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# Exploring young children's images on robots

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## Abstract

In recent years, human features of the robots are increasingly studied. For example, educational robots are developed and marketed to accompany children. Above all, humanoid robots must deliver friendly images to those young children to interact with. Although many prior studies aimed at the inquiry of robot images based on adult's view, there are few in-depth studies of children's perceptions of robot image. This study aims to investigate kindergarten and elementary school students' perceptions on robots, including perceptions on robot personalities, appearance, and associated emotional expression. A questionnaire about robot's image was designed to investigate the perception of kindergarten and elementary school students (N = 250). The results indicated that the children had different perceptions of robot emotion with diverse robot appearance, and the children with difference gender had diverse perceptions of robot behavior and emotion. The results of this study can be applied to robot's design and development in the future.

## Keywords

Robot personality, perception on robot, robot appearance, robot image, gender, robot design

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## Introduction

Robots are becoming prevalently used in human–robot services, such as educational, entertainment, or therapeutic applications. However, studies regarding social aspect of robots are still limited. So far, it is still not clear to what extent the physical appearance of a robot influences users' impression. Furthermore, perception on robots with different appearances and functions varies among groups of gender, ages, or intentions. Design considerations need to take a wide range of physical and behavioral features into account, as well as the psychological impact a robot may have on its users.<sup>1</sup>

A recent study carried out among 26,751 European Union (EU) citizens revealed that European perceptions of robots are positive and permissive. Nevertheless, fields which robots have already been used, such as manufacturing, military, and rescue work, turn out to be the most popular areas; the least preferred areas include care of children, education, and leisure.<sup>2</sup> Thus, while the role of automatization and industrial robots

has been generally considered, it is a challenge to transform people's perceptions on social robots.

Several studies indicated that the robot's appearance and initial behavior changed the way people perceive the robots, particularly during first encounters and short-term interaction. Preferences for robot appearance differed between different gender and age groups.<sup>1,3–5</sup>

A study regarding the effect of robot appearance on the scale of likeability indicated that people considered

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the zoomorphic robot to be more likeable than the machine-like robot.<sup>6</sup> Also, there was no significant difference on the scale of likeability between the anthropomorphic and the zoomorphic robots. The result implied that humanoid and animal features are capable to increase people's familiarity to the robots and consequently result in an increased likeability. Furthermore, a robot with an overall animal appearance will not be perceived differently to a robot with a humanlike appearance and thus may be perceived more as a person rather than a machine. The overall appearance of robots is important as it influences people's expectations when interacting with a robot.<sup>1</sup>

As shown by prior studies, people's perception and social representation of robots are powerfully influenced by popular culture and media.<sup>7</sup> For example, in comparison with males, females showed higher levels of robot phobia and liked robots less. The reason may be that males are generally more exposed to technology and have more experience with robots, and females have traditionally shown more negative attitudes interacting with robots.<sup>8–10</sup>

People tend to assign personality qualities to robots in order to help the user to understand how to engage with the robot; this may be particularly important for children.<sup>11</sup> As suggested in a study by Woods, elementary school-aged children would develop a symbolic relationship with a robot if they perceived the robot as a person. If robots are to be used as playmate, friend, or teacher within an educational context, how to design a robot that school children are willing to engage with and accept it as part of a relationship is a crucial issue. Therefore, this study enquires into children's attitudes and perceptions on robots to provide some insights toward a successful design. By investigating children's preferences and perceptions on robots in terms of physical attributes and behavioral intentions, the appearance and personality features of robots preferred by boys and girls can be identified to determine the proper appearance for educational tasks in a human–robot interaction context. The results should be of value in the design of robots for application areas involving child users.

## Research methods

### Research methods

This study adopted quantitative research method. First, questionnaire survey was used to collect and analyze children's perceptions on robots. Then, children were interviewed for data collection analysis to triangulate the results from the questionnaires.

### Research design

The questionnaires were distributed to each child simultaneously. Each child made comparative decisions

based on the different robot images for their questionnaire responses. Afterward, one-to-one interviews with selected students were conducted confidentially according to their answers.

### Research instruments

To understand children's attitude toward robots, a questionnaire was developed. It consisted of two parts, namely, perceptions on robot personality, as well as robot appearance and associated emotional expression. First part comprised of a series of four statements that children were asked to answer with a 5-point Likert scale ranging from disagreement to agreement. These four statements are "Robots are friendly while interacting with humans," "Robots are aggressive while interacting with humans," "Robots are shy while interacting with humans," and "Robots are bossy while interacting with humans."

The second part comprised of six robot images (as shown in Figure 1) and statements. The first statement was to ask each child to select his or her favorite robot. The other statements were 5-point Likert scale ranging from disagreement to agreement. For each robot image, children were asked to rate the 5 kinds of feeling associated with the specific robot outlook. For example, students needed to rate the feelings of happiness, anger, sadness, fear, and understanding about robot A.

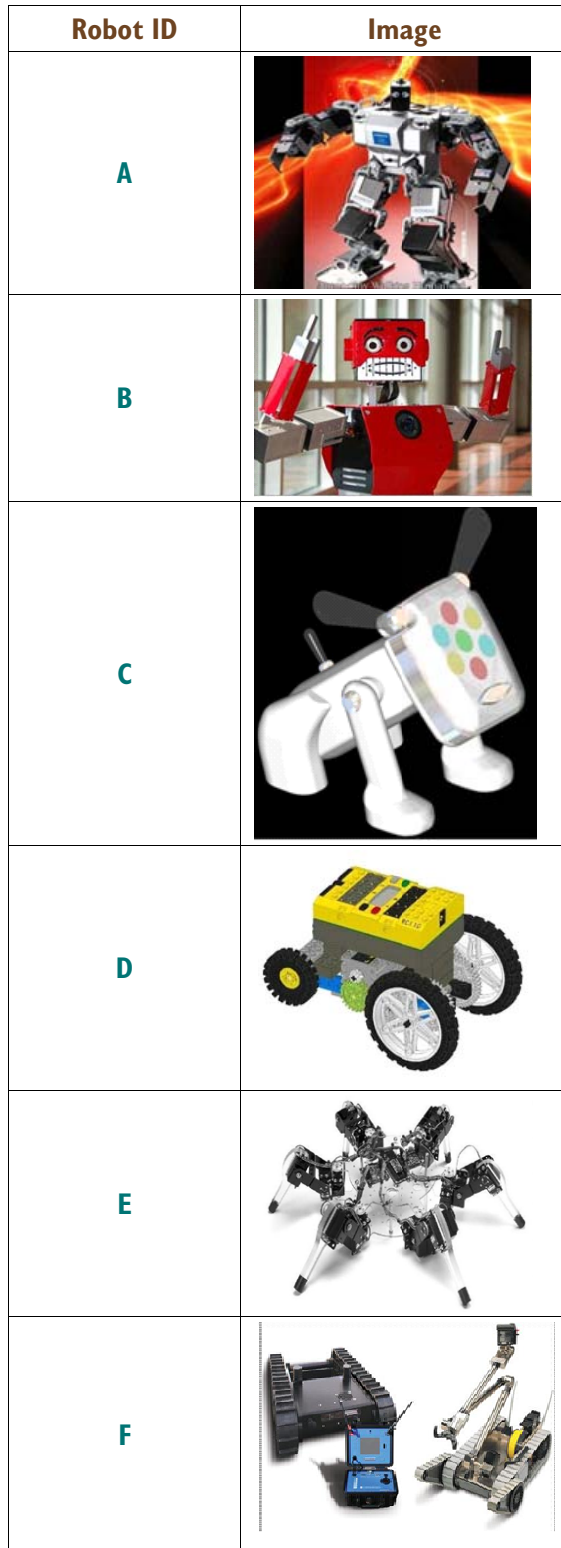
### Research participants

A total of 10 elementary schools and 2 kindergartens, across seven cities, were selected to participate in this study. There were 178 elementary students, ranging from grade 3 to grade 6 (age between 8 and 11 years old). Among the 154 valid questionnaires, 94 students (61%) were male. For the kindergarten children, 96 children (5 years old) (53 were male) were individually interviewed and orally instructed to answer questions because of their limited reading ability. The research team consisted of two professors of education field and four graduate students with elementary school or kindergarten teaching experiences.

## Results

### Student perceptions on robot personality

Children were asked to rate their perceptions on personalities of a robot. The personalities included friendly, aggressive, shy, and bossy. According to Woods' study, friendliness and shyness were seen as positive behavioral intention, while aggressiveness and bossiness were as negative behavioral intention.<sup>1</sup> Except being aggressive, as indicated in Table 1, children evaluated a robot as friendly, shy, and bossy. In other words, children considered that robots would



**Figure 1.** Images of robots.

exercise control over human being. Additionally, the results of t-test showed no significant difference between male and female students.

**Table 1.** Perceptions on robot personalities between male and female children (all students).

Personalities	Gender	N	Average	SD
Friendly	Male	146	3.85	1.159
	Female	101	3.91	1.305
	Total	247	3.87	1.218
Aggressive	Male	146	2.47	1.287
	Female	101	2.41	1.250
	Total	247	2.44	1.270
Shy	Male	146	3.77	1.173
	Female	101	3.80	1.273
	Total	247	3.79	1.212
Bossy	Male	146	3.77	1.057
	Female	101	3.50	1.163
	Total	247	3.66	1.107

SD: standard deviation.

A further analysis revealed a significant difference on shyness between elementary and kindergarten students (Table 2). In other words, kindergarten children tended to perceive that robots were shy than elementary children did.

In addition, gender difference existed within the elementary group but not in the kindergarten group (see Tables 3 and 4). The result of t-test indicated that a significant difference existed between male and female children on perceiving robots' friendliness in elementary group only. Specifically, the gap of considering robot friendly between genders enlarged as age increased. Comparing with kindergarten students, male elementary students considered robots less friendly, while female elementary students considered robots more friendly.

### Student perceptions on robot appearance

Being shown pictures of six robot types, as shown in Figure 1, children were asked to select their favorite one. A chi-square test indicated the significant difference on children's selections in terms of age and gender. As indicated in Table 5, kindergarten children preferred robot A and robot B significantly than elementary children, while elementary children preferred robot C and robot E significantly than kindergarten children.

Regarding the gender difference, the chi-square tests and post hoc comparisons confirmed the statistical significance that more female children than male students preferred robot B and C, while more male children than female students preferred robot A (see Table 6). Furthermore, gender difference on robot F emerged in elementary stage (see Tables 7 and 8). That is to say that male children became more interested in robot F as they grew up.

### Robot appearance and emotional expression

Prior studies showed that robot appearance was usually associated with emotional expression, which would

**Table 2.** Perceptions on robot personalities between kindergarten and elementary children.

Behavior	Age	N	Average	SD	t	df	Significance
Friendly	Kin.	93	3.7	1.573	-1.768	245	0.078
	Ele.	154	3.98	0.932			
Aggressive	Kin.	93	2.38	1.539	-0.624	245	0.533
	Ele.	154	2.48	1.08			
Shy	Kin.	93	3.99	1.500	2.067	245	0.040*
	Ele.	154	3.66	0.985			
Bossy	Kin.	93	3.53	1.434	-1.471	245	0.142
	Ele.	154	3.74	0.846			

df: degree of freedom; SD: standard deviation.

\*p &lt; 0.05.

**Table 3.** Perceptions on robot personalities between male and female children (elementary school).

Personalities	Gender	N	Average	SD	t	df	Significance
Friendly	M	94	3.80	0.93	-3.130	152	0.002*
	F	60	4.27	0.86			
Aggressive	M	94	2.57	1.11	1.355	152	0.177
	F	60	2.33	1.02			
Shy	M	94	2.29	0.91	-0.794	152	0.428
	F	60	2.42	1.09			
Bossy	M	94	2.19	0.86	-1.255	152	0.211
	F	60	2.37	0.82			

df: degree of freedom; SD: standard deviation.

\*p &lt; 0.01.

**Table 4.** Perceptions on robot personalities between male and female children (kindergarten).

Personalities	Gender	N	Average	SD	t	df	Significance
Friendly	M	52	3.94	1.478	1.698	91	0.093
	F	41	3.39	1.641			
Aggressive	M	52	2.27	1.548	-.754	91	0.453
	F	41	2.51	1.535			
Shy	M	52	3.88	1.542	-.756	91	0.452
	F	41	4.12	1.452			
Bossy	M	52	3.69	1.351	1.257	91	0.212
	F	41	3.372	1.524			

df: degree of freedom; SD: standard deviation.

**Table 5.** Preferences to robot appearance between elementary and kindergarten children.

Robot type	Elementary		Kindergarten		Post hoc comparison
	N	%	N	%	
A	34	22.1	34	35.4	Kin. > Ele.
B	22	14.3	21	21.9	Kin. > Ele.
C	54	35.1	21	21.9	Ele. > Kin.
D	8	5.2	7	7.3	
E	21	13.6	7	7.3	Ele. > Kin.
F	15	9.7	6	6.2	

**Table 6.** Preferences to robot appearance between male and female children (all).

Robot type	Male		Female		Post hoc comparison
	N	%	N	%	
A	65	44.2	3	2.9	M > F
B	7	4.8	36	35.0	F > M
C	28	19.0	47	45.6	F > M
D	8	5.4	7	6.8	
E	21	14.3	7	6.8	
F	18	12.2	3	1.2	M > F

**Table 7.** Preferences to robot appearance between male and female children (elementary).

Robot type	Male		Female		Post hoc comparison
	N	%	N	%	
A	33	35.1	1	1.7	M > F
B	3	3.2	19	31.7	F > M
C	23	24.5	31	51.7	F > M
D	4	4.3	4	6.7	
E	16	17.0	5	8.3	
F	15	16.0	0	0	M > F

**Table 8.** Preferences to robot appearance between male and female children (kindergarten).

Robot type	Male		Female		Post hoc comparison
	N	%	N	%	
A	32	60.4	2	4.7	M > F
B	4	7.5	17	39.5	F > M
C	5	9.4	16	37.2	F > M
D	4	7.5	3	7.0	
E	5	9.4	2	4.7	
F	3	5.7	3	7.0	

**Table 9.** Emotional expression associated with robot appearance.

Emotional expression	Robot type					
	A	B	C	D	E	F
Happiness	2.25	3.86*	3.74*	2.64	2.49	2.62
Anger	3.38*	1.74	1.92	1.71	2.30*	1.94
Sadness	1.92	1.90	2.02	1.73	1.86	1.78
Fear	1.55	1.97	1.85	1.64	1.90	1.68
Understanding	2.99	3.45*	3.58*	2.84	2.94	2.88

\* $p < 0.001$ .

influence children's preference.<sup>1</sup> In order to understand children's perception on robot appearance and emotional expression, elementary school children were asked to rate the emotion associated with each of the robot pictures. As indicated in Table 9, a one-way

analysis of variance (ANOVA) on children's perceptions on robot emotional expression existed for types of the robot appearance. For each kind of emotion, the ANOVA results and post hoc comparisons were further discussed.

**Happiness.** A one-way ANOVA significant mean differences between the six types of appearance were found ( $F = 35.227, p < 0.001$ ). Post hoc comparisons revealed significant differences between groups as  $C > A, C > D, C > E, C > F, B > A, B > D, B > E,$  and  $B > F$ . In other words, robot C and robot B associated with happiness more than the other robots did.

**Anger.** A one-way ANOVA significant mean differences between the six types of appearance were found ( $F = 47.851, p < 0.001$ ). Post hoc comparisons revealed significant differences between groups as  $A > B, A > C, A > D, A > E, A > F, E > B,$  and  $E > D$ . In other words, robot A and robot E associated with anger more than the other robots did.

**Sadness.** A one-way ANOVA significant mean difference between the six types of appearance was not found ( $F = 1.430, p = 0.211 > 0.001$ ).

**Fear.** A one-way ANOVA significant mean differences between the six types of appearance were found ( $F = 4.176, p = 0.001 < 0.05$ ). Post hoc comparisons revealed significant differences between groups as  $B > A$  and  $E > A$ .

**Understanding.** A one-way ANOVA significant mean differences between the six types of appearance were found ( $F = 7.831, p < 0.001$ ). Post hoc comparisons revealed significant differences between groups as  $C > A, C > D, C > E, C > F, B > D, B > E,$  and  $B > F$ . In other words, robot C and robot B associated with human understanding more than the other robots did.

## Discussion

### *Student perceptions on robot*

In general, children's perceptions on robot personalities of friendliness, shyness, and bossiness were higher than 3.5 and lower than 2.5 on aggressiveness of the 5-point scale. In other words, children held positive attitude toward robots but considered that they could have harmless control over human being.

Comparing with elementary students, the kindergarten children tended to perceive robots' personalities of shyness. The reason is that younger children still have anthropomorphic thinking, which formed images delivered from the cartoon or comic books. Additionally, gender difference in perceptions on robots' personalities of friendliness emerged at the elementary stage. Specifically, male children considered robots less friendly and female children considered robots more friendly as age increased. The influence could be the effects from media or maturity.

### *Student perceptions on robot appearance*

Elementary children's favorite robot was robot C, followed by robot A; however, kindergarten children's favorite robot was robot A, followed by robot B and robot C. Statistical significance confirmed the existence of difference between age groups: Kindergarten children preferred robot A, and elementary children preferred robot C.

Students usually associate emotional expression with robots with certain appearance. If the appearance is associated with positive emotional expression, children will hold positive attitude toward it. Therefore, emotional expression association with robot appearance helped to understand why children preferred specific type of robot appearance. The results showed that positive emotional expressions such as happiness and understanding were associated with robot C and robot B, which were the favorite robots. Nevertheless, anger, a negative emotional expression, was associated with robot A and robot E, which were children's second favorite robots. The reason was that anger often expressed in animations or movies of robot fighting.

### *Implications for educational robot design*

The research findings revealed that children had positive attitude toward robots, which is an advantage to design a companion robot for children. Nevertheless, gender and age differences existed in perceptions on robot appearance. For pre-school children, robot A and robot B are popular because a positive relationship between the use of humanoid robots and recognition of human-likeness attributes, which is consistent with previous findings that the use of more anthropomorphic robots makes human partners more likely to treat them as real people.<sup>10</sup> For elementary students, their favorite robots have diversity of appearance. In addition to robots with positive emotional expression, they liked robots with anger emotion, which could be influenced by battle scenes in video games or media.

A prior study claimed that females tend to prefer cooperative modes of relationships rather than competitive ones. Therefore, it is possible to argue that females may not feel threatened by robots.<sup>10</sup> In this study, girls preferred robots associated with happiness and understanding, such as robot B and robot C; therefore, robots with cute or soothing features would be more popular with girls than boys. Likewise, boys prefer war-related robots such as robot A and robot F. These robots appeared to be capable of fighting.

## Conclusion

This study provided a clear picture how young children perceived robots with different appearances and the

associated personality traits. Using a psychological approach to investigate children's perceptions on robot appearance and emotional expression, the findings can provide useful implications for the robot design. In particular, the research results highlighted the need to consider the difference between age groups and gender groups, which was important for design robots based on robot–child interactions of targeted users.

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