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Impressions Made by Blinking Light Used to Create Artificial Subtle Expressions and by Robot Appearance in Human-Robot Speech Interaction

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Abstract— **The impressions made by a blinking light used to create artificial subtle expressions (ASEs) and by a robot's appearance on users were investigated. The blinking light, which shows the user that the robot is performing speech recognition and thereby prevents utterance collisions, was separated from the robot by embedding it in a pedestal unit. In an evaluation experiment, participants performed five tasks with a spoken dialogue system coupled to a robot placed on the pedestal. The participants' impressions of the dialogue interactions and of the robot were obtained under four conditions (w/ light blinking or w/o blinking; humanoid or cuboid robot). The cuboid robot created a stronger impression of comfort and excitement for the interactions while the blinking light did not create a strong impression of anything. The robot's appearance and the blinking did not create a strong impression of anything for the robot. This suggests that the blinking light in the pedestal unit is a factor that is independent of robot appearance, meaning that the pedestal unit can be applied to robots with various appearances.**

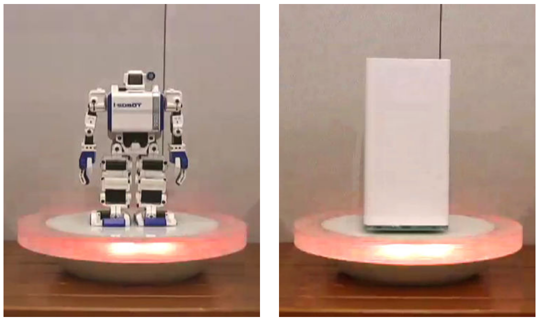
I. Introduction

People usually communicate with each other verbally, but nonverbal information, such as facial expression, gaze direction, and gestures, also plays an important role [1]. People can more easily understand the internal states of others from such information [2]. Even subtle changes in nonverbal information affect human communications. Such changes are called "subtle expressions" [3]. Ward [4] reported that subtle expressions of pitch in speech reflect one's emotional state even when contradicted by the literal meanings of the words spoken. Cowell & Ayesh [5] and Song et al. [6] investigated the recognition of subtle facial expressions because people do not always make clear facial expressions in actual situations.

On the basis of such subtle changes, researchers have tried to implement humanoid robots and life-like agents for smooth communication using subtle expressions. Bartneck & Reichenbach [7] investigated the effect of the geometrical intensity of synthetic facial expressions for use in developing synthetic characters. Sugiyama et al. [8] created a humanoid robot that can change its behaviors slightly on the basis of situation recognition. Kipp & Gebhard [9] developed a dexterous avatar agent that can slightly change its facial expression in accordance with the user's gaze direction. However, implementing the capability of subtle expressions in robots and life-like agents requires many joints and complicated control systems, making implementation very expensive.

We have discovered that simple signals, like a blinking light or a beeping sound, from artificial agents play a role similar to that of subtle human expressions. For example, smooth turn-taking was achieved in human-robot speech interaction by having a robot cause a small LED to blink to indicate that it was in the state of user utterance recognition [10], [11]. Expression of an agent's attitude was achieved by having the agent make appropriately inflected beeping sounds [12]. Communication of a robot's confidence level in the advice given to a user was achieved by having the robot make inflected beeping sounds [13], [14]. On the basis of the results of these studies, we propose using "artificial subtle expressions (ASEs)" as an intuitive notification methodology for conveying an artificial agent's internal state to the user.

The advantages of ASEs are low cost implementation and intuitive understanding. Moreover, ASEs created by a blinking light give users a better impression of dialogue interaction with a robot and of the robot itself [10], [11]. Ideally, ASEs should not depend on the robot's appearance because this would enable robot developers to better design



(a) Humanoid robot (b) Cuboid robot

Fig. 1. Robots on pedestal unit

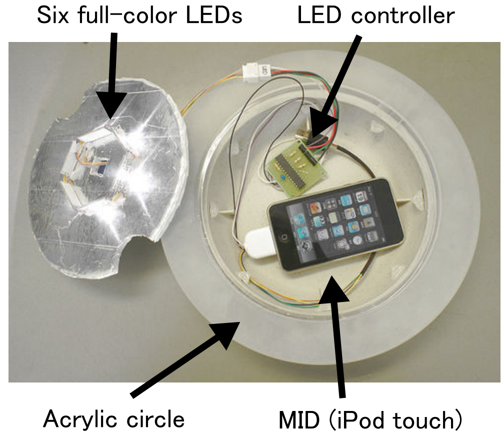


Fig. 2. Inner structure of pedestal unit

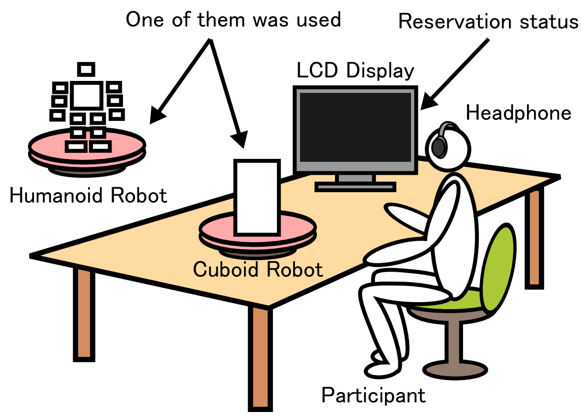


Fig. 3. Experimental environment

robots that can smoothly interact with people. However, the conditions under which ASEs give the user a positive impression need to be clarified.

In the study reported here, we investigated the impressions made by a blinking light used to create ASEs and by a robot's appearance on users. The blinking light was separated from the robot by embedding it in a pedestal unit. Experimental results suggest that the blinking light in the pedestal unit is an independent factor from robot appearance, meaning that the pedestal unit can be applied to robots with various appearances.

II. Approach to Implementing ASEs

To make the ASEs independent of the robot itself, we implemented the ASE function in a pedestal unit, as shown in Fig. 1. A light in the pedestal blinks independently of the object on it.

The pedestal unit includes a battery-powered control circuit and light, and the light blinks when an external device sends an appropriate command through a WiFi connection. Figure 2 shows six LEDs, an LED controller, and an iPod touch mobile internet device (MID). The unit has two layers; the lower layer contains the controller and the MID, and the upper layer contains the six LEDs. The outer ring of the unit is translucent acrylic, which enables the blinking light to be seen externally. The controller and the MID are connected with a cable and communicate using universal asynchronous reception/transmission. The controller controls not only the blinking but also the light intensity and LED color in accordance with the received commands.

When a spoken dialogue system coupled to the robot on the pedestal detects an audio signal, the light in the pedestal begins to blink. The blinking stops when the robot begins its response. The role of the blinking light is to show the user that the robot is performing speech recognition. Previous studies showed that such a blinking light prevents utterance collisions between the user and the robot [10], [11].

III. Experiment

We investigated the effects of the robot's appearance and the blinking light on user impressions of human-robot speech interaction.

A. Method

We conducted a speech interaction experiment between a robot on the pedestal unit and participants, who were instructed to reserve hotel rooms by talking with the robot. The spoken dialogue system was the same as that used in our previous work [15], [16]. The system was equipped with the robot on the pedestal unit. Participants' utterances were recognized by an automatic speech recognizer Julius [1], and interpreted by an in-house language understander. The robot's utterances were voiced by a commercial speech synthesizer. The LCD display in Fig. 3 was used only to show reservation details at last.

A humanoid robot and a cuboid robot were used. These two types of robot were distinctly different and typical appearances of a human-like and a non-human-like one.

The blinking patterns were created using a rectangular wave (15 Hz), which has been shown to give users a comfortable feeling [10], [11], [15], [16]. The light color was red as same as the previous work [15], [16]. The blinking time was the participant's utterance time plus four seconds. The system detected the termination of their utterance by watching the silence for 3.6 seconds. There was a processing

[1] http://julius.sourceforge.jp/

TABLE I

RATED ADJECTIVE PAIRS FOR IMPRESSIONS OF DIALOGUE INTERACTIONS AND FACTOR LOADING MATRIX FOR FACTOR ANALYSIS (PROMAX ROTATION, MAXIMUM LIKELIHOOD METHOD)

Adjective pairs		Humanoid				Cuboid				Factors			
Positive	Negative	w/ blinking		w/o blinking		w/ blinking		w/o blinking		1	2	3	4
		Mean	SD	Mean	SD	Mean	SD	Mean	SD				
comprehensible	incomprehensible	3.46	2.07	3.23	1.74	4.38	1.04	4.25	1.54	0.90	-0.12	-0.12	0.04
easy	not easy	3.31	1.60	2.62	1.04	3.15	0.90	3.33	1.37	0.80	-0.10	0.04	-0.08
peaceful	agitated	3.85	1.68	2.85	1.41	4.08	1.19	4.00	1.41	0.79	-0.22	0.21	0.01
calm	stormy	4.38	1.76	4.62	1.19	4.00	1.00	3.92	1.16	-0.74	-0.10	0.14	0.04
likable	unlikable	3.46	1.27	3.23	1.01	4.23	0.83	3.67	0.89	0.73	0.12	-0.10	0.07
spirited	spiritless	3.23	1.09	3.23	1.09	3.38	0.51	3.17	0.72	0.73	-0.06	0.08	-0.01
good	poor	3.08	1.12	3.38	1.12	3.85	0.80	3.67	0.89	0.71	0.22	-0.09	-0.05
pleasant	unpleasant	3.85	1.07	3.31	1.25	4.54	0.66	3.92	0.90	0.55	0.31	-0.08	-0.10
smooth	rough	2.69	1.65	2.46	1.05	2.54	1.13	2.33	0.78	0.54	0.14	0.04	-0.15
light	dark	3.08	1.04	3.31	1.18	4.00	0.71	3.33	1.23	0.33	0.32	-0.11	0.28
interesting	boring	4.38	1.56	4.38	1.80	5.23	0.83	4.00	1.28	-0.02	0.80	0.03	-0.03
exciting	dull	3.31	1.25	3.62	1.61	4.77	1.24	4.25	1.66	-0.05	0.69	-0.08	-0.11
leisurely	hurried	5.54	1.51	4.77	1.54	5.08	0.86	5.33	1.07	-0.17	-0.02	0.90	-0.22
polite	impolite	4.38	1.33	3.69	1.44	3.85	0.55	4.08	0.90	0.45	-0.24	0.57	0.07
informal	formal	2.69	1.60	2.85	1.41	3.00	0.71	3.17	1.34	-0.04	0.44	0.51	0.19
warm	cold	3.15	1.57	2.92	1.55	3.23	0.83	3.50	1.17	0.20	0.14	0.42	0.16
casual	grave	2.92	0.86	4.08	1.55	3.54	1.13	3.50	0.80	-0.16	-0.16	-0.17	1.10
relaxed	tense	3.15	1.72	3.77	1.54	3.62	1.19	3.00	0.85	0.09	0.19	0.04	0.46

TABLE II

CORRELATION BETWEEN DIALOGUE IMPRESSION FACTORS

Factors	1. comfort	2. excitement	3. generousness	4. relaxation
1. comfort	1.00	0.62	0.63	0.32
2. excitement	0.62	1.00	0.47	0.47
3. generousness	0.63	0.47	1.00	0.36
4. relaxation	0.32	0.47	0.36	1.00

TABLE III

DIALOGUE IMPRESSION FACTOR SCORES

Factor	Humanoid				Cuboid				main effect of appearance		main effect of blinking		interaction effect	
	w/ blinking		w/o blinking		w/ blinking		w/o blinking							
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	$F_{1,47}$	p	$F_{1,47}$	p	$F_{1,47}$	p
1. comfort	-0.06	1.29	-0.39	1.07	0.33	0.42	0.13	0.81	2.95	0.09	0.96	0.33	0.06	0.81
2. excitement	-0.32	0.98	-0.11	1.11	0.48	0.51	-0.05	0.85	2.94	0.09	0.43	0.52	2.18	0.15
3. generousness	0.20	1.17	-0.26	1.13	-0.08	0.39	0.16	0.80	0.07	0.79	0.17	0.68	1.81	0.18
4. relaxation	-0.46	0.96	0.32	1.26	0.13	0.86	0.02	0.67	0.30	0.58	1.57	0.22	2.65	0.11

delay of 0.4 seconds.

Figure 3 shows the experimental environment. The participants sat on a chair and reserved hotel rooms by interacting with a spoken dialogue system coupled to the robot placed in front of them. They wore headphones so that the system could easily distinguish their voices from the robot's voice and performed five hotel reservation tasks. In each task, they tried to reserve one to three rooms. The participants did not receive any instuctions on the reservation procedures such as the order of giving reservation information and the acceptable utterance patterns. After the five trials, they completed a questionnaire on their impressions of the interactions, the robots, and so on.

The participants were 26 men and 27 women. Their mean age was 26.0 (SD=7.8), and their ages ranged from 19 to 50. They were divided into four groups, each with a different experimental setting: humanoid robot with light blinking, cuboid robot with light blinking, humanoid robot without light blinking, and cuboid robot without light blinking.

B. Results

1) Impressions of dialogue interactions: Table I shows the participants' ratings of the dialogue interactions. The adjective pairs are translations of the Japanese words used in the questionnaire. The ratings are based on a seven-point Likert scale (1: strong agreement with a negative adjective, 4: neutral, 7: strong agreement with a positive adjective).

We performed factor analysis (promax rotation and maximum likelihood method) for the impressions of the dialogue interactions. Four factors were extracted from the evaluated items by using a scree plot and were interpreted on the basis of our previous work [16], [17]: *comfort*, *excitement*, *generousness*, and *relaxation*. The right side of Table I shows the factor loadings. Table II shows the correlations between the factors, none of which were high-value factors.

The factor scores were calculated using a regression method. Two-way ANOVAs were then performed with the scores of the four factors as dependent variables and the robot appearance parameter (humanoid or cuboid) and light

TABLE IV

RATED ADJECTIVE PAIRS FOR IMPRESSIONS OF ROBOTS AND FACTOR LOADING MATRIX FOR FACTOR ANALYSIS (PROMAX ROTATION, MAXIMUM LIKELIHOOD METHOD)

Adjective pairs		Humanoid				Cuboid				Factors				
Positive	Negative	w/ blinking		w/o blinking		w/ blinking		w/o blinking		1	2	3	4	5
		Mean	SD	Mean	SD	Mean	SD	Mean	SD					
modest	boastful	4.46	1.20	4.54	0.97	4.38	0.65	4.33	1.07	0.92	-0.06	-0.19	-0.07	-0.07
broad-minded	narrow-minded	3.92	1.19	4.15	0.90	4.00	0.58	3.92	0.51	0.71	-0.17	0.08	0.18	0.17
careful	careless	4.46	1.20	4.85	1.14	4.77	1.09	4.92	0.90	0.69	-0.13	-0.04	-0.24	0.44
sociable	unsociable	3.69	1.38	3.31	1.65	4.31	1.11	4.17	1.19	0.56	0.32	-0.02	0.03	-0.13
patient	impatient	4.46	1.33	5.15	1.14	4.85	0.80	5.17	1.11	0.52	-0.39	-0.02	0.37	-0.19
discreet	indiscreet	4.00	1.22	4.15	0.99	4.77	1.01	4.50	1.00	0.43	0.19	-0.20	0.30	0.20
kind	unkind	3.85	1.52	4.08	1.66	4.15	1.34	4.17	0.94	0.38	0.24	0.01	0.34	0.01
innocent	wicked	4.46	1.05	4.38	1.33	4.46	0.78	4.17	0.83	0.33	0.27	0.24	0.24	-0.16
aggressive	defensive	4.23	1.36	3.62	1.66	4.38	0.77	3.83	0.83	0.07	1.01	-0.15	-0.19	0.02
excited	cool	3.54	1.20	3.77	1.24	3.85	0.90	3.58	0.51	-0.13	0.65	0.15	-0.03	-0.21
confident	not confident	4.23	1.42	4.23	1.36	4.23	1.09	4.25	0.75	-0.22	0.58	0.09	0.06	0.06
impressive	unimpressive	4.85	1.14	4.77	0.83	5.00	0.71	4.58	0.67	-0.14	0.56	-0.05	0.12	0.48
active	inactive	3.92	1.26	3.69	1.65	4.31	1.38	4.08	1.08	0.11	0.47	0.17	0.00	0.16
accessible	inaccessible	3.62	1.39	3.85	1.52	3.38	1.04	3.50	0.80	-0.29	-0.02	0.88	0.00	0.11
friendly	unfriendly	4.31	1.65	3.85	1.86	3.92	0.86	3.25	0.97	0.45	0.23	0.56	-0.33	-0.04
pretty	ugly	4.23	1.09	4.69	1.03	4.31	0.85	4.50	0.80	0.00	0.08	0.55	0.16	-0.09
polite	impolite	4.31	1.32	4.23	1.36	4.54	1.05	3.92	0.67	0.04	0.26	0.43	0.31	0.05
responsible	irresponsible	3.54	1.56	4.38	1.33	4.69	1.32	4.42	1.24	-0.01	0.14	-0.15	0.89	0.00
respectful	disrespectful	5.00	1.35	4.92	1.32	4.77	1.09	5.00	1.04	-0.04	-0.28	0.30	0.56	0.15
serious	frivolous	4.54	1.61	4.69	1.03	4.62	1.33	4.25	0.75	0.01	-0.07	0.07	0.09	0.98

TABLE V

CORRELATION BETWEEN ROBOT IMPRESSION FACTORS

Factors	1. gentleness	2. aggressiveness	3. friendliness	4. credibility	5. seriousness
1. gentleness	1.00	0.54	0.45	0.53	0.23
2. aggressiveness	0.54	1.00	0.57	0.46	0.36
3. friendliness	0.45	0.57	1.00	0.42	0.10
4. credibility	0.53	0.46	0.42	1.00	0.27
5. seriousness	0.23	0.36	0.10	0.27	1.00

TABLE VI

ROBOT IMPRESSION FACTOR SCORES

Factor	Humanoid				Cuboid				main effect of appearance		main effect of blinking		interaction effect	
	w/ blinking		w/o blinking		w/ blinking		w/o blinking							
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	$F_{1,47}$	p	$F_{1,47}$	p	$F_{1,47}$	p
1. gentleness	-0.08	1.35	0.00	1.04	0.11	0.67	-0.04	0.63	0.08	0.78	0.02	0.89	0.18	0.67
2. aggressiveness	0.07	1.05	-0.22	1.40	0.30	0.59	-0.16	0.51	0.28	0.60	1.91	0.17	0.11	0.74
3. friendliness	0.13	1.08	0.14	1.30	-0.05	0.66	-0.24	0.48	1.11	0.30	0.13	0.72	0.14	0.71
4. credibility	-0.39	1.10	0.11	0.94	0.20	0.79	0.09	0.88	1.20	0.28	0.53	0.47	1.34	0.25
5. seriousness	0.04	1.32	0.10	0.85	0.08	1.11	-0.24	0.64	0.28	0.60	0.20	0.66	0.44	0.51

parameter (w/ blinking or w/o blinking) as independent variables. The results are shown in Table III, with the main and interaction effects of appearance and blinking shown on the right side. No significant interaction effects were found (comfort: $F_{1,47} = 0.06, p = 0.81$, excitement: $F_{1,47} = 2.18, p = 0.15$, generousness: $F_{1,47} = 1.81, p = 0.18$, relaxation: $F_{1,47} = 2.65, p = 0.11$) while 10%-level significant differences were found in the main effect of appearance for the first factor, comfort ($F_{1,47} = 2.95, p = 0.09$) and the second factor, excitement ($F_{1,47} = 2.94, p = 0.09$). The corresponding factor scores were higher for the cuboid robot, suggesting that the cuboid robot gave the participants a more comfortable and excited impression of the interactions.

2) Impressions of robots: Table IV shows the participants' ratings of the robots. Again, the adjective pairs are translations of the original Japanese, and the ratings are based on a seven-point Likert scale.

We performed factor analysis (promax rotation and maximum likelihood method) for the robot impressions. Five factors were extracted from the evaluated items by using a scree plot and were interpreted on the basis of our previous work: *gentleness*, *aggressiveness*, *friendliness*, *credibility*, and *seriousness*. Table V shows the correlations between the factors, none of which were high-value factors.

We again calculated the factor scores using a regression method. Two-way ANOVAs were then performed with the scores of the five factors as dependent variables and the robot appearance parameter (humanoid or cuboid) and light parameter (w/ blinking or not w/o blinking) as independent variables. The results are shown in Table VI, with the main and interaction effects of appearance and blinking shown on the right side. No significant interaction effects were

TABLE VII

RATED VALUES FOR QUESTIONS ABOUT RESERVATION SYSTEM

Question	Humanoid				Cuboid				main effect of appearance		main effect of blinking		interaction effect	
	w/ blinking		w/o blinking		w/ blinking		w/o blinking							
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	$F_{1,47}$	p	$F_{1,47}$	p	$F_{1,47}$	p
Q1	3.00	1.83	3.15	1.77	3.62	1.50	3.92	1.62	2.13	0.15	0.23	0.63	0.02	0.88
Q2	3.69	1.75	3.08	1.55	3.69	1.49	3.50	1.57	0.22	0.64	0.82	0.37	0.22	0.64
Q3	4.17	1.13	3.31	1.35	3.01	0.84	2.98	0.96	5.89	0.02	2.09	0.16	1.86	0.18

Q1: useful – useless (1–7)
Q2: hope to use – hope not to use (1–7)
Q3: time it took for robot to began replying (seconds)

found (gentleness: $F_{1,47} = 0.18, p = 0.67$, aggressiveness: $F_{1,47} = 0.11, p = 0.74$, friendliness: $F_{1,47} = 0.14, p = 0.71$, credibility: $F_{1,47} = 1.34, p = 0.25$, seriousness: $F_{1,47} = 0.43, p = 0.51$), and no significant differences were found in the main effect of appearance and blinking for any of the factors. This suggests that the robot's appearance and the blinking did not significantly affect the participants' impressions of the robots.

3) Other impressions: The questionnaire administered to the participants after they completed the five tasks focused on their impressions of the reservation system, the blinking light, and the pedestal unit. It contained seven pairwise choices "useful–useless (Q1)," "hope to use–hope not to use (Q2)," and "the time it took for robot to begin replying (Q3)" for the reservation system, "noticed blinking–did not notice blinking (Q4)," "blinking light was too strong–blinking light was not too strong (Q5)," and " blinking created good feeling–blinking created bad feeling (Q6)" for the blinking light, and "had feeling of unity between robot and pedestal–had no feeling of unity between robot and pedestal (Q7)" for the pedestal unit. Tables VII and VIII show the results. The items were evaluated on a seven-point Likert scale except for Q3, Q4, and Q5. Q3 was evaluated in terms of seconds, and Q4 and Q5 were simply evaluated as 1 (yes) or 0 (no). Two-way ANOVAs were then performed with the evaluated values for Q1 to Q3 as dependent variables and the robot appearance parameter (humanoid or cuboid) and light parameter (w/ blinking or w/o blinking) as independent variables. No significant interaction effects were found (Q1: $F_{1,47} = 0.02, p = 0.88$, Q2: $F_{1,47} = 0.22, p = 0.64$, Q3: $F_{1,47} = 1.86, p = 0.18$) while a significant difference was found in the main effect of appearance for Q3 ($F_{1,47} = 5.89, p = 0.02$). This suggests that the participants felt that the spoken dialogue system replied more quickly when it was coupled to the cuboid robot than when it was coupled to the humanoid robot. In fact, the response times were identical for both robots.

One-way ANOVAs were performed with the evaluated values for Q6 and Q7 as dependent variables and the robot appearance parameter (humanoid or cuboid) as an independent variable. No significant differences were found. This suggests that the robot's appearance did not significantly affect the participants' impression of the blinking light or of the feeling of unity between the robot and the pedestal unit.

TABLE VIII

RATED VALUES FOR QUESTIONS ABOUT BLINKING AND PEDESTAL UNIT

Question	Humanoid		Cuboid		main effect of appearance	
	blinking		blinking			
	Mean	SD	Mean	SD	$F_{1,24}$	p
Q4	1.00	0.00	1.00	0.00	—	—
Q5	0.15	0.38	0.15	0.38	—	—
Q6	4.00	1.00	4.23	1.09	0.32	0.58
Q7	4.62	1.85	5.31	1.70	0.99	0.33

Q4: noticed blinking – did not noticed blinking (1:yes or 0:no)
Q5: blinking light was too strong –
blinking light was not too strong (1:yes or 0:no)
Q6: blinking created good feeling – blinking created bad feeling (1–7)
Q7: had feeling of unity between robot and pedestal
– had no feeling of unity between robot and pedestal (1–7)

IV. DISCUSSION

The experimental results suggest that the robot's appearance affects the user's impression of the dialogue interaction. A robot having a cuboid appearance provides a stronger impression of comfort and excitement than one having a humanoid appearance. Moreover, the participants felt that the cuboid robot replied more quickly than the humanoid robot although the response times were actually identical. It is thus important to identify in advance which robot appearances create a positive impression on users. Such identification is beyond the scope of this study and remains for future work. We speculate that the consistency between the robot's appearance and the synthesized voice and the gap between the anticipated and actual ability of the robot [18] are important factors in the impression that is created.

The results also suggest the blinking light does not significantly affect the user's impression while previous work [16] suggested that the blinking light provides a feeling of comfort about the dialogue interaction. The difference in the blinking light effect is attributed to the difference in the number of utterance collisions. There were few collisions in this experiment. If the positive impression in the previous work was caused by decreasing the number of collisions, it would be reasonable that a similar effect of the blinking light was not observed in this work. Because the effect of the blinking light is useful when a speech recognition system is unstable due to noise, ASEs might not have played a significant role in this work due to the high recognition rate.

A negative blinking light effect and an interaction effect between robot appearance and the blinking light were not found in this work. This suggests that the blinking light in the pedestal unit is a factor that is independent of robot appearance. If so, the pedestal unit can be used for robots with various appearances. This means that robot designers do not need to identify the most effective combination of a blinking light and a robot's appearance.

Use of the pedestal unit separates the blinking light layout problem from the robot appearance design problem. The layout design of the blinking light is difficult because it significantly affects the robot's appearance. The experimental results suggest that there is a certain level of unity between the robot and the unit, which will facilitate the application of ASEs to robots.

V. Conclusion

We have investigated the impressions made by a blinking light used to create artificial subtle expressions (ASEs) and by a robot's appearance on users. We separated the blinking light from the robot by embedding it in a pedestal unit.

In our experiment, we obtained the participants' impressions of the dialogue interactions and of the robots under four conditions (w/ blinking or w/o blinking; humanoid or cuboid robot). The participants performed five hotel reservation tasks with a spoken dialogue system coupled to a robot placed on the pedestal unit. The robots responded by speech and by light blinking.

The cuboid robot created a stronger impression of comfort and excitement for the interactions while the blinking light did not create a strong impression of anything. The robot's appearance and the blinking did not create a strong impression of anything for the robot. This suggests that the blinking light in the pedestal unit is a factor that is independent of robot appearance, meaning that the pedestal unit can be applied to robots with various appearances.

However, a question remains: why did the robot with the cuboid appearance create a more positive impression than the one with the humanoid appearance. The answer may depend on the consistency between the robot's appearance and the synthesized voice and the gap between the anticipated and actual ability of the robot.

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