Perceived Robot Attitudes of Other People and Perceived Robot Use Self-efficacy as Determinants of Attitudes Toward Robots

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Abstract. The emergence of artificial intelligence and robotization is prospected to transform societies remarkably. This study examined the associations between perceived robot attitudes of other people, perceived robot use self-efficacy, and attitudes toward robots. An online survey was collected from respondents living in the United States ($N = 969$). Analyses were conducted using t-tests, linear regression models, and mediation analyses with bootstrapped estimates. Results showed that participants with prior robot use experience expressed more positive attitudes toward robots, more positive perceived robot attitudes of other people, higher robot use self-efficacy, and higher general interest in technology and its development compared to participants without prior robot use experience. Perceived positive robot attitudes of other people, perceived robot use self-efficacy, and general interest in technology correlated with more positive attitudes toward robots among all study participants. Further, results showed that the association between perceived robot use self-efficacy and attitudes toward robots was particularly strong among those without prior robot use experience, highlighting the importance of self-efficacy beliefs in the early stages of technology adoption. The mediation analysis showed that the association between perceived robot attitudes of other people and attitudes toward robots was indirect through perceived robot use self-efficacy. The association between perceived robot use self-efficacy and attitudes toward robots was indirect through general interest in technology. Results indicate the importance of social psychological aspects of robot use and their usefulness in professionals' implementation of new robot technologies.

Keywords: Robots · Attitudes · Social psychology · Social influence · Robot use self-efficacy

1 Introduction

The emergence of artificial intelligence and robotization is prospected to transform societies remarkably [26]. Different human characteristics predicting successful implementation of novel technologies have been a topic of researchers' interest for decades [25]. This line of research is relevant also today as robots become more familiar to people. Increasingly, scholars have been investigating attitudes toward robots and their

M. Kurosu (Ed.): HCII 2021, LNCS 12763, pp. 262–274, 2021.
https://doi.org/10.1007/978-3-030-78465-2_20

acceptance in various fields and walks of life [6, 13, 28–30, 35]. However, more research is needed on the social psychological factors determining attitudes toward robots beyond the traditional technology acceptance models. Social psychological research has established that social factors and confidence in one's own abilities to successfully perform in certain tasks could influence people's thinking and behavior [2, 5, 8, 9]. Despite the possible high relevance of these factors in determining attitudes toward robots, they have been sporadically studied thus far in the context of robots and investigations have been limited to a specific field or a robot type.

Attitudes refer to relatively steady positive, negative, or neutral evaluations of the target [14]. They are formed, as suggested by attitude multicomponent theory, through three main components: cognitive, affective, and behavioral information [33]. Cognitive component mirrors one's beliefs and cognitive evaluations of the object, affective information considers feelings of and emotional responses to the object, and behavioral part refers to individuals' behavioral intentions and self-reported or observable behaviors [7, 28]. Treating dimensions as a single attitude construct has proven to be valid [1, 32], and together the dimensions can provide a comprehensive view on attitudes. Various widely used technology acceptance models have identified human attitude as determining factor of behavioral intention or actual use of novel technologies including social robots [10, 16, 39].

Social influence, drawing upon social information processing theory, suggests that information conveyed by the individual's own social network influences the way one views the target technology [34, 36]. In addition to information persuasion, social psychologists investigating conformity, compliance, and social norms have studied the idea that people's behavior and opinions are affected by social factors [8, 9]. In the context of technology, social norms have been adapted and further studied, extending the original technology acceptance model (TAM) to include social influence [11, 21]. Attitudes have been suggested to function socially – that is, attitudes are also affected by social influences, including adopting other peoples' attitudes [40].

Self-efficacy beliefs refer to one's perceptions of own capabilities to succeed in a specific situation or a task [2, 5]. Self-efficacy beliefs shape the way how individuals think, feel, behave, and motivate themselves [4]. The concept of perceived self-efficacy is based on social cognitive theory (STC) [3] which explains human activity through triadic reciprocal determinism among personal, environmental, and behavioral aspects bidirectionally affecting each other [37]. Self-efficacy beliefs have been explored yet only sporadically within the context of robots, even though it has a long history in technology acceptance research in general. In the context of robots, robot use self-efficacy has been identified as a separate construct from general self-efficacy beliefs [38], and to associate with higher acceptance of robots [24], and trust toward robots and artificial intelligence [31].

In the light of previous literature, the role of firsthand experiences of robots remains somewhat ambiguous. However, several studies have indicated that previous robot use experience predicts more positive attitudes toward robots [6, 16, 29]. In earlier technology research, it has been demonstrated that prior user experience of technology associates with stronger technology-specific self-efficacy beliefs [17, 20]. However, the net effect of positive self-efficacy beliefs has also found to decrease when one gains more user experience of the technology [18]. In addition to prior user experience and technological expertise, various sociodemographic factors may influence human attitudes toward robots, including gender, age, and educational background [12, 13, 19].

The aim of this survey study was to explore the associations between perceived robot attitudes of other people, perceived robot use self-efficacy, and attitudes toward robots. Differences between those with and without previous robot use experience were examined. Further, additional analyses were conducted to explore the role of perceived robot use self-efficacy and general interest in technology as potential mediators. Our hypotheses were:

H1: Perceived positive robot attitudes of other people associate with more positive attitudes toward robots.
H2: Perceived robot use self-efficacy associates with more positive attitudes toward robots.
H3: Participants with prior robot use experience express more positive attitudes toward robots than ones without.
H4: Participants with prior robot use experience express higher perceived robot use self-efficacy than ones without experience.

2 Methods and Materials

2.1 Participants

A survey was conducted online among American respondents in April 2019 ($N = 969$; 51.15% female, $M_{age} = 37.15$ years, $SD_{age} = 11.35$ years, *range* 15–94 years). Majority of respondents worked full or part time (86.58%), roughly ten percent (10.63%) were unemployed, and some of them were students (2.79%). More than half (65.53%) of the participants had achieved a college, a master's degree, professional degree, or higher. Approximately one-third of the study participants (33.23%) had previous experiences of interacting or using robots, while the majority (60.78%) reported not having any previous experiences, and some (5.99%) respondents were unsure if they had used or interacted with a robot previously.

2.2 Procedure

Amazon Mechanical Turk's pool of respondents was utilized for participant recruitment. The study applied the protocol offered by [22] to guarantee that the respondents were located in the United States. In the survey, respondents filled out their sociodemographic information, answered to psychological measures, views on robots, and previous user experiences. The academic ethics committee of Tampere region confirmed in December 2018 that the research project did not involve ethical problems.

2.3 Measures

Attitudes toward robots were measured applying its three dimensions: cognitive, affective, and behavioral information [33]. Question items utilized were: “How positive or negative is your view on robots if you think about your gut feeling?”, “How positive or negative is your view on robots if you think about the facts you know about robots?”, and “How positive or negative is your view on robots if you think about using or interacting with a robot?”. Respondents answered on a scale from 1 (*very negative*) to 7 (*very positive*). Three statement items were used: “I would interact with a robot, if given the opportunity”, “I feel excited when I think about robots of the future”, and “Based on my knowledge about robots, I think they are a necessary part of the future”. Answers were given on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*). A six-item composite variable was created for analyses showing excellent reliability based on McDonald’s omega coefficient ($\omega = .93$; $M = 4.83$; $SD = 1.30$).

Perceived robot attitudes of other people were measured with three questions and three statements. Questions utilized in this study were: “How positive or negative is the view on robots in general of the people that are close to you?”, “How positive or negative is the view on robots in general of other people you know?”, and “How positive or negative is the view on robots in general of the people that you respect?”, to which respondents answered on a scale from 1 (*very negative*) to 7 (*very positive*). Statement measures were: “I know a lot of people who have a positive view on robots”, “Most of the people who are close to me have a positive view on robots”, and “Most of the people I respect have a positive view on robots” to which responses were given on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*). A six-item composite variable was created showing excellent reliability ($\omega = .93$; $M = 4.64$; $SD = 1.16$).

Perceived robot use self-efficacy was measured with three items applied from the robot use self-efficacy scale (RUSH-3) [38]. The items used in this study were: “I’m confident in my ability to learn how to use robots”, “I’m confident in my ability to learn simple programming of robots if I were provided the necessary training”, and “I’m confident in my ability to learn how to use robots in order to guide others to do the same”. Scale adjustment included dropping a word ‘care’ from the original scale. Answers were given on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*). A three-item composite variable was coded showing good inter-item reliability ($\omega = .87$; $M = 5.38$, $SD = 1.19$).

As control variables, age was measured as continuous, and gender as a binary (0 = male, 1 = female) variable. A degree in engineering or technology was asked “Do you have a degree from the field of engineering or technology?”, to which participants answered either no or yes (0 = no, 1 = yes). Prior robot use experience question was formed as “Have you ever used a robot or been in an interaction with a robot?”, to which participants answered on a scale “Yes”, “No”, or “I don’t know”. For analysis, a dummy variable was created (0 = no/don’t know, 1 = yes). General interest in technology and its development was asked: “I am interested in technology and its development”, the answer options ranged from (*strongly disagree*) to 7 (*strongly agree*).

2.4 Statistical Techniques

All analyses were conducted with Stata 16 software. Beyond descriptive statistics, analyses included Welch two sample t-tests with unequal variances, ordinary least square

(OLS) regression. Mediation analyses were run with 2000-replication bootstrap [15, 27] using khb command [23]. The background assumptions of OLS models were tested with the correlation matrix, VIF values, and Breusch-Pagan test to detect drawbacks from multicollinearity and heteroscedasticity. Heteroscedasticity was detected in OLS models via significant results in the Breusch-Pagan test ($p < .001$). Hence, we report OLS regression models with robust Huber-White standard errors (*Robust SE B*), unstandardized (B) and standardized (β) regression coefficients, model goodness-of-fit measures (R^2), and model test (F) and p values.

3 Results

Results from t-test for two independent samples indicated that based on means, participants with prior robot use experience expressed significantly more positive attitudes toward robots ($M = 5.13$, $SD = 1.15$, $t[732.93] = -5.5513$, $p < .001$), and perceived robot attitudes of other people ($M = 4.98$, $SD = 1.06$, $t[706.63] = -6.6637$, $p < .001$), higher perceived robot use self-efficacy ($M = 5.59$, $SD = 1.04$, $t[755.32] = -4.2926$, $p < .001$), and more general interest in technology and its development ($M = 5.73$, $SD = 1.28$, $t[650.999] = -2.3281$, $p = .010$) compared to participants without prior robot use experience. Hence, respondents were divided into two groups for the regression models: those with ($n = 322$, 33.23%) and those without or not sure if they had previous robot use experience ($n = 647$, 66.77%). Table 1 shows the descriptive overview of the two sub-samples.

Table 1. Descriptive overview of two study samples.

Variables	Group 1: With prior robot use experience ($n = 322$)				Group 2: Without prior robot use experience ($n = 647$)			
	N	%	*M*	*SD*	*N*	%	*M*	*SD*
Attitudes	322		5.13	1.15	647		4.67	1.34
Attitudes of others	322		4.98	1.06	647		4.48	1.18
Self-efficacy	322		5.59	1.04	647		5.27	1.25
Technology interest	322		5.72	1.28	647		5.52	1.30
Age	322		35.80	10.92	647		37.83	11.51
Gender	318				636			
Female	143	44.97			345	54.25		
Male	175	55.03			291	45.75		
Degree in technology	322				647			
Yes	135	41.93			125	19.32		
No	187	59.07			522	80.68		

Note. Attitudes = Attitudes toward robots, Attitudes of others = Perceived positive robot attitudes of other people, Self-efficacy = Perceived robot use self-efficacy, Technology interest = General interest in technology and its developments

Table 2 shows the results of linear regression models for attitudes toward robots among participants with prior robot use experience. In model 1, perceived positive robot attitudes of others correlated positively with attitudes ($\beta = .76, p < .001$). In model 2, both perceived positive robot attitudes of other people ($\beta = .63, p < .001$), and perceived robot use self-efficacy ($\beta = .27, p < .001$) correlated with the attitudes. In model 3, in addition to perceived positive robot attitudes of other people ($\beta = .62, p < .001$), and perceived robot use self-efficacy ($\beta = .15, p = .025$), interest in technology ($\beta = .21, p = .001$) correlated with more positive attitudes. In the final model 4, all three positive correlates remained significant while controlling for age, female gender, and degree in technology or engineering. The final model explained 67% of the variance for attitudes toward robots ($R^2 = .67, F = 106.20, p < .001$).

Table 3 shows the results of linear regression for attitudes toward robots among participants without prior robot use experience. In model 1, perceived positive robot attitudes of other people correlated positively with more positive attitudes ($\beta = .78, p < .001$). In model 2, both perceived positive robot attitudes of other people ($\beta = .66, p < .001$), and perceived robot use self-efficacy ($\beta = .26, p < .001$) correlated with the attitudes. In model 3, perceived positive robot attitudes of other people ($\beta = .62, p < .001$), and perceived robot use self-efficacy ($\beta = .18, p < .001$), and interest in technology ($\beta = .16, p < .001$) correlated with more positive attitudes. In the final model 4, positive associations remained statistically significant while adjusting for background variables. The final model explained 67% of the variance for attitudes toward robots ($R^2 = .67, F = 301.71, p < .001$).

Given the observed changes in coefficients between different steps in both regression models, final part of the analyses focused on examining potential mediators with all study participants ($N = 969$). Two potential indirect effects were examined: 1) indirect effects of perceived robot use self-efficacy on the link between perceived positive robot attitudes of other people and attitude toward robots, and 2) indirect effects of general interest in technology on the link between perceived robot use self-efficacy and attitude toward robots.

Figure 1 illustrates the mediation analysis for perceived robot use self-efficacy. As expected, perceived positive robot attitudes of other people were found to directly associate with more positive attitudes toward robots ($B = .87$, $SE = .02$, $t = 42.06$, $\beta = 78$, $p < .001$), also when controlling perceived robot use self-efficacy ($B = .73$, $SE = .03$, $t = 25.17$, $\beta = 66$, $p < .001$). Further, perceived positive robot attitudes of others were directly associated with higher perceived robot use self-efficacy ($B = .48$, $SE = .03$, $t = 13.67$, $\beta = .47$, $p < .001$). Finally, perceived robot use self-efficacy affected significantly the link between perceived positive robot attitudes of others and attitudes toward robots, and the bootstrapped unstandardized indirect effect was .14 ($z = 7.16$, $p < .001$, 95% CI = $.098 - .172$).

Figure 2 illustrates the mediation analysis for general interest in technology. Perceived robot use self-efficacy associated directly with more positive attitudes toward robots ($B = .62$, $SE = .03$, $t = 20.15$, $\beta = .57$, $p < .001$), also when adjusting for interest in technology ($B = .42$, $SE = .04$, $t = 9.88$, $\beta = .39$, $p < .001$). Further, perceived robot use self-efficacy associated directly with interest in technology ($B = .66$, $SE = .03$, $t = 18.36$, $\beta = .61$, $p < .001$). Finally, interest in technology had an indirect effect

Table 2. Regression model for attitudes toward robots among participants with prior robot use experience in Study 1 ($n = 322$).

Measure	M1			M2			M3			M4		
	B	*Rob SE B*	β	*B*	*Rob SE B*	β	*B*	*Rob SE B*	β	*B*	*Rob SE B*	β
Attitudes of others	.83	.04	.76***	.69	.05	.63***	.67	.05	.62***	.66	.05	.61***
Self-efficacy				.30	.06	.27***	.16	.07	.15*	.15	.07	.13*
Technology interest							.19	.06	.21**	.19	.06	.22**
Age										.00	.00	−.02
Female										−.09	.07	−.04
Degree in technology										.11	.08	.05
Model R^2	.58			.64			.66			.67		
Model *F*	415.68			278.44			213.42			106.20		
Model *p*	***			***			***			***		

Note. Dependent variable: Attitudes toward robots
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 3. Regression model for attitudes toward robots among participants without prior robot use experience in Study 2 ($n = 647$).

Measure	M1			M2			M3			M4		
	B	*Rob SE B*	β	*B*	*Rob SE B*	β	*B*	*Rob SE B*	β	*B*	*Rob SE B*	β
Attitudes of others	.88	.02	.78***	.75	.04	.66***	.71	.04	.62***	.70	.04	.62***
Self-efficacy				.28	.04	.26***	.20	.04	.18***	.20	.04	.18***
Technology interest							.16	.03	.15***	.16	.04	.16***
Age										.00	.00	−.01
Female										−.13	.06	−.05*
Degree in technology										.07	.06	.02
Model R^2	.60			.66			.67			.67		
Model F	1250.85			937.44			626.18			301.71		
Model p	***			***			***			***		

Note. Dependent variable: Attitudes toward robots
*$p < .05$. **$p < .01$. ***$p < .001$.

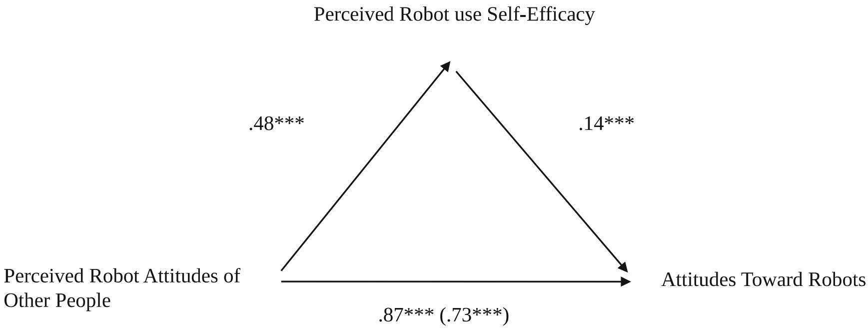

Fig. 1. Unstandardized regression coefficients for the relationship between perceived robot attitudes of other people and attitudes toward robots as mediated by perceived robot use self-efficacy among all study participants ($N = 969$). The unstandardized regression coefficients between perceived robot attitudes of others and attitudes toward robots controlling for perceived robot use self-efficacy is in parentheses. *** $p. < .001$.

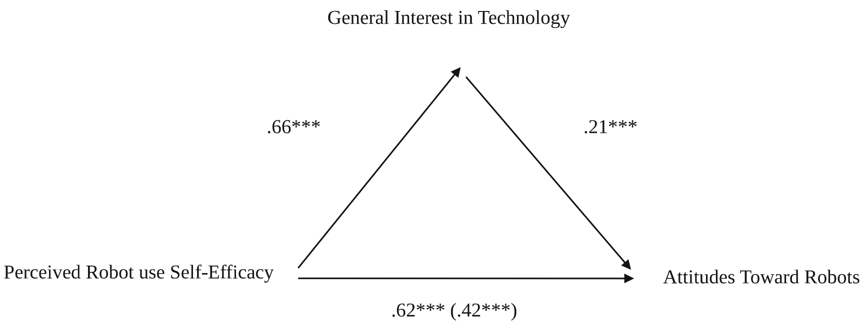

Fig. 2. Unstandardized regression coefficients for the relationship between perceived robot use self-efficacy and attitudes toward robots as mediated by interest in technology among all study participants ($N = 969$). The unstandardized regression coefficients between perceived robot use self-efficacy and attitudes toward robots controlling for general interest in technology is in parentheses. *** $p. < .001$.

on the link between perceived robot use self-efficacy and attitudes toward robots, and the bootstrapped unstandardized indirect effect was .21 ($z = 7.66$, $p < .001$, 95% CI = .155 – .262). Age, female gender, and degree in engineering or technology were used as control variables for both bootstrapped estimations.

4 Discussion

This study investigated the associations between perceived robot attitudes of others, perceived robot use self-efficacy, and attitudes toward robots. Perceived positive robot attitudes of other people were found to associate with more positive attitudes toward robots among those who had prior robot use experience and those who did not, thus confirming our first hypothesis. The findings support previous observations that attitudes can be influenced by others and ones' social environment to a certain extend [34, 36, 40].

To confirm our second hypothesis, results also showed that perceived robot use self-efficacy was associated with more positive attitudes toward robots in both models. Results support previous findings on the link between self-efficacy beliefs and robot acceptance in care work context [24, 38]. Results also showed that general interest in technology associated significantly with more positive attitudes toward robots among respondents with and without firsthand experiences of robots, stressing its important role in the formation of attitudes.

Differences between those with and without previous robot use experience were assessed. Results indicated that participants with prior robot use experience expressed significantly more positive attitudes toward robots (H3), higher robot use self-efficacy (H4), more positive perceived robot attitudes of others, and higher general interest in technology and its development compared to participants without prior robot use experience. However, in the regression models the differences remained limited in terms of significancy of associations. Female gender was negatively associated with attitudes toward robots among those without prior robot use experience only. The association between female gender and more negative attitudes toward robots has also been demonstrated in previous studies [12, 13, 19].

The results also showed that the association between perceived robot use self-efficacy and attitudes toward robots was especially strong among those without prior robot use experience. This finding supports the literature suggesting that prior user experience predicts higher technology-specific self-efficacy beliefs [17, 20], but the net effect of positive self-efficacy beliefs can decrease after gaining more user experience [18]. Finding highlights the importance of supporting individuals' self-efficacy beliefs in the early stages of technology adoption. Among participants with prior robot use experience, the association between general interest in technology and attitudes toward robots was notably strong, suggesting the importance of general technology interest in attitude formation after the first user experiences.

Additional mediation analyses examined the interrelations between the studied variables. Perceived robot use self-efficacy was found to have a significant indirect effect on the connection between perceived positive robot attitudes of other people and attitudes toward robots. General interest in technology had a significant indirect effect on the association between perceived robot use self-efficacy and attitudes toward robots, suggesting a partial mediation effect. Finding is understandable from the perspective that self-efficacy beliefs influence the way humans feel, think and motivate themselves [4], for example, in the form of increasing interest in target technology. Both indirect effects were significant but moderate, implying that the variables are related to each other only to some extent.

Our study has limitations in terms of its cross-sectional design and the fact that its only respondents were U.S. residents. However, our study is strengthened by the fact that the sample was relatively large and consisted of respondents who are geographically widespread and come from different sociodemographic backgrounds. We also adjusted for numerous factors in the models, including age, gender, and educational background. Future studies could continue investigating the potential long-term effects of perceived robot attitudes of other people, perceived robot use self-efficacy on the attitudes toward robots, and the actual use of robots. Further, as robots are becoming more familiar to humans, it is important to continue studying the role of user experiences from the perspective of the quality of such experiences and accumulation of experience after multiple uses and encounters.

Our results underline the importance of social psychological factors related to the formation of attitudes toward robots. People give high value to how their own social circles and salient others perceive robots. Attitudes toward robots are also connected to beliefs of own abilities to use such technology. General interest in technology and user experiences of robots both promote positive attitudes toward robots. Results stress the importance of social psychological aspects of robot use and their usefulness in professionals' implementation of new robot technologies.

Funding Acknowledgment. This work was supported by the Finnish Cultural Foundation (Robots and Us Project, 2018–2020, PIs Jari Hietanen, Atte Oksanen, and Veikko Sariola).

Disclosure statement. The authors report no conflict of interest.

References

1. Bagozzi, R.P., Burnkrant, R.E.: Single component versus multicomponent models of attitude: some cautions and contingencies for their use. In: Olson, J.C., Abor, A., MI: Association for Consumer Research (eds.) Advances in Consumer Research, vol. 7, pp. 339–344 (1980)
2. Bandura, A.: Self-efficacy: toward a unifying theory of behavioral change. Psychol. Rev. **84**(2), 191–215 (1977)
3. Bandura, A.: Social Foundations of Thought and Action: A Social Cognitive Theory. Prentice-Hall, Englewood Cliffs (1986)
4. Bandura, A.: Self-efficacy. In: Ramachaudran, V.S. (ed.) Encyclopedia of Human Behavior, vol. 4, pp. 71–81. Academic Press, New York (1994)
5. Bandura, A.: Self-Efficacy: The Exercise of Control. Freeman, New York (1997)
6. Bartneck, C., Suzuki, T., Kanda, T., Nomura, T.: The influence of people's culture and prior experiences with Aibo on their attitude towards robots. AI Soc. **21**(1–2), 217–230 (2007)
7. Breckler, S.J.: Empirical validation of affect, behavior, and cognition as distinct components of attitude. J. Pers. Soc. Psychol. **47**(6), 1191–1205 (1984)
8. Cialdini, R.B., Goldstein, N.J.: Social influence: compliance and conformity. Annu. Rev. Psychol. **55**, 591–621 (2004)
9. Cialdini, R.B., Trost, M.R.: Social influence: social norms, conformity and compliance. In: Gilbert, D.T., Fiske, S.T., Lindzey, G. (eds.) The Handbook of Social Psychology, pp. 151–192. McGraw-Hill (1998)
10. Davis, F.D., Bagozzi, R.P., Warshaw, P.R.: User acceptance of computer technology: a comparison of two theoretical models. Manage. Sci. **35**(8), 983–1003 (1989)
11. Dickinger, A., Arami, M., Meyer, D.: The role of perceived enjoyment and social norm in the adoption of technology with network externalities. Eur. J. Inf. Syst. **17**(1), 4–11 (2008)
12. Flandorfer, P.: Population ageing and socially assistive robots for elderly persons: the importance of sociodemographic factors for user acceptance. Int. J. Popul. Res. **2012**, article ID 829835 (2012). https://doi.org/10.1155/2012/829835
13. Gnambs, T., Appel, M.: Are robots becoming unpopular? Changes in attitudes towards autonomous robotic systems in Europe. Comput. Hum. Behav. **93**, 53–61 (2019)

14. Haddock, G., Maio, G.R.: Attitudes. In: Hewstone, M., Stroebe, W., Jonas, K. (eds.) Introduction to Social Psychology, 6th edn., pp. 171–200. Wiley (2015)
15. Hayes, A.F., Scharkow, M.: The relative trustworthiness of inferential tests of the indirect effect in statistical mediation analysis: does method really matter? Psychol. Sci. **24**(10), 1918–1927 (2013)
16. Heerink, M., Kröse, B., Evers, V., Wielinga, B.: Assessing acceptance of assistive social agent technology by older adults: the almere model. Int. J. Soc. Rob. **2**(4), 361–375 (2010)
17. Hill, T., Smith, N.D., Mann, M.F.: Role of efficacy expectations in predicting the decision to use advanced technologies: the case of computers. J. Appl. Psychol. **72**(2), 307–313 (1987)
18. Hu, P.J.H., Clark, T.H., Ma, W.W.: Examining technology acceptance by schoolteachers: a longitudinal study. Inf. Manage. **41**(2), 227–241 (2003)
19. Hudson, J., Orviska, M., Hunady, J.: People's attitudes to robots in caring for the elderly. Int. J. Soc. Rob. **9**(2), 199–210 (2017)
20. Igbaria, M., Iivari, J.: The effects of self-efficacy on computer usage. Omega **23**(6), 587–605 (1995)
21. Im, I., Hong, S., Kang, M.S.: An international comparison of technology adoption: testing the UTAUT model. Inf. Manage. **48**(1), 1–8 (2011)
22. Kennedy, R., Clifford, S., Burleigh, T., Waggoner, P.D., Jewell, R., Winter, N.J.: The shape of and solutions to the MTurk quality crisis. Polit. Sci. Res. Methods **8**(4), 614–629 (2020)
23. Kohler, U., Karlson, K.B., Holm, A.: Comparing coefficients of nested nonlinear probability models. Stata J. **11**(3), 420–438 (2011)
24. Latikka, R., Turja, T., Oksanen, A.: Self-efficacy and acceptance of robots. Comput. Hum. Behav. **93**, 157–163 (2019)
25. Lee, Y., Kozar, K.A., Larsen, K.R.: The technology acceptance model: past, present, and future. Commun. Assoc. Inf. Syst. **12**(1), 50 (2003)
26. Makridakis, S.: The forthcoming artificial intelligence (AI) revolution: its impact on society and firms. Futures **90**, 46–60 (2017)
27. MacKinnon, D.P., Lockwood, C.M., Williams, J.: Confidence limits for the indirect effect: distribution of the product and resampling methods. Multivar. Behav. Res. **39**(1), 99–128 (2004)
28. Naneva, S., Sarda Gou, M., Webb, T.L., Prescott, T.J.: A systematic review of attitudes, anxiety, acceptance, and trust towards social robots. Int. J. Soc. Rob. **12**, 1179–1201 (2020)
29. Nomura, T., Kanda, T., Suzuki, T.: Experimental investigation into influence of negative attitudes toward robots on human–robot interaction. AI Soc. **20**(2), 138–150 (2006)
30. Nomura, T., Suzuki, T., Kanda, T., Kato, K.: Measurement of negative attitudes toward robots. Inter. Stud. **7**(3), 437–454 (2006)
31. Oksanen, A., Savela, N., Latikka, R., Koivula, A.: Trust toward robots and artificial intelligence: an experimental approach to human-technology interactions online. Front. Psychol. **11**, 568256 (2020)
32. Ostrom, T.M.: The relationship between the affective, behavioral, and cognitive components of attitude. J. Exp. Soc. Psychol. **5**(1), 12–30 (1969)
33. Rosenberg, M.J., Hovland, C.I.: Cognitive, affective and behavioral components of attitudes. In: Rosenberg, M.J., Hovland, C.I. (eds.) Attitude Organization and Change: An Analysis of Consistency Among Attitude Components, pp. 1–14. Yale University Press (1960)
34. Salancik, G.R., Pfeffer, J.: A social information processing approach to job attitudes and task design. Adm. Sci. Q. **23**(2), 224–253 (1978)
35. Savela, N., Turja, T., Oksanen, A.: Social acceptance of robots in different occupational fields: a systematic review. Int. J. Soc. Rob. **10**(4), 493–502 (2018)
36. Schmitz, J., Fulk, J.: Organizational colleagues, media richness, and electronic mail: a test of the social influence model of technology use. Commun. Res. **18**(4), 487–523 (1991)

37. Stajkovic, A.D., Luthans, F.: Social cognitive theory and self-efficacy: going beyond traditional motivational and behavioral approaches. Organ. Dyn. **26**(4), 62–74 (1998)
38. Turja, T., Rantanen, T., Oksanen, A.: Robot use self-efficacy in healthcare work (RUSH): development and validation of a new measure. AI Soc. **34**, 137–143 (2019)
39. Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D.: User acceptance of information technology: toward a unified view. MIS Q. **27**(3), 425–478 (2003)
40. Yang, H.D., Yoo, Y.: It's all about attitude: revisiting the technology acceptance model. Decis. Support Syst. **38**(1), 19–31 (2004)