Gender preference for humans, android-type robots, and mechanical-type robots in sports and physical activities[1)]

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Introducing robots into sports and physical activities may increase motivation and promote physical activity. This study aimed to clarify whether people prefer robots with a male or female appearance in sports and physical activities. It moreover aimed to determine whether this preference is based on their gender preference for humans. In the study, 1200 adult men and women participated and responded to question for assessing gender preference for humans, android-type robots, and mechanical-type robots. The results showed that "either" was selected by most of the respondents, and there was no relationship between these responses and participants' gender. Furthermore, there was a moderately strong relationship between the gender preferences for humans and robots. The results indicate that the assignment of a robot's gender does not seem to be necessary when introducing robots into sports and physical activities that improve people's health. It may be appropriate to introduce a robot with a neutral appearance to avoid reproducing any gender bias.

Keywords: **HRI (human–robot interaction), sport, physical activity, gender preference, gender bias**

Introduction

It is important to live a healthy life, and physical activity is necessary for that goal. Previous studies have revealed that interaction with others increases motivation and can promote physical activity. In addition to interaction with humans, interaction with robots has also been considered as a way to promote physical activity, and this approach has also been investigated. The results of a previous study suggest that robots are effective in motivating exergaming (Feltz, Forlenza, Winn, & Kerr, 2014), and promoting physical activity (Yamada, Ohsuga, Hashimoto, Inoue, & Nakaizumi, 2010). In addition, research has indicated that some people prefer robots to humans in sports and physical activity interactions, and this preference is more pronounced in people with social anxiety (Suzuki, Yamada, Nomura, & Kanda, 2021).

The appearance of a robot is important not only in daily communication situations but also during physical activities. Furthermore, the influence of gender on appearance cannot be ignored. Robots are easily assigned gender by their physical characteristics, and problems associated with robots with gender-specific properties (so-called "gendered robots") may then arise. Hence, we should carefully examine and discussed these matters when introducing robots. Previous studies suggest that men tend to prefer robots with female features and women tend to prefer robots with male features. In other words, cross-gender effects—men tend to prefer robots with female features, and women tend to prefer robots with male features—have been observed (Alexander, Bank, Yang, Hayes, & Scassellati, 2014; Koulouri, Lauria, Macredie, & Chen, 2012; Siegel, Breazeal, & Norton, 2009). By contrast, other studies have shown that robots assigned the same sex are evaluated more preferably (Kuchenbrandt, Häring, Eichberg, Eyssel, & André, 2014). Furthermore, a person's gender preference for a robot might be based on gender stereotypes people have toward people (Eyssel & Hegel, 2012; Tay, Jung, & Park, 2014). It is considered that the interaction between preferences for human gender and robot gender may differ depending on various types of interaction factors, such as the situation, task, and the human's gender stereotypes. Accordingly, factors related to robot gender must be taken into account when considering the introduction of robots into daily life.

At this time, the gendered expectations for robots remain unclear. Whether these gender stereotypes are related to existing gender stereotypes in people is also not obvious. The impact of robot gender may interact with many factors and gender preference for robots depends on these factors. Hence, this study aimed to clarify whether people prefer robots with male or female appearances in sports and physical activities and whether this preference is based on gender preferences for humans.

Method

Participants

The participants in this study consisted of 1200 adult men and women in their 20s to 60s (600

men and 600 women, 240 in each 10-year age range).

Questionnaire

Physical activity and sports situations. The physical activity and sports situations were prepared with reference to a previous study (Suzuki et al., 2021). There are seven different situations, each with two targets: an instructor and a partner. These situations are common physical activities that people can perform. Additionally, communication can occur in these situations. In each situation, an instructor and a partner were considered as the interacting people.

Gender preference for humans. In each situation, the respondents were asked to choose whether they wanted to interact with a human with the same gender or a human with the different gender in each situation by responding with one of the following options: "I want a human with the same gender to interact with," "I don't mind either," or "I want a human with another gender to interact with."

Gender preference for robot. For the robot, the respondents were asked to choose whether they wanted to interact with android-type or mechanical-type robots of the same gender or another gender and each situation by responding with one the following options: "I want a robot with the same gender type to interact with," "I don't mind either," or "I want a robot with another gender type to interact with." In this survey, the android-type robot was defined as "a robot that looks exactly like a human," and the mechanical-type robot was defined as "a robot that is similar to a human but has the appearance of metal and machinery." Furthermore, sample images of the robots (refer to Appendix 1) were shown to the respondents so that they could easily imagine the android- and mechanical-type robots.

Procedure

We counterbalanced the order of robot types, the order of physical activity and sports situations, and the order of instructors and partners.

The survey was conducted in October 2020 by monitors registered with a web-based survey company (iBRIDGE Corporation). This study was approved by the ethics review committee of the university to which the second author belongs.

Results

Prior to the subsequent analysis, the answers regarding gender preference were converted from the same gender and another gender to male and female based on the gender of the respondent. That is, the answers were re-categorized into "male," "neither," and "female" and then used for the following analysis.

First, we summarized the gender preference ratios of humans, android-type robots, and mechanical-type robots in sports and physical activities situations. In most situations, "either" or "female" were selected by more than 90% of the respondents for humans, android-type robots, and mechanical-type robots. Furthermore, for mechanical type-robots, "either" was selected noticeably more often than "female." The results of the gender preference ratios are presented in Table 1 (The number of responses for gender preferences before converting the answers are presented in Appendix 2 for reference).

The association between participants' gender and gender preferences was examined. The associations between gender and gender preferences for humans, android-type robots, and mechanical-type robots are presented in Table 2. For some situations, gender preference for humans differed according to the participant's gender, but gender preference for android- and mechanical-type robots did not differ considerably. There was no difference with respect to target (instructor or partner).

The association between gender preference for humas, android-type robots, and mechanical-type robots was also examined (Table 3). In all situations and for all targets, the gender preferences for humans, android-type robots, and mechanical-type robots were moderately related.

Table 1 Number of responses for gender preferences in various activities

		Human			Android-type robot			Mechanical-type robot		
		Male	Either	Female	Male	Either	Female	Male	Either	Female
Walking/Jogging	I	98	803	299	67	916	217	55	1004	141
		(8.2)	(66.9)	(24.9)	(5.6)	(76.3)	(18.1)	(4.6)	(83.7)	(11.8)
	P	94	755	351	63	921	216	47	1011	142
		(7.8)	(62.9)	(29.3)	(5.3)	(76.8)	(18.0)	(3.9)	(84.3)	(11.8)
Training at a sports gym	I	165	723	312	83	919	198	71	993	136
		(13.8)	(60.3)	(26.0)	(6.9)	(76.6)	(16.5)	(5.9)	(82.8)	(11.3)
	P	148	716	336	91	899	210	63	993	144
		(12.3)	(59.7)	(28.0)	(7.6)	(74.9)	(17.5)	(5.3)	(82.8)	(12.0)
Swimming	I	128	646	426	83	878	239	50	995	155
		(10.7)	(53.8)	(35.5)	(6.9)	(73.2)	(19.9)	(4.2)	(82.9)	(12.9)
	P	124	635	441	82	869	249	54	990	156
		(10.3)	(52.9)	(36.8)	(6.8)	(72.4)	(20.8)	(4.5)	(82.5)	(13.0)
Ball games	I	163	773	264	81	925	194	60	1015	125
		(13.6)	(64.4)	(22.0)	(6.8)	(77.1)	(16.2)	(5.0)	(84.6)	(10.4)
	P	142	782	276	82	913	205	57	1015	128
		(11.8)	(65.2)	(23.0)	(6.8)	(76.1)	(17.1)	(4.8)	(84.6)	(10.7)
Gymnastics/Yoga/ Aerobics	I	72	639	489	50	891	259	42	993	165
		(6.0)	(53.3)	(40.8)	(4.2)	(74.3)	(21.6)	(3.5)	(82.8)	(13.8)
	P	80	639	481	59	872	269	40	985	175
		(6.7)	(53.3)	(40.1)	(4.9)	(72.7)	(22.4)	(3.3)	(82.1)	(14.6)
Stretching exercises	I	94	664	442	50	893	257	37	1008	155
		(7.8)	(55.3)	(36.8)	(4.2)	(74.4)	(21.4)	(3.1)	(84.0)	(12.9)
	P	113	619	468	66	876	258	44	995	161
		(9.4)	(51.6)	(39.0)	(5.5)	(73.0)	(21.5)	(3.7)	(82.9)	(13.4)
Dancing	I	88	704	408	62	902	236	44	1008	148
		(7.3)	(58.7)	(34.0)	(5.2)	(75.2)	(19.7)	(3.7)	(84.0)	(12.3)
	P	94	657	449	69	875	256	45	991	164
		(7.8)	(54.8)	(37.4)	(5.8)	(72.9)	(21.3)	(3.8)	(82.6)	(13.7)

Note. I: Instructor, P: partner. The values in parentheses are percentages.

Table 2 Associations between a participant's gender and gender preferences

		Participant's gender vs. gender preference for humans				Participant's gender vs. gender preference for android-type robots				Participant's gender vs. gender preference for mechanical-type robots			
		Cramér's *V*	χ^2	*df*	*p*-value	Cramér's *V*	χ^2	*df*	*p*-value	Cramér's *V*	χ^2	*df*	*p*-value
Walking/Jogging	I	.09	10.01	2	.01	.11	15.66	2	.00	.03	1.22	2	.54
	P	.07	5.65	2	.06	.08	8.67	2	.01	.01	0.05	2	.98
Training at a sports gym	I	.19	42.48	2	.00	.11	15.37	2	.00	.09	8.97	2	.01
	P	.19	42.72	2	.00	.12	17.39	2	.00	.06	4.96	2	.08
Swimming	I	.23	66.03	2	.00	.11	14.29	2	.00	.03	0.90	2	.64
	P	.24	69.59	2	.00	.09	10.38	2	.01	.06	4.03	2	.13
Ball games	I	.18	39.24	2	.00	.12	16.51	2	.00	.03	0.78	2	.68
	P	.19	41.63	2	.00	.13	21.36	2	.00	.03	0.91	2	.64
Gymnastics/Yoga/ Aerobics	I	.14	22.07	2	.00	.06	4.92	2	.09	.04	1.82	2	.40
	P	.16	30.72	2	.00	.05	3.22	2	.20	.04	1.81	2	.40
Stretching exercises	I	.16	29.96	2	.00	.07	6.66	2	.04	.03	1.13	2	.57
	P	.21	51.82	2	.00	.05	2.89	2	.24	.04	1.62	2	.45
Dancing	I	.07	6.70	2	.04	.14	23.29	2	.00	.05	3.25	2	.20
	P	.17	32.92	2	.00	.18	40.53	2	.00	.07	6.36	2	.04

Note. I: Instructor, P: partner.

Table 3 Associations between each gender preference

		Gender preference for humans vs. gender preference for android-type robots				Gender preference for humans vs. gender preference for mechanical-type robots				Gender preference for android-type robots vs. gender preference for mechanical-type robots			
		Cramér's *V*	χ^2	*df*	*p*-value	Cramér's *V*	χ^2	*df*	*p*-value	Cramér's *V*	χ^2	*df*	*p*-value
Walking/Jogging	I	.44	474.65	4	.00	.31	237.90	4	.00	.44	462.51	4	.00
	P	.44	463.59	4	.00	.30	220.56	4	.00	.42	432.15	4	.00
Training at a sports gym	I	.42	429.00	4	.00	.27	180.27	4	.00	.45	490.71	4	.00
	P	.42	424.94	4	.00	.30	209.96	4	.00	.48	551.00	4	.00
Swimming	I	.43	445.03	4	.00	.28	184.18	4	.00	.46	502.24	4	.00
	P	.45	476.59	4	.00	.25	154.14	4	.00	.43	438.45	4	.00
Ball games	I	.45	494.73	4	.00	.30	214.64	4	.00	.47	520.38	4	.00
	P	.44	454.56	4	.00	.29	206.38	4	.00	.47	541.28	4	.00
Gymnastics/ Yoga/Aerobics	I	.43	434.10	4	.00	.30	216.44	4	.00	.47	523.40	4	.00
	P	.38	352.07	4	.00	.30	215.65	4	.00	.44	454.47	4	.00
Stretching exercises	I	.42	429.03	4	.00	.28	192.40	4	.00	.42	432.20	4	.00
	P	.42	419.72	4	.00	.27	176.37	4	.00	.41	396.03	4	.00
Dancing	I	.43	445.93	4	.00	.28	184.03	4	.00	.46	517.36	4	.00
	P	.49	572.10	4	.00	.31	230.18	4	.00	.46	510.15	4	.00

Note. I: Instructor, P: partner.

Discussion

This study aimed to clarify whether people prefer robots with a male or female appearance in sport and physical activities and whether this preference is based on gender preferences for humans.

The results showed that in the selection ratio of human, android-type robots, and mechanical-type robots, for all situations and targets, “male” was not selected; instead, “female” or “either” were selected. Furthermore, the number of respondents who chose “either” was higher than the number who chose “female,” and this was more noticeable for the mechanical-type robot. Furthermore, there was no relationship between these responses and participants’ gender, which indicates that the preferred gender of the robot tended to be independent of the gender of participants, regardless of the target’s role in sports and physical activity situations. Therefore, in terms of users’ needs, it is not necessary to assign a gender to a robot when introducing it into sports and physical activities, and it may be good to introduce a robot with a neutral gendered appearance.

There was a moderately strong relationship between the gender preferences for humans and robots. In other words, the results suggested that the attitudes for humans was reflected in the attitudes for robots. Furthermore, although there was some relationship between the gender preferences for the android-type robot and the machine-type robot, the gender preference for the android-type robot tended to be somewhat more strongly related to the gender preference for humans than the gender preference for the machine-type robot. Therefore, the results also suggested that the gender preference for humans was more likely to be reflected in the presence of human elements in robots. These trends were similar for all the sports and physical activity situations as well as for both instructor and partner targets. When introducing robots, it may be necessary to take into account some gender preferences for humans. However, as already mentioned, many people do not care about gender in the first place, so the introduction of a neutral gendered robot in a sports or physical activity may be a better alternative. The results of this study show that many respondents do not care about the gender of the robot they are interacting with, and from this point of view, it is not necessary to introduce a robot that clearly indicates its gender. That is, a gender does not

need to be assigned to robots when introducing them into sports and physical activities.

It has been pointed out that gendered robots may lead to the reproduction of gender stereotypes (e.g., Marchetti-Bowick ,2009; Robertson, 2010; Weber & Bath, 2007). Hence, because gender assignment without taking into account the consequences can be a serious problem, the introduction of gendered robots needs to be carefully considered. Considering the results of the present study, it is possible that the introduction of robots into sports or physical activities can be used to promote physical activity without causing the reproduction of gender stereotypes by not necessarily assigning a gender to the robot. In addition, the introduction of non-gendered robots can prevent the reproduction of stereotypes and reduce existing gender stereotypes.

There were no differences between the results for instructor and partner targets. The content and frequency of communication and physical contact between instructors and partners differ because of the differences in their roles. Regardless of these differences, the tendency to choose robots over people was confirmed, suggesting that the introduction of robots for the promotion of sport and physical activity can be performed without regard to the role or type of sports or physical activity. Of course, there is a possibility that this tendency will be different for the sports and physical activities that were not examined in this study, and it will be important to examine the situation again for each situation in which robots are introduced.

The assignment of a robot's gender does not seem to be necessary when introducing robots into sports and physical activities for improving people' s health. Although people who do not have a gender preference for humans are less likely to have a gender preference for robots in this study, to prevent the reproduction of gender stereotypes through robots, gender elimination in the design may be a better solution. For good health, it is important to start and maintain sports and physical activity, and there is a good probability that robots will be useful for this purpose. The introduction of robots, for example, may make it easier for people with high social anxiety to participate in these activities. The introduction of non-gendered robots may also have the secondary effect of reducing the gender stereotyping of peoples.

Finally, the limitations of this study are listed. Although several physical activities and sports situations were set up, there is a possibility that the assumed interactions differed for each person. For example, in the case of a ball game, the interaction may change depending on whether it is an individual game or a group game. This in turn may change the gender preference. In future, considering the characteristics of the interactions in more specific physical activities and sports situations will be necessary. In addition, many of the participants chose "I don't mind either." However, they may have chosen this because they were unable to sufficiently imagine the situation. Therefore, the degree of imagination must also be dealt with and its possible influence must be analyzed. Lastly, in this study, the answers regarding gender preference were converted from "same gender" and "another gender" to "male" and "female" based on the gender of the respondent prior to analysis. If the survey asked the respondents to choose either "male" or "female" as the gender preference, gender stereotypes may have influenced their responses. This is another important consideration for further study.

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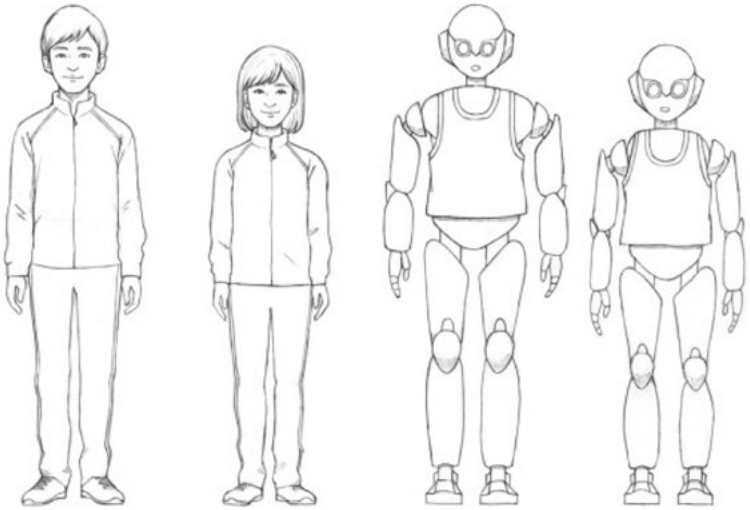
Appendix 1 The images presented as an example



Human/ Android-type robot　　Mechanical-type robot

Appendix 2 Number of responses for gender preferences before converting answers in various activities

		Human			Android-type robot			Mechanical-type robot		
		Same	Either	Another	Same	Either	Another	Same	Either	Another
Walking/Jogging	I	217	803	180	124	916	160	94	1004	102
		(18.1)	(66.9)	(15.0)	(10.3)	(76.3)	(13.3)	(7.8)	(83.7)	(8.5)
	P	239	755	206	129	921	150	93	1011	96
		(19.9)	(62.9)	(17.2)	(10.8)	(76.8)	(12.5)	(7.8)	(84.3)	(8.0)
Training at a sports gym	I	300	723	177	138	919	143	122	993	85
		(25.0)	(60.3)	(14.8)	(11.5)	(76.6)	(11.9)	(10.2)	(82.8)	(7.1)
	P	305	716	179	153	899	148	115	993	92
		(25.4)	(59.7)	(14.9)	(12.8)	(74.9)	(12.3)	(9.6)	(82.8)	(7.7)
Swimming	I	366	646	188	178	878	144	108	995	97
		(30.5)	(53.8)	(15.7)	(14.8)	(73.2)	(12.0)	(9.0)	(82.9)	(8.1)
	P	374	635	191	185	869	146	119	990	91
		(31.2)	(52.9)	(15.9)	(15.4)	(72.4)	(12.2)	(9.9)	(82.5)	(7.6)
Ball games	I	245	773	182	134	925	141	91	1015	94
		(20.4)	(64.4)	(15.2)	(11.2)	(77.1)	(11.8)	(7.6)	(84.6)	(7.8)
	P	251	782	167	136	913	151	96	1015	89
		(20.9)	(65.2)	(13.9)	(11.3)	(76.1)	(12.6)	(8.0)	(84.6)	(7.4)
Gymnastics/Yoga/ Aerobics	I	328	639	233	146	891	163	111	993	96
		(27.3)	(53.3)	(19.4)	(12.2)	(74.3)	(13.6)	(9.3)	(82.8)	(8.0)
	P	337	639	224	160	872	168	117	985	98
		(28.1)	(53.3)	(18.7)	(13.3)	(72.7)	(14.0)	(9.8)	(82.1)	(8.2)
Stretching exercises	I	325	664	211	140	893	167	95	1008	97
		(27.1)	(55.3)	(17.6)	(11.7)	(74.4)	(13.9)	(7.9)	(84.0)	(8.1)
	P	369	619	212	164	876	160	109	995	96
		(30.8)	(51.6)	(17.7)	(13.7)	(73.0)	(13.3)	(9.1)	(82.9)	(8.0)
Dancing	I	232	704	264	116	902	182	84	1008	108
		(19.3)	(58.7)	(22.0)	(9.7)	(75.2)	(15.2)	(7.0)	(84.0)	(9.0)
	P	214	657	329	112	875	213	89	991	120
		(17.8)	(54.8)	(27.4)	(9.3)	(72.9)	(17.8)	(7.4)	(82.6)	(10.0)

Note. Same: same gender, Another: another gender. I: Instructor, P: partner. The values in parentheses are percentages.

日本語タイトル
スポーツや身体活動場面における人やロボットに対する性選好

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要旨
　スポーツや身体活動の場面にロボットを導入することは，モチベーションの向上そして活動促進につながる可能性がある。本研究は，スポーツや身体活動において，男女どちらの外見のロボットが好まれるのか，そして，その好みが人間に対する性別の好みに基づいているのかを明らかにすることを目的とした。成人男女1200名が，人間，アンドロイド型ロボット，機械型ロボットに対する性別の選好をたずねる質問に回答した。分析の結果，ほとんどの参加者が「どちらでもよい」を選択し，また，その回答と参加者の性別との間には関係が認められなかった。さらに，人間とロボットの性別の好みには中程度の強い関係が見られた。これらの結果から，人々の健康増進を目的としたスポーツや身体活動にロボットを導入する際には，ロボットの性別をあえて割り当てる必要はないと考えられた。ジェンダーバイアスの再生産を避けるという点でも，中性的な外見のロボットを導入するのが適切な可能性が考えられる。

キーワード：HRI（ヒューマン・ロボット・インタラクション），スポーツ，身体活動，性選好，ジェンダーバイアス

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