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Impression Changes of a Live Stage by Lighting in Terms of a Virtual Pop Idol Show

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ABSTRACT

Stage lighting is one of the important factors which construct live performances on stages. In the present study, audio-visual stimuli with different areas of the stage illuminated by lights and the various colors of the lghting were prepared. In Experiment 1, the color of the lights was fixed at light blue, and the area of the lights illuminated on the stage was varied. The results showed that the wider the area illuminated, the more powerful and tighter it came to be perceived. In Experiment 2, nine different areas of lighting on the stage were selected from the areas used in Experiment 1, and twelve colors of the lights were selected from the color wheel. The results showed that the wider the area illuminated, the more powerful and tighter it came to be perceived. Moreover, a warm color of the lights was perceived as tense and a cool color was perceived as loose. A prime color was perceived as heavy and a mixed color was perceived as light.

Keywords: Lighting, Live music show, Virtual idol, Color, Semantic differential method

INTRODUCTION

In recent years, LEDs have replaced halogen bulbs or incandescent bulbs for lights on stages. The response time of the LEDs is shorter than those of halogen bulbs and incandescent bulbs, therefore it has become easier to control lights temporally and complex lighting patterns are being used for live music shows especially in pop music. Due to the COVID-19 pandemic, internet distribution of concerts has become popular. Especially, virtual idol's live shows (e.g., Hatsune Miku's live shows) have become very popular in the last two years in Japan. In the present study, audio-visual stimuli with different areas of the stage illuminated by lights and the various colors of the lighting were prepared and live pop music shows performed by a virtual idol, Miss Monochrome were synthesized using the software SHOWMAKER[1].

EXPERIMENT 1

Methods

SHOWMAKER is a computer software for synthesizing live pop music shows. In this software, a virtual idol Miss Monochrome sings and dances several pop songs on a stage. Using this software, different types of stage lights which illuminate different area of the stage and different colors of the lighting are able to use. In Experiment 1, a song was selected from prepared songs. Twenty-nine different areas of the lighting on the stage were synthesized using the combinations of two types of top lights, one type of side light and four types of back lights. The color of the lights was fix at light blue (R, G, B = 30, 255, 255). In addition to these 29 lighting areas, the stage performance without lighting was prepared. In total 30 audio-visual stimuli of live music shows performed by Miss Monochrome were synthesized.

These stimuli were presented to participants and the impressions for the stimuli were rated using SD (semantic differential) method. Each audio-visual stimulus was presented to fifteen participants, then the participants were requested to rate their impressions of the stimulus using 24 seven-step bipolar scales listed in Table 1. In addition to the 24 SD scales, the degrees of preference, special sense of live performance and presence were also rated using seven-step scales. The fifteen participants were recruited from the Kanazawa Institute of Technology. The video of a stimulus was presented through a display Flex Scan SX246W and the audio was presented through headphones STAX SR407 at the level of LAeq = 66.5 dB. The experiment was conducted in a soundproof dark room.

Results and Discussion

For each SD scale, the rated scores were averaged over the participants. Using the mean scores, factor analysis was performed. The results of the analysis showed a three-factor solution with the cumulative contribution rate of 85%. Table 1 shows the factor loadings for each SD scale. The three factors were labelled potency, tension and tightness, respectively, after the SD scales which showed large loading values.

Figure 1 shows the plots of the stimuli on the impression space spanned by potency, tension and tightness, based on the factor scores. Figure 2 shows the centroids for the stimuli including side lights and the stimuli for no side light is included, on the potency-tense plane. Figure 2 shows that when the side lights are used the performance is perceived as powerful and tense.

Figure 3 shows the centroids for the different types of top lights and for the case no top light is used, on the potency-tense plane. Figure 3 shows that the stimuli are perceived as tight when the top light 13, which illuminates a narrow area on the stage. Figure 4 shows the centroids for the different types of the back lights on the potency-tightness plane. Back lights 22 and 31 illuminated a part of the back wall, while back lights 34 and 37 illuminated entire of the back wall. Figure 4 shows that the stimuli are perceived as tight when a part of the back wall is illuminated, and they are perceived as powerful when entire of the back wall is illuminated.

Multiple-regression analyses were performed, using factor scores of the three factors as explanatory variables and the degrees of preference, special sense of live performance, and presence as criterion variables, respectively. Table 2 shows the results of the analyses. The vectors in Figure 1 show the

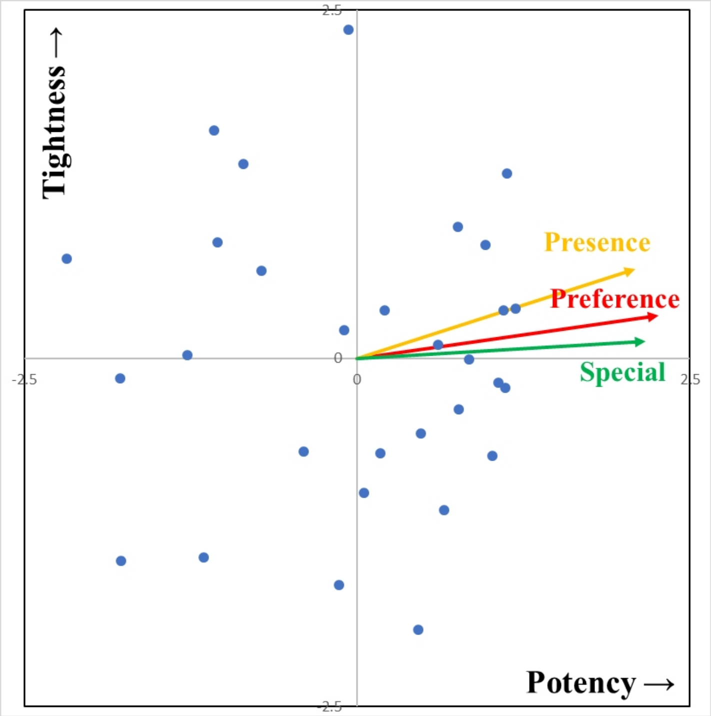
Table 1. Factor loadings of the SD scales in Experiment 1.

Scale			Factor loading		
			Potency	Tension	Tightness
Dirty	–	Clean	.810	-.329	.168
Dull	–	Delightful	.950	.111	.099
Unimpressive	–	Impressive	.887	.282	.137
Uncute	–	Cute	.844	-.283	-.092
Unpleasant	–	Pleasant	.826	-.294	.122
Mixed	–	Neat	-.760	-.586	.110
Sober	-	Showy	.950	.230	-.007
Powerless	–	Powerful	.909	.393	-.013
Feeble	–	Majestic	.906	.321	-.256
Soft	–	Hard	-.787	.101	.525
Weak	–	Strong	.878	.433	.057
Unexcited	–	Excited	.953	.208	.130
Closed	–	Expansive	.869	.297	-.337
Quiet	–	Active	.850	.387	.250
Cold	–	Warm	.901	.113	-.165
Shabby	–	Vivid	.913	.351	-.005
Dark	–	Bright	.927	.255	-.124
Monotonous	–	Varied	.846	.416	-.101
Sordid	–	Fresh	-.453	-.800	-.035
Relaxed	–	Tense	.002	.764	.422
Bovine	–	Nimble	.040	-.728	-.013
Loose	–	Tight	-.035	.021	.829
Light	–	Heavy	.431	.656	.224
Restless	–	Tranquil	-.051	-.347	-.613
Cumulative contribution rate			.594	.768	.851

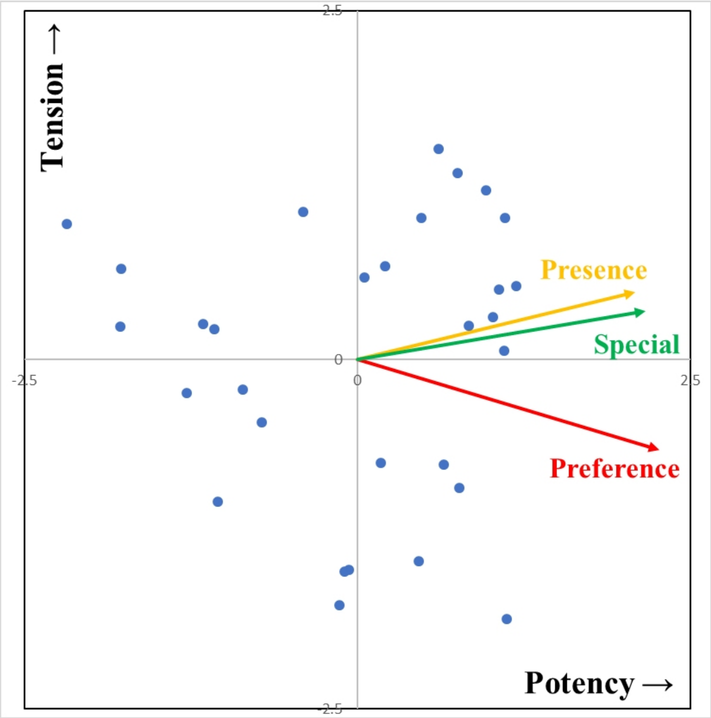
Table 2. The results of the multiple-regression analyses.

		Standard partial regression coefficent		
	Coefficent of determination	Potency	Tension	Tightness
Preference	.895	.906	−.258	.122
Special	.795	.836	.193	.255
Presence	.773	.866	.139	.050

directions of the criterion variables on the impression space. Table 2 and Figure 1 shows that the more powerful stage performance is perceived, the more strongly preference, special sense of live performance and presence are felt.



(a) Potency – Tension plane



(b) Potency – Tightness plane

Figure 1: Plots of the stimuli on the impression space in Experiment 1.

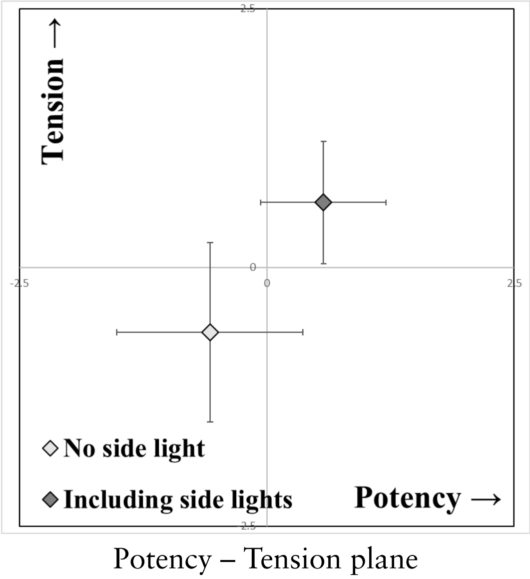


Figure 2: Centroids for the cases where side lights were included and no side light is used.

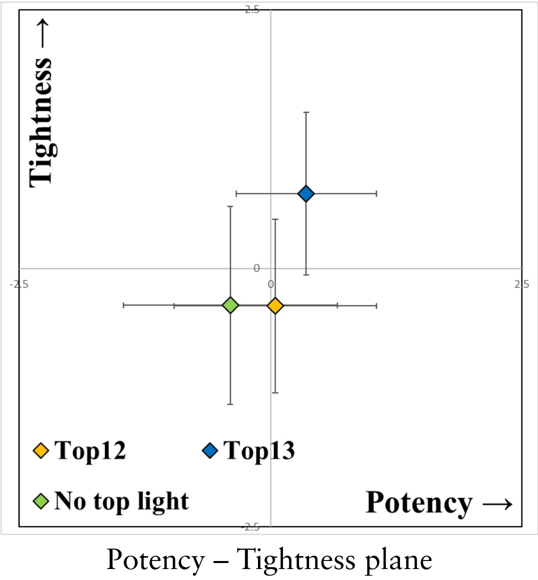
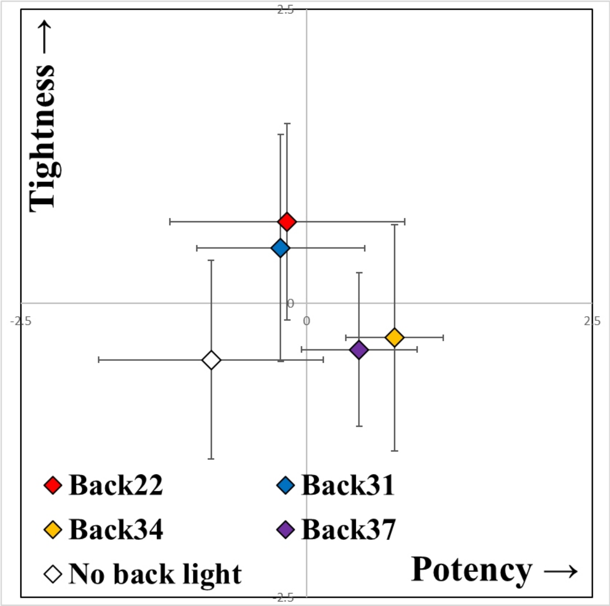


Figure 3: Centroids for different top lights.

EXPERIMENT 2

Methods

In the present experiment, nine settings of the stage lights were selected (Table 3) from the settings used in Experiment 1, and twelve colors of the lights were selected. Combining a setting and a color, 97 stage performances were synthesized. A part of the stage performance was used for the stimuli. The colors were selected from the HLS wheel of pure colors. The wheel was



Potency – Tightness plane

Figure 4: Centroids for different back lights.

Table 3. Light settings used in Experiment 2.

	Side Light	Top Light	Back Light
#1	Yes	Top12	Back37
#2	Yes	Top13	Back31
#3	No	Top13	Back34
#4	No	Top12	Back34
#5	No	Top12	Back22
#6	No	No	Back37
#7	No	Top12	No
#8	No	Top13	Back22
#9		Without Lighting	

equally divided into twelve referring Iwamiya and Hayashi (1999), and the twelve colors were selected as Table 4. The audio stimuli were presented at the level of LAeq = 77.5 dB. The participants and the other experimental procedure were the same as Experiment 1.

Results and Discussion

For each SD scale, the rated scores were averaged over the participants. Using the mean values, factor analysis was performed. The results of the analysis showed a three-factor solution with the cumulative contribution of 82%. Table 5 shows the factor loadings for each SD scale. The three factors were labelled potency, tension and lightness, respectively.

Using the light setting and color as factors, two-way analyses of variance and multiple-comparison tests were performed. The results of the analyses of

Table 4. HLS and RGB values of colors used in Experiment 2.

	HLS value			RGB value		
Color name	H	L	S	R	G	B
Red	0	50	100	255	0	0
Orange	30	50	100	255	127	0
Yellow	60	50	100	255	255	0
YellowGreen	90	50	100	127	255	0
Green	120	50	100	0	255	0
GreenCyan	150	50	100	0	255	127
Cyan	180	50	100	0	255	255
BlueCyan	210	50	100	0	127	255
Blue	240	50	100	0	0	255
Violet	270	50	100	127	0	255
Pink	300	50	100	255	0	255
RedPink	330	50	100	255	0	127

Table 5. Factor loadings of the SD scales in Experiment 2.

Scale			Factor loading		
			Potency	Tension	Lightness
Dull	–	Delightful	.859	.016	.407
Unimpressive	–	Impressive	.960	.019	-.116
Sober	-	Showy	.834	.470	.097
Powerless	–	Powerful	.965	.121	-.063
Feeble	–	Majestic	.942	-.069	-.043
Weak	–	Strong	.822	.331	-.366
Unexcited	–	Excited	.859	.412	.010
Closed	–	Expansive	.888	-.145	.106
Shabby	–	Vivid	.807	.532	-.086
Monotonous	–	Varied	.864	.153	.004
Sordid	–	Fresh	-.223	-.816	.491
Relaxed	–	Tense	.227	.763	-.498
Quiet	–	Active	.322	.908	-.149
Cold	–	Warm	.082	.825	-.061
Restless	–	Tranquil	-.263	-.701	.396
Uncute	–	Cute	.164	-.175	.875
Soft	–	Hard	-.262	.230	-.754
Light	–	Heavy	.484	.282	-.765
Bovine	–	Nimble	-.444	-.355	.741
Loose	–	Tight	-.166	-.202	-.121
Dirty	–	Clean	.338	-.637	.582
Unpleasant	–	Pleasant	.226	-.648	.632
Mixed	–	Neat	-.527	-.595	.350
Dark	–	Bright	.568	.328	.387
Cumulative contribution rate			.391	.628	.816

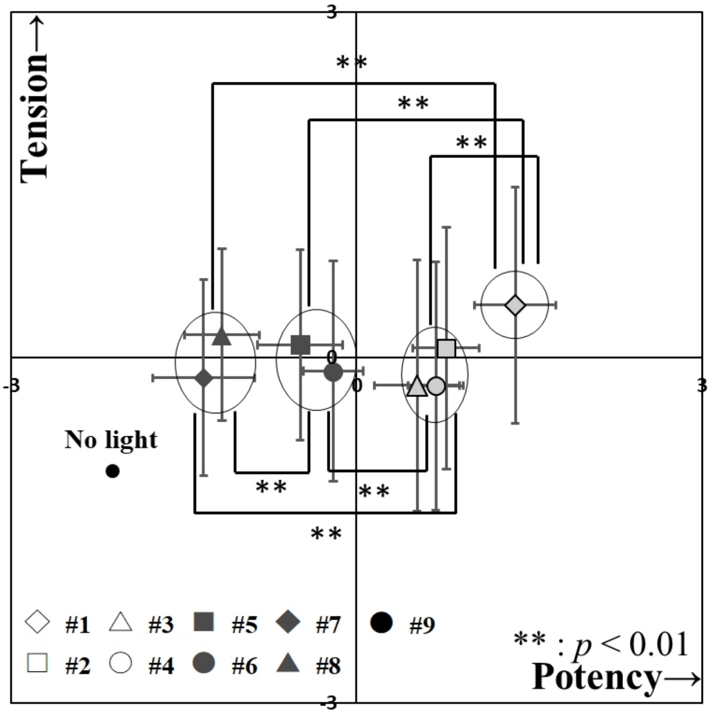
variance are shown in Table 6. The results of the analyses show that the light setting affects potency while the color affects tension and lightness largely.

Figure 5 shows the impressions for different light settings on the potency-tension plane, with the results of the multiple-comparison tests. Figure 6 shows that the wider the area of the stage is illuminated, the more powerful the live performance is perceived. This is consistent to the results of Experiment 1.

Figure 6 shows the impressions for different colors on the tension-lightness plane. Figure 6 shows that the colors are grouped into three clusters on the tension axis; warm colors, cold colors and intermediate colors. A warm color is perceived as tense and a cold color is perceived as loose. Figure 6 also shows that the colors are grouped into two on the lightness axis; prime colors and

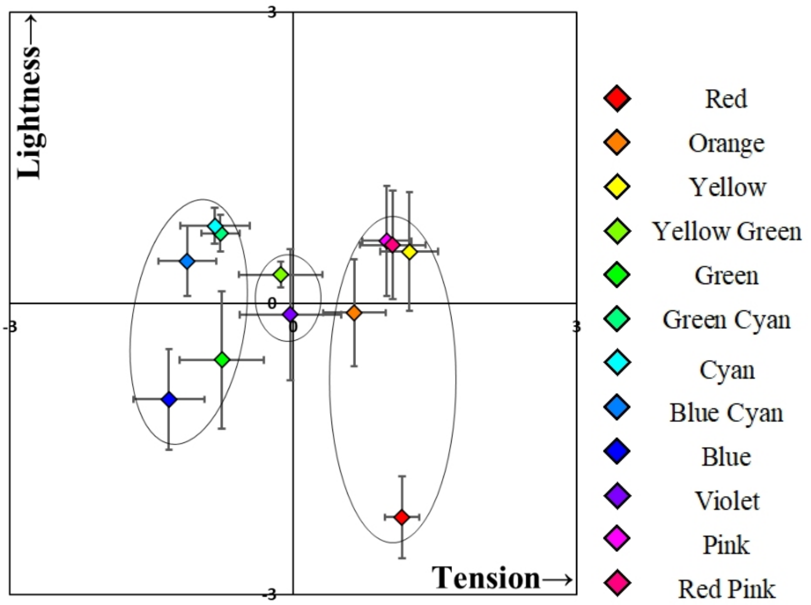
Table 6. Results of the two-way ANOVAs.

Factor		df	F	*p*
	Potency	7	155.421	0.000
Light Setting	Tension	7	8.085	0.000
	Lightness	7	4.196	0.001
	Potency	11	6.431	0.000
Color	Tension	11	81.804	0.000
	Lightness	11	28.707	0.000



Potency – Tension plane

Figure 5: Centroids for different light settings.



Tension – Lightness plane

Figure 6: Centroids for different colors.

mixed colors. A primary color is perceived as heavy and a mixed color is perceived as light.

CONCLUSION

In the present study, live pop music performances were synthesized with various light settings and colors and the impressions of the performances were rated. The results showed the performance is perceived as powerful when the lights illuminated a wide area on the stage. It is perceived as tight when a warm color is used and as loose for a cold color. It is perceived as heavy when a prime color is used and light for a mixed color.

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