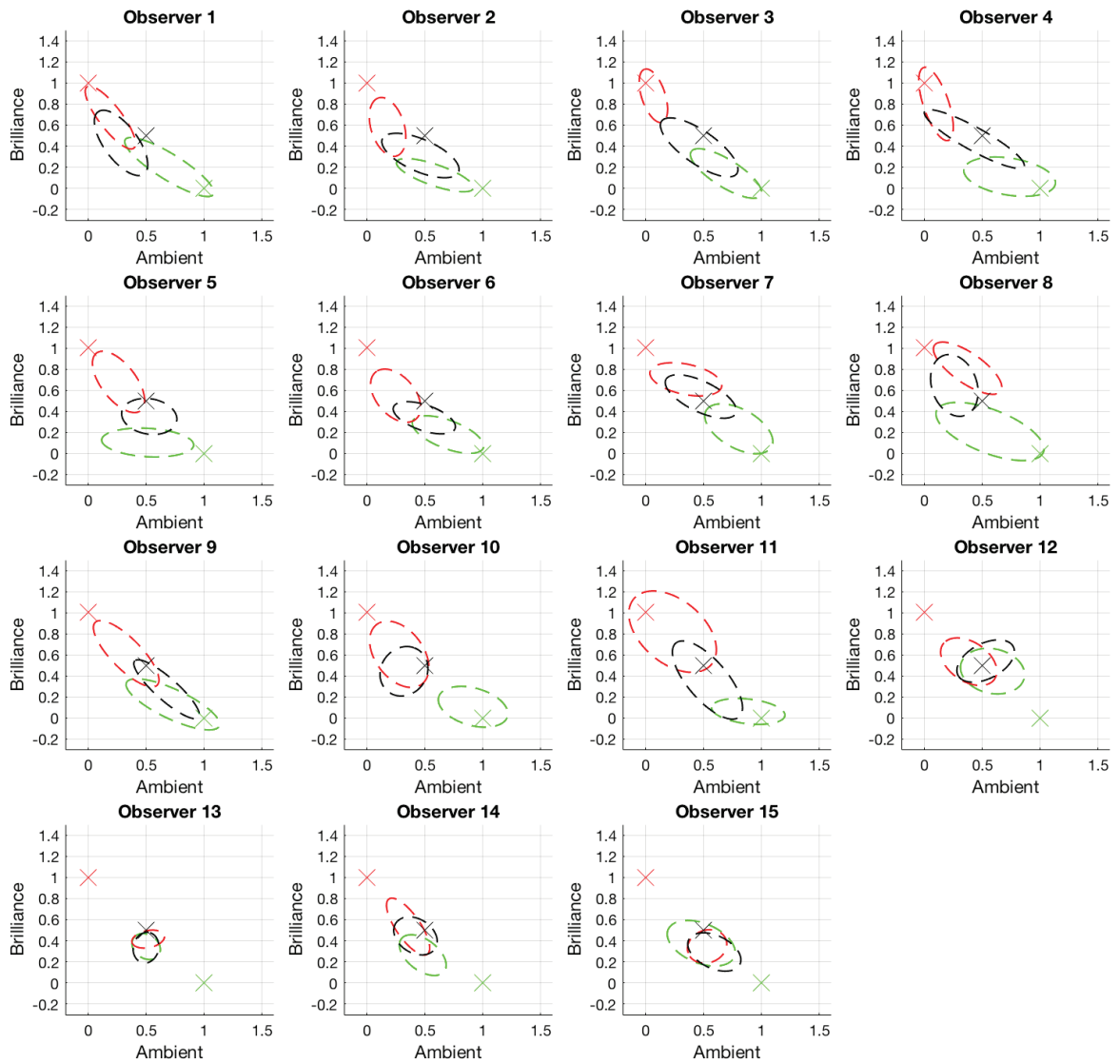
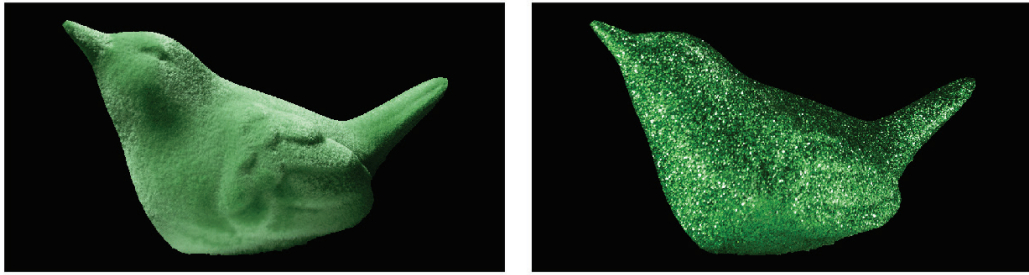


Figure S4. The bivariate plots for combination of ambient (green) and brilliance (red) lighting modes for each observer in Experiment 1. The subplots are results for different observer. Different colors correspond to different lighting weight combinations in the stimuli, which are depicted by the crosses. The ellipses represent one standard deviation of bivariate normal distributions fitted to the data. Observer 1 to 4 are experienced observers. Observer 5 to 15 are inexperienced observers. Except for the last four observers, all performed well above chance if evaluated by the ratio r (Figure4).

velvety-focus v.s. glittery-brilliance, accuracy = 0.94



matte-brilliance v.s. specular-focus, accuracy = 0.25

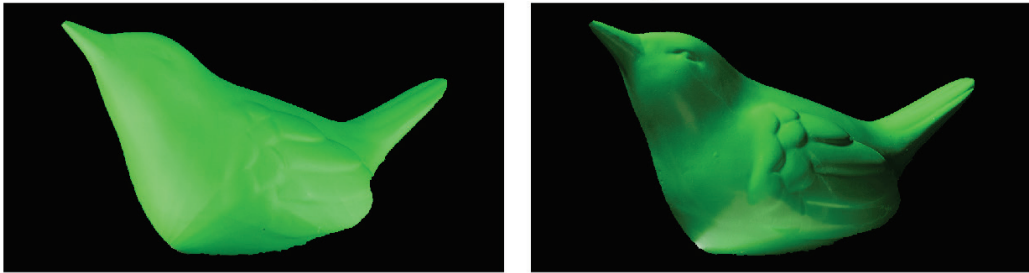


Figure S5. The examples of the pairs of stimulus images in the “different materials different lightings” category for which the observers were the most accurate (top) and the least accurate (bottom).

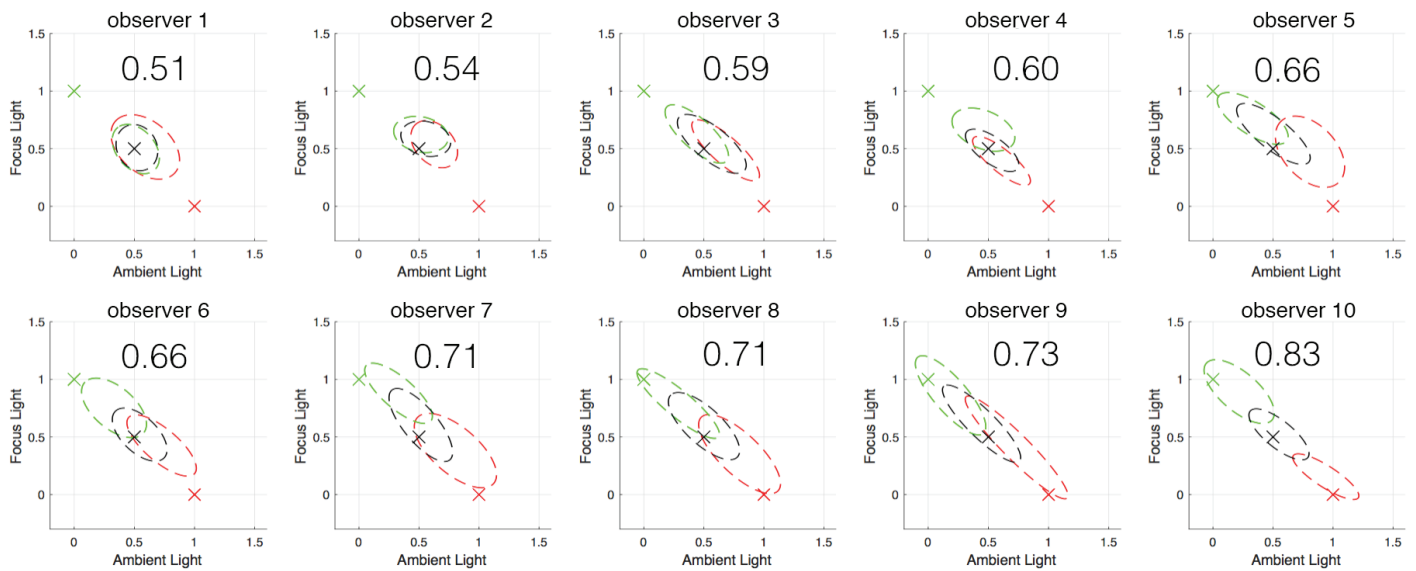


Figure S6. The bivariate plots for combination of ambient (red) and focus (green) lighting modes for each observer in Experiment 3, ordered according to performance measure r . The subplots are results for different observers. Different colors correspond to different lighting weight combinations in the stimuli, which are depicted by the crosses. The ellipses represent one standard deviation of bivariate normal distributions fitted to the data. The number in each subplot represents the ratio r for each observer (chance level 0.5).

Table S1. Individual results of the SDT data of Experiment 2 ($N = 8$).

Participant	Materials				Lightings			
	$z(Hit)$	$z(Fa)$	d'	c	$z(Hit)$	$z(Fa)$	d'	c
1	1.82	-1.06	2.87	-0.38	0.89	-0.89	1.77	0
2	1.09	-1.23	2.31	0.07	0.95	-0.55	1.49	-0.2
3	1.15	-1.09	2.24	-0.03	0.73	-0.89	1.61	0.08
4	1.12	-1.30	2.41	0.09	0.59	-1.53	2.12	0.47
5	1.49	-1.09	2.57	-0.2	0.95	-0.89	1.83	-0.03
6	1.16	-0.84	1.99	-0.16	1.03	-0.57	1.59	-0.23
7	1.09	-0.91	2	-0.09	1.19	-0.25	1.43	-0.47
8	1.18	-1.30	2.48	0.06	0.89	-1.81	2.7	0.46
<i>Mean</i>	1.26	-1.10	2.36	-0.08	0.90	-0.92	1.82	0.01
<i>SEM</i>	0.09	0.06	0.10	0.06	0.06	0.18	0.15	0.12

Table S2. Individual results of the SDT data of Experiment 3 ($N = 10$).

Participant	Discrimination								Matching
	Materials				Lightings				r
	$z(\text{Hit})$	$z(\text{Fa})$	d'	c	$z(\text{Hit})$	$z(\text{Fa})$	d'	c	
1	0.43	-1.53	1.96	0.55	0.33	-0.97	1.29	0.32	0.51
2	0.61	-0.89	1.5	0.14	0.05	-0.89	0.94	0.42	0.54
3	0.11	-1.15	1.25	0.52	0.32	0.16	0.16	-0.24	0.59
4	0.61	-1.39	1.99	0.39	0.89	-0.49	1.38	-0.2	0.6
5	0.82	-1.26	2.07	0.22	0.06	-0.68	0.73	0.31	0.66
6	0.21	-0.75	0.95	0.27	0.27	-0.55	0.81	0.14	0.66
7	1.54	-1.06	2.59	-0.24	1.06	-1.06	2.11	0	0.71
8	1.06	-1.26	2.31	0.1	0.97	-0.55	1.52	-0.21	0.71
9	0.68	-1.38	2.06	0.35	0.68	-0.44	1.11	-0.12	0.73
10	0.67	-1.15	1.82	0.24	0.97	-0.21	1.18	-0.38	0.83
<i>Mean</i>	0.67	-1.18	1.85	0.25	0.56	-0.57	1.12	0	0.65
<i>SEM</i>	0.13	0.08	0.16	0.07	0.13	0.12	0.16	0.09	0.03