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Media effects on the perceptions of robots

Nina Savela | Tuuli Turja | Rita Latikka | Atte Oksanen

Faculty of Social Sciences, Tampere University, Tampere, Finland

Correspondence
Nina Savela, Faculty of Social Sciences, Tampere University, Kalevantie 5, 33100 Tampere, Finland.
Email: nina.savela@tuni.fi

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Abstract

This study utilizes the media persuasion perspective to investigate the connection of media exposure of robots on the general attitude and trust toward robots of people from different cultural backgrounds. Study 1 utilized 2016 survey data from Finnish care workers ($N = 3800$). Study 2 used two 2019 datasets from the adult population of the United States ($N = 1003$; $N = 969$), and Study 3 involved a trust game experiment on robots ($n = 331$). Results showed that the overall media exposure of robots is linked to a positive general attitude toward robots, but only fact-based media channel exposure had a positive impact on trust in robots. Results suggest that the experience of robots gained through media exposure is a relevant factor affecting people's perceptions of robots. The findings contribute to the discussions on media effects and have practical implications for gaining evidence about the precursors of accepting robots.

KEYWORDS
attitudes, cultivation, dual-process theories, fiction, media, mere-exposure, nonfiction, persuasion, robot, trust

1 | INTRODUCTION

Over the years, science fiction entertainment has produced a vast number of images and narratives about robots influencing the representations of robots available to people. Even the concept of a *robot* originates from an entertainment production: a Czech play *R.U.R.* by Karel Čapek from 1920 (Stone, 2004). Several stories and visual imagery using the concept of robots have since increased in the entertainment products of various genres, some of which have become familiar cultural products for people from different cultural backgrounds. Similar to the first fictional representation of robots, dystopian elements depicting robots as a threat to humankind have been a part of classic entertainment media products such as Fritz Lang's *Metropolis* (1927), Ridley Scott's *Bladerunner* (1982, based on Philip K. Dick's *Do Androids Dream of Electric Sheep* [1968]), and *Terminator* (1984) and its sequels (1991–2019).

Hollywood also has history in presenting more utopistic visions of robots that not only aid humans but also provide companionship similar to other humans, such as in the case of droids in the *Star Wars* franchise, which has had a massive cultural significance since the first *Star Wars* movie in 1977. Therefore, it is not surprising that C-3PO and R2-D2 from the *Star Wars* universe are one of the first representations of robots that people recall (Broadbent et al., 2010; Khan, 1998; Kriz et al., 2010). The newer robot representations in entertainment media include both animated robots, such as the science fiction animation *WALL-E* (2008), and more realistic robot designs positioned in the emerging fields of robotics, such as the science fiction indie drama *Robot and Frank* (2012). In addition to popular media, robots have also been part of the contemporary discourses through somewhat more reality-based channels, such as documentaries, exhibitions, and news, which also provide information about existing robot products.

Media is a significant part of people's daily lives influencing the conversation topics and thinking processes going through our minds (King et al., 2017). Previous research has shown that people are affected by the news (Berkowitz, 1991; Johnston & Davey, 1997). Thus, journalistic content, such as news and documentaries on robots, is also likely to influence people's perceptions about robots. Receiving robot information through various media channels might evoke certain representations of robots in individuals and even cultivate the previously held conceptions toward new adjusted ones. Perceptions are also prone to be affected when consuming fictive stories and imagery (Green et al., 2008; Sargent et al., 2002; van Laer et al., 2014). Researchers have suspected that science fiction narratives and images have a significant influence on the field of robotics and people's perceptions of robots (Bartneck et al., 2007; Bruckenberger et al., 2013; Ray et al., 2008). However, currently, there is a lack of stronger empirical evidence about the impact of both fiction- and fact-based robot information on people's perceptions of robots.

This article aims to fulfill the research gap by examining the topic of robot perceptions with the focus on the persuasive nature of robot information mediated through fiction- and fact-based sources. Our research question was: Are positive attitude and trust toward robots stronger among people with more extensive media exposure to robots? With this approach, our goals were to gain evidence about and contribute to the on-going discussion on attitudes and trust toward technology, as well as the conditions of technology usage in general (Hancock et al., 2020; Oksanen et al., 2020; Shin, 2021b, 2021c, 2021d, 2021f). In this article, our theoretical framework combines the media persuasion perspective, utilizing the following theories: cultivation theory (Gerbner et al., 2002), familiarity principle (Reis et al., 2011), mere-exposure effect (Zajonc, 1968), multiple source effect (Harkins & Petty, 1981), elaboration likelihood model (ELM; Petty & Cacioppo, 1986) and heuristic-systematic model of information processing (HSM; Chaiken, 1980), narrative transportation theory (Gerrig, 1993), cognitive dissonance theory (Festinger, 1957), and the idea of cognition-based trust in trust theory (McAllister, 1995). Although ELM and HSM have been deployed to comprehend how users perceive artificial intelligence (AI) in the context of algorithmic journalism (Shin, 2021b, 2021e), the theoretical framework of media persuasion has not previously been utilized in the analysis of trust and general attitude toward robots.

2 | MEDIA PERSUASION EFFECTS ON ATTITUDES AND TRUST

Attitudes refer to subjective assessments on a certain person or object and are often categorized as positive, negative, or neutral but also overlapping, ambivalent, and varying in strength (Bohner & Dickel, 2011). When asked about their attitudinal stance, it is suggested that people first activate an unconscious appraisal from memory intuitively, deliberately search information and previous assessments, and, finally, summarize the information from previous phases into a response (Krosnick et al., 2005). Attitude assessment therefore relies on the mental and socially shared representations of the object based on previously received information and experiences that are recalled from a memory when requested (Moscovici, 1990; Smith, 1998). Specific concepts and discourse might influence what memories and imagery are triggered, and in which the evaluations will ultimately be based on (de Groot, 1989; Wagner et al., 1996, 1999).

Trust toward a person or object can be seen as a concept close to attitude or even as a hyponym to it, as trust has also been defined as an affective attitude (Jones, 1996). However, trust theories have conceptualized both an affective and cognitive basis for trust (McAllister, 1995). This multidimensional view of trust is similar to some theoretical views on attitudes and persuasion (Petty & Cacioppo, 1986), and it has been utilized in research regarding trust in information technology (Li et al., 2008). Both attitude and trust concepts have been included when measuring the acceptance of robots and other technology (Shin, 2021d; Venkatesh et al., 2003). Trust in AI has been found to be associated with both emotional factors, such as uneasiness and comfortableness (Nomura et al., 2006; Shin, 2021d), and cognitive factors, such as explainability and accountability (Shin, 2020a, 2020b, 2021c, 2021f). This highlights the similar components in both attitude and trust constructs.

Differences in attitude and trust can also be found depending on the specific type of attitude and trust being measured. Attitude measurement can be a useful tool to capture anticipated attitudes in general toward a technology before the adoption (Perugini & Bagozzi, 2001). A complementing trust measurement could then be targeted at measuring trust in specific user situations or actual trusting behavior. Because self-reported survey questions about general trust in the target object are not necessarily the best predictors of trusting behavior (Glaeser et al., 2000), one reliable option would be to measure trust in a precise trust factor, such as trust in the technology's safety, or indirectly through a behavioral experiment. A trust game is an experimental method that originates from investment games in the field of economics (Berg et al., 1995; Camerer, 2003) and has been used to measure trust toward various opponents in different contexts (Johnson & Mislin, 2011; Samson & Kostyszyn, 2015; Xin et al., 2016).

Assessing trust regarding specific user situations and through trusting behavior in a monetary game could steer one's focus more on fact-based information and responding with cognitive-based trust (McAllister, 1995; Petty & Cacioppo, 1986). Thus, when looking at the attitude and trust formation and experiences that are recalled when evaluating one's perceptions, research performed under the theoretical framework of persuasion is critical for examining how people's beliefs, motivations, and behavior are influenced (Wood, 2000). The persuasiveness of the information concerns the information content (Wood et al., 1985) and source credibility (Heesacker et al., 1983). The two-route persuasion mechanism is manifested in ELM (Petty & Cacioppo, 1986) and HSM (Chaiken, 1980) research, which both aim to explain the cognitive process of persuasion with two information processing paths, a central or systematic route and a peripheral or heuristic route, the former one used when strongly motivated and latter one used to minimize cognitive effort. The dual-process framework of ELM and HSM have been utilized to study trust and attitudes toward AI in the context of algorithmic journalism (Shin, 2021b, 2021e).

When people hold incoherent attitudes or contradictory knowledge about something, this cognitive dissonance is said to drive people to re-evaluate their beliefs to reduce the dissonance (Festinger, 1957). Although the cognitive dissonance theory offers explanation on how fact-based information is processed, it does not explain how fiction influences people's thinking. Narrative transportation theory (Gerrig, 1993) is one attempt to unravel the mechanism in which fictional stories impact perceptions. Stories stored in memory have argued to have long-lasting effects (Hamby et al., 2020), even though the information content and source are known to be fiction-based and created to attract the receiver by other means (van Laer et al., 2014). In the context of entertainment media effects, consuming media content is likely to influence people's thinking gradually, as demonstrated in the cultivation theory (Potter, 2014).

Finally, one branch of persuasion theory and research on the mere-exposure effect (Zajonc, 1968) and familiarity principle (Reis et al., 2011) also argue that, regardless of the content and source, the mere frequency of exposure is inclined to positively affect one's attitude due to familiarity attraction. The multiple source effect argues that being exposed to the information through multiple channels instead of just one increases its trustworthiness because people consider it more credible if the same information is provided in multiple sources (Harkins & Petty, 1981). In the field of marketing, researchers have suggested that extensive coverage increases the cognitive processing of the information, although the effect on attitude is not necessarily positive (Chang & Thorson, 2004).

3 | MEDIA PERSUASION AND PERCEPTIONS OF ROBOTS

There is some existing research literature on media persuasion and perceptions of robots indicating that media persuasion affects the perceptions of robots as well. One field study found that participants watching a fictional film featuring a humanoid robot gained better understanding of humanoid robots, which predicted willingness to interact with them (Appel et al., 2016). Based on another field experiment, participants who read a fictive story of robot protagonist perceived humanoid robots less eerie compared to the ones who read nonnarrative information or received no prior information about robots (Mara & Appel, 2015). One survey study found that people who recalled a higher number of media portrayals of robots had lower level of anxiety toward robots (Sundar et al., 2016).

Eurobarometer (2017) asked Europeans about their general attitude toward and opinions about AI and robots as well as whether people had seen, heard, or read about AI in the last 12 months. People exposed to information about AI had more positive general attitude toward robots and AI compared to those not exposed (75 vs. 49%; Eurobarometer, 2017). The average attitudes toward robots vary among different countries, and researchers have hypothesized that this is partly caused by different emphasis in the media depending on the culture (Li et al., 2010; Turja & Oksanen, 2019). De Graaf et al. (2016) suggested that preadoption perceptions are based on affect or cognition and can be gained through indirect experiences with technology, such as media exposure. The potential of media influence was apparent in the interview results because participants recalled movie and documentary representations when asked what comes to mind when thinking about robots (de Graaf et al., 2016).

Previous researchers have also found that user characteristics such as sociodemographic factors are associated with the perceptions of robots (de Graaf & Allouch, 2013; Flandorfer, 2012; Gnambs & Appel, 2019). The influence of age and gender has varied depending on the specific dependent variable being explained, but older people's and women's perceptions and anticipated interaction with robots seem to be more negative than what younger people and men have (de Graaf & Allouch, 2013). Researchers have also suggested that technological education influences human–robot interaction (Nomura & Takagi, 2011). However, the relationship between sociodemographic factors and the acceptance of robots seems to be fairly complex, and Flandorfer (2012) has proposed that previous experiences of technology are likely to mitigate such connections.

People seem to be more willing to accept robots when they have firsthand experiences of them (Bartneck et al., 2007; Heerink et al., 2010; Nomura et al., 2006), which is in line with the research on technology adoption in general (Jeyaraj et al., 2006). Without firsthand experiences people are expected to use, for example, fictional representations of robots to reduce the uncertainty (Spatola & Urbanska, 2020). Similar notions are found in research on trust in technology. Trust in the automation literature shows that trust is established by gaining knowledge and experience through interactions (Hancock et al., 2011, 2020; Lee & See, 2004; Schaefer et al., 2016). However, lack of prior interaction experience with and direct information about a technology has been stated to direct people to depend on indirect sources such as second-hand knowledge, the degree of cognitive familiarity determining their initial trusting beliefs toward it (Li et al., 2008).

4 | RESEARCH OVERVIEW

We examined in three survey studies whether previous media exposure to robots is associated with general attitude and trust toward robots. Our studies are based on persuasion theories and the literature on the acceptance of robots. In the light of cultivation theory, we were interested in media effects cultivating over time, rather than short-term reactions to specific messages (Potter, 2014). In Study 1, we investigated the connection of prior robot media exposure to the positive attitude and trust toward robots with a Finnish sample of care work professionals. In Study 2, we examined whether the association of media exposure and positive attitude toward robots was found in the general adult population of the United States. Finally, Study 3 focused on media exposure and trust toward robots using a trust game experiment.

Previous literature has suggested that the overall exposure to an attitude object increases the positivity toward it due to the familiarity (Reis et al., 2011; Zajonc, 1968). In addition, the multiple source effect (Harkins & Petty, 1981) states that the effect of media exposure on perceptions increases as the variety of media exposure sources increases. Based on these theoretical arguments and on previous findings regarding exposure to fictive robots (Appel et al., 2016; de Graaf et al., 2016; Mara & Appel, 2015; Sundar et al., 2016), we expected that more extensive media exposure to robots would be connected to positive general attitude toward robots (H1).

We also divided the media exposure in fiction and fact-based media outlets and investigated the difference of fiction- and fact-based media persuasion on attitudes and trust. Based on the cognitive and calculative bases of trust in two-dimensional trust theory (McAllister, 1995) and the previous literature on the cognitive factors behind trusting robots and other technology (Hancock et al., 2011, 2020; Lee & See, 2004; Li et al., 2008; Schaefer et al., 2016), we expected the more extensive fact-based media exposure to robots to be connected to higher trust toward robots (H2). We treated age, gender, technological education, and firsthand experience with robots as control variables in all analyzed models.

> **H1.** Positive attitude toward robots increases as the variety of sources in prior media exposure to robots increases.

> **H2.** Trust toward robots increases as the variety of sources in prior fact-based media exposure to robots increases.

5 | STUDY 1

A fairly new domain for robotics is welfare services, to which robots are currently being designed to aid social and health care staff and take over some of the tasks previously done by care workers (Maalouf et al., 2018; Savela et al., 2018). As care workers are one of the main end users in this field, their attitudes and trust toward robots are key issues in the overall acceptance and successful deployment of new technology. In Study 1, we examined Finnish care workers' prior media experiences with robots and their perceptions of robots. Thus, Study 1 investigated the connection of prior robot media exposure to attitude and trust toward robots (H1 and H2) in a specific end user group.

5.1 | Method

5.1.1 | Participants

In Study 1, we utilized random sample of Finnish care workers ($N = 3800$, 95% female, $M_{\text{age}} = 46.5$ years, $SD_{\text{age}} = 11.3$ years, range 17–70 years) in December 2016. The sample was collected in co-operation with two Finnish trade unions. Drawing the sample from the trade union member registers was rationalized by the fact that a high proportion (90%) of Finnish nurses are unionized. The division between practical nurses (64.9%) and registered (35.1%) nurses in the sample was similar to the division between practical (64.7%) and registered (35.3%) nurses in the Finnish care worker population (Turja et al., 2019).

5.1.2 | Measures

The first dependent variable was the participants' perceived general attitude toward robots, which was measured by asking the participants to rate their response on a scale from 1 to 4: "Generally speaking, how positive or negative is your view on robots?" We grouped together the values 1–2 and 3–4 for a dummy variable as the first dependent variable in the analysis, value 1 indicating positive and value 0 negative. To analyze the second dependent variable, trust in the safety of care robots, we drew a subsample ($n = 544$) from the care worker sample. This subsample included those care workers who had some firsthand experience with care robots. Each of the four robot types reported to have been used opened up seven additional questions from the Almere model (Heerink et al., 2010)—for example, the intention to use the robot and trust in the safety of the robot. The answers were given on a 5-point Likert scale from *totally disagree* to *totally agree*, and after standardizing the scales, a higher rating indicated more trust toward the robot ($M = 3.26$, $SD = 1.08$).

Main independent variable, previous media exposure to robots, was measured by asking the participants if they had heard, read, or seen anything about robots in any of the following eight outlets: books and other stories; movies or TV shows; games; documentary movies or TV shows; news websites; newspapers; or educational or promotional event. We considered the last option to be interactive media in the sense that it is a channel mediating fact-based information. We defined the first three as fiction-based and the four latter ones as fact-based outlets. For analyses, we created three summative sum variables: prior media exposure (scale 0–7), prior fiction-based media exposure (scale 0–3), and prior fact-based media exposure (scale 0–4).

Control variables included age, gender, a technology degree, and firsthand experience with robots. We used age and firsthand robot experience as continuous variables and gender and a technology degree (4% of the respondents) as dummy variables. The firsthand robot experience measured any robot use experience prior to the study at home, work, or elsewhere (e.g., 88% no experience, 10.9% experienced in one of the contexts, 1.1% experienced in two or three contexts). All Study 1 variables are presented in Table 1.

5.1.3 | Analysis

We used the binary logistic regression method for analyzing general attitude and ordinary least squares (OLS) regression with trust

TABLE 1 Summary of descriptive statistics of the Study 1 variables ($N = 3800$)

Measure	*n*	%	*M*	*SD*	Range
General attitude toward robots	2771		2.58	0.71	1–4
1 = Positive	2771	58.4			
0 = Negative	2771	41.6			
Trust in the safety of care robots	456		3.24	1.08	1–5
Age	3700		46.50	11.30	17–70
Gender	3685				
0 = Female		95			
1 = Male		5			
A degree from technology	3670				
1 = Yes		4			
0 = No		96			
Firsthand experience with robots	3736				
1 = Yes		21			
0 = No/Maybe		79			
Prior media exposure to robots	3396				
Fiction-based	3396		0.62	0.92	0–3
Fact-based	3996		1.94	1.02	0–4

analysis. We also report Pearson product–moment correlation *r* and p values for the main variables. For logistic regression, we report odds ratios (ORs), confidence intervals for ORs (95% CI), p values for the different measures, Nagelkerke pseudo R^2, and model test χ^2 statistics. For the linear regression model, we report unstandardized regression coefficients (*B*) and their standard errors (SE *B*), standardized beta coefficients (β), and p values for the different measures, in addition to model goodness-of-fit measure (R^2), model test (*F*), and the p value of the model. We did not detect problematic multicollinearity or heteroscedasticity in the regression models.

5.2 | Results

Based on the Pearson correlation results in Study 1, general attitude toward robots correlated with overall media exposure ($r = .25$, $p < .001$), fiction-based media exposure ($r = .16$, $p < .001$), and fact-based media exposure ($r = .24$, $p < .001$) to robots. Table 2 shows the regression analysis results for general attitude. While controlling for confounding effects of the background variables, more extensive overall exposure to robots in various media outlets was associated with positive general attitude toward robots in Model 1 (OR = 1.40, $p < .001$). The association was similar separately for fiction- (OR = 1.52, $p < .001$) and fact-based (OR = 1.26, $p < .001$) media exposure to robots in Model 2.

Trust toward the safety of care robots correlated with fact- ($r = .11$, $p = .019$) but not fiction-based media exposure. Similarly, regression analysis results for trust reported in Table 3 show that trust toward the safety of care robots was associated only with fact-based media exposure ($\beta = .13$, $p = .014$).

6 | STUDY 2

In Study 2, we aimed to replicate the result in Study 1 regarding attitudes and the first hypothesis (H1) in the general adult population of the United States. Again, we measured the media exposure as an aggregate factor and divided it further into fiction- and fact-based media outlets. Differently from the previous study, in Study 2, we measured general attitude in a scale of 1–7, treated it as a continuous variable, and, for the linear correlations, utilized an OLS regression instead of a nonparametric method. We considered age, gender, a degree in technology, and firsthand experience with robots as control variables, as in Study 1.

6.1 | Method

6.1.1 | Participants

We collected survey data in 2019 in January ($N = 1003$, 48.89% male, $M_{age} = 37.36$ years, $SD_{age} = 11.80$ years, range 19–78 years) and April ($N = 969$, 48.85% male, $M_{age} = 37.15$ years, $SD_{age} = 11.35$ years, range 15–94 years). We used Amazon's Mechanical Turk for recruiting respondents as a reliable method to reach various demographical groups of the US adult population so as to carry out behavioral research that includes survey experiments (Huff & Tingley, 2015; Paolacci & Chandler, 2014; Yeager et al., 2019). To guarantee the validity of the data and to avoid any problems caused by nonnaive respondents, the second sample included only unique participants who did not take part in the previous sample (Chandler et al., 2014,

TABLE 2 Summary of regression analyses for Study 1 variables, general attitude toward robots as a dependent variable: Finnish care workers ($N = 3800$)

	Model 1			Model 2		
Measure	**OR**	**95% CI**	**p**	**OR**	**95% CI**	**p**
Age	1.02	1.01–1.02	<.001	1.02	1.01–1.02	<.001
Female gender	.68	.46–1.01	.056	.67	0.45–0.99	.044
Technology degree	1.26	.83–1.93	.276	1.27	0.84–1.94	.262
Firsthand robot experience	.58	.46–.72	<.001	.59	0.47–0.74	<.001
Prior media exposure to robots	1.40	1.32–1.48	<.001			
Prior fiction-based media exposure to robots				1.26	1.14–1.39	<.001
Prior fact-based media exposure to robots				1.52	1.39–1.65	<.001
Model Nagelkerke pseudo-R^2		.10			.10	
Model X^2		206.35			212.78	
Model p		<.001			<.001	

Note: Dependent variable: General attitude toward robots.

TABLE 3 Summary of regression analyses for Study 1 variables, Trust in the Safety of care robots as a dependent variable: Finnish care workers ($n = 544$)

	Model 1			Model 2		
Measure	***B***	**SE *B***	***β***	***B***	**SE *B***	***β***
Age	.01	.01	.01	.00	.01	−.01
Female gender	−.23	.21	−.06	−.21	.21	−.05
Technology degree	.00	.24	.00	.01	.24	.00
Overall firsthand experience with robots	.12	.09	.07	.11	.09	.06
Prior media exposure to robots	.05	.03	.09			
Prior fiction-based media exposure to robots				−.03	.06	−.03
Prior fact-based media exposure to robots				.12	.05	.13*
Model R^2		.02			.02	
Model *F*		1.30			1.60	
Model p		.26			.15	

Notes. Dependent variable: Trust in the safety of care robots.
*p < .05

2015). We also excluded non-US participants from the data (Kennedy et al., 2020) and checked the data for odd response behavior, such as too quick responses or identical answers throughout the survey.

Participants were informed that by completing the survey they give their consent for the data to be used for research purposes. According to the standards of the Ethics Committee of the Tampere Region and the Finnish National Board on Research Integrity for Human Sciences, our research does not include any ethical problems.

6.1.2 | Measures

The dependent variable was the participants' perceived general attitude toward robots. This was measured in both samples on a scale from 1 to 7 (1 = *very negative*, 7 = *very positive*) by asking participants to rate their attitude with one question: "Generally speaking, how positive or negative is your view on robots?"

The main independent variable was again prior media exposure to robots, which we measured by asking the participants if they had heard, read, or seen anything about robots in any of the following eight outlets: movies; TV shows; games; fiction literature (novels, etc.); nonfiction literature (textbooks, etc.); newspapers or news websites; nonfiction movies or TV shows (documentaries, etc.); and research, exhibition, or promotional event. We considered the last option to be interactive media in the sense that it is a channel mediating fact-based information. For analyses, we created three summative sum variables: prior media exposure (scale 0–8), prior fiction-based media exposure (scale 0–4), and prior fact-based media exposure (scale 0–4).

Control variables included age, gender, a technology degree, and firsthand experience with robots. We used age as a continuous variable and the other ones as dummy variables. In terms of firsthand robot experience, the options were *yes*, *no*, or *do not know*, from which we created a dummy variable (1 = *yes*, 0 = *no/do not know*). Study 2 variables are presented in Tables 4 and 5.

6.1.3 | Analysis

We used Pearson product–moment correlation and OLS regression analysis methods. We report Pearson's *r* and p values for the main variables. We also report unstandardized regression coefficients (*B*) and their standard errors (*B* SE), standardized beta coefficients (β), and p values for the different measures, in addition to model goodness-of-fit measure (R^2), model test (*F*), and the p value of the model. We did not detect problematic multicollinearity, and the residuals met the expectations of OLS for homoscedasticity and normality.

6.2 | Results

Based on the Pearson correlation results in Study 2, general attitude toward robots correlated with prior overall media exposure ($r = .14$, $p < .001$; $r = .09$, $p = .007$), fiction-based media exposure ($r = .12$, $p < .001$; $r = .07$, $p = .036$), and fact-based media exposure ($r = .11$, $p < .001$; $r = .08$, $p = .013$) to robots. We represent the regression analysis results for Samples 1 and 2 in Tables 6 and 7, respectively. Study 2 replicated results from Study 1 regarding the overall media effect exposure on attitudes. More extensive exposure to robots in various media outlets was associated with positive general attitude toward robots in Model 1 for Sample 1 ($\beta = .10$, $p = .001$) and Sample 2 ($\beta = .09$, $p = .009$) while controlling for the confounding effects of background variables.

The second models, however, showed that fact-based media exposure did not have an independent connection to general attitude toward robots in Sample 1 ($\beta = .01$, $p = .697$) or Sample 2 ($\beta = .03$, $p = .376$). Fiction-based media exposure explained variation in the general attitude toward robots in Sample 1 ($\beta = .11$, $p = .002$). The connection was also similar in Sample 2 but remained statistically

TABLE 4 Summary of descriptive statistics of the Study 2 variables: Sample 1 ($N = 1003$)

Measure	*n*	%	*M*	*SD*	Range
General attitude toward robots	1003		4.96	1.37	1–7
Age	1000		37.36	11.80	19–78
Gender	988				0–1
1 = Female	505	51.11			
0 = Male	483	48.89			
A degree from technology	1003				0–1
1 = Yes	203	20.24			
0 = No	800	79.76			
Firsthand experience with robots	1003				0–1
1 = Yes	301	30.01			
0 = No/Maybe	702	69.99			
Prior media exposure to robots	1003		4.61	2.12	0–8
Fiction-based	1003		2.97	1.15	0–4
Fact-based	1003		1.64	1.35	0–4

TABLE 5 Summary of descriptive statistics of the Study 2 variables: Sample 2 ($N = 969$)

Measure	*n*	%	*M*	*SD*	Range
General attitude toward robots	969		4.89	1.34	1–7
Age	969		37.15	11.35	15–94
Gender	954				0–1
1 = Female	488	51.15			
0 = Male	466	48.85			
A degree from technology	969				0–1
1 = Yes	260	26.83			
0 = No	709	73.17			
Firsthand experience with robots	969				0–1
1 = Yes	260	26.83			
0 = No/Maybe	709	73.17			
Prior media exposure to robots	969		4.15	2.21	0–8
Fiction-based	969		2.77	1.21	0–4
Fact-based	969		1.38	1.36	0–4

TABLE 6 Summary of regression analyses for Study 2 variables: Attitude toward robots as a dependent variable, Sample 1 ($N = 1003$)

	Model 1			Model 2		
Measure	*B*	SE *B*	*β*	*B*	SE *B*	*β*
Age	.00	.00	.03	.00	.00	.04
Female gender	−.04	.09	−.02	−.04	.09	−.01
Technology degree	.33	.11	.10**	.35	.11	.10**
Firsthand experience with robots	.47	.10	.16***	.50	.10	.17***
Prior media exposure to robots	.07	.02	.10**			
Prior fiction-based media exposure to robots				.13	.04	.11**
Prior fact-based media exposure to robots				.01	.04	.01
Model R^2		.06			.06	
Model *F*		12.52			10.99	
Model p		***			***	

Notes: Dependent variable: General attitude toward robots.
*p < .01;
**p < .001.

TABLE 7 Summary of regression analyses for Study 2 variables: Attitude toward robots as a dependent variable, Sample 2 ($N = 969$)

	Model 1			Model 2		
Measure	*B*	SE *B*	β	*B*	SE *B*	β
Age	.00	.00	.01	.00	.00	.01
Female gender	−.14	.09	−.05	−.14	.09	−.05
Technology degree	.34	.11	.11**	.34	.11	.11**
Firsthand experience with robots	.25	.09	.09**	.26	.09	.09**
Prior media exposure to robots	.05	.02	.09**			
Prior fiction-based media exposure to robots				.08	.04	.07
Prior fact-based media exposure to robots				.03	.04	.03
Model R^2		.04			.04	
Model *F*		7.36			6.20	
Model p		***			***	

Notes: Dependent variable: General attitude toward robots.
*p < .01;
**p < .001.

nonsignificant (β = .07, p = .060). We controlled the found connections for age (Sample 1: β = .04, p = .227; Sample 2: β = .01, p = .717), female gender (β = −.01, p = .680; β = −.05, p = .113), technology education (β = .10, p = .002; β = .11, p = .001), and firsthand experience with robots (β = .17, p < .001; β = .09, p = .006).

7 | STUDY 3

In Study 3, we aimed to validate the preliminary finding from Study 1 concerning the connection of robot media exposure and trust toward robots (H2) in the general adult population of the United States. In Study 3 we utilized the trust game method to measure trust toward robots. As in Study 1, we used linear OLS regression as an analysis method. Again, we considered age, gender, a degree in technology, and firsthand experience with robots as control variables.

7.1 | Method

7.1.1 | Participants and procedure

The US survey sample collected from Amazon's Mechanical Turk in April 2019 included a trust game measuring trust toward robot opponents in an online survey experiment. In the experiment, we randomly assigned participants to different groups following a between-subject study design. Initially, the trust game involved three opponent types (robot, AI, human) combined with one of two names (Michael, jdrx894); hence, six groups presented with a different opponent: Michael (robot), jdrx894 (robot), Michael (AI), jdrx894 (AI), Michael (human), and jdrx894 (human). Each participant was assigned to only one of the six groups. For the objectives and aims of this study, we focused on the two robot conditions only ($N = 331$, 52.31% male, $M_{age} = 37.82$ years, $SD_{age} = 11.56$ years, range 15–71 years) to address participants' trust toward robots in particular. The opponent for the robot conditions was either a robot named Michael or a robot named jdrx894.

The trust game begins with the participants being presented with a hypothetical situation of receiving $1000 either to keep or to share part of it with a hypothetical opponent player. The experimenter is then told to triple the amount of money given to the other player. For example, if a player gives $400 to the other player, they receive $1200. Participants are informed that their opponent could choose to return any amount of money or none to the first player. They are then asked to write an amount between $0 and $1000 to an open-ended response field. Here, the respondent solely takes an action in the game.

7.1.2 | Measures

Table 8 shows the measures used in Study 3. The dependent variable, trust in robots, was operationalized as participants' trust that the robot would return money in a survey experiment trust game. In other words, trust was measured with the outcome to a trust game and hence the amount of money ($0–1000; $M = 499.13$, $SD = 316.82$, $Mdn = 500$) given to an opponent.

We measured the main independent variables the same way as in Study 2: prior media exposure to robots (0–8), prior fiction-based media exposure to robots (0–4), and prior fact-based media exposure (0–4). To consider the previously noted potential influence of anthropomorphic factors in human-robot interaction online (Shin, 2021e) we controlled for the opponent name condition using a dummy variable (0 = *Michael*, 1 = *jdrx894*). Other control variables included age, gender, a technology degree, and firsthand experience with robots. We used age as a continuous variable and the other ones as dummy variables. For firsthand experience with robots, the options were *yes*, *no*, or *do not know*, from which we created a dummy variable (1 = *yes*, 0 = *no/do not know*).

7.1.3 | Analysis

For the analysis, we used the Pearson product–moment correlation coefficient and OLS regression models. We report Pearson's r and p values, unstandardized regression coefficients (B) and their standard errors (B SE), standardized beta coefficients (β), and p values for the different measures, in addition to model goodness-of-fit measure (R^2), model test (F), and the p value of the model. We did not detect problematic multicollinearity or heteroscedasticity.

7.2 | Results

Based on the Pearson correlation results in Study 3, general attitude toward robots correlated with prior overall media exposure ($r = .10$, $p = .064$), fiction-based media exposure ($r = .04$, $p = .511$), and fact-based media exposure ($r = .13$, $p = .016$) to robots. We present the regression analysis results of Study 3 in Table 9. Similar to findings regarding attitudes in Studies 1 and 2, prior exposure to robots in various media outlets was positively connected to trusting behavior toward robots in Model 1 ($\beta = .13$, $p = .025$). However, Model 2 shows that only fact-based media exposure to robots explained variation in the amount of money given to the robot opponents ($\beta = .14$, $p = .026$). The main result was not affected by controlling for the name of the robot opponent ($\beta = .14$, $p = .008$), age ($\beta = .02$, $p = .698$), female gender ($\beta = -.06$, $p = .267$), technology education ($\beta = 14.21$, $p = .020$), or firsthand experience with robots ($\beta = -.02$, $p = .773$).

TABLE 8 Summary of descriptive statistics of the Study 3 variables ($N = 331$)

Measure	*n*	%	*M*	*SD*	Range
Trust in robots	331		499.13	316.82	0–1000
The name of the robot opponent	331				
1 = *jdrx894*	154	46.53			
0 = *Michael*	177	53.47			
Age	331		37.82	11.56	15–71
Gender	325				0–1
1 = Female	155	47.69			
0 = Male	170	52.31			
A degree from technology	331				0–1
1 = Yes	83	25.08			
0 = No	248	74.92			
Firsthand experience with robots	331				0–1
1 = Yes	97	29.31			
0 = No/Maybe	234	70.69			
Prior media exposure to robots	331		4.25	2.17	0–8
Fiction-based	331		2.82	1.20	0–4
Fact-based	331		1.43	1.34	0–4

TABLE 9 Summary of regression analyses for Study 3 variables: Trust toward robots as a dependent variable ($N = 331$)

	Model 1			Model 2		
Measure	B	SE B	β	B	SE B	β
The name of the robot opponent	93.32	34.46	.15**	91.35	34.48	.14**
Age	.91	1.53	.03	.60	1.55	.02
Female gender	−33.25	35.53	−.05	−39.99	35.95	−.06
Technology degree	111.89	43.79	.15*	103.34	44.34	.14*
Firsthand experience with robots	−8.29	40.16	−.01	−11.60	40.23	−.02
Prior media exposure to robots	18.83	8.39	.13*			
Prior fiction-based media exposure to robots				1.53	16.74	.01
Prior fact-based media exposure to robots				33.73	15.03	.14*
Model R^2		.06			.07	
Model F		3.43			3.15	
Model p		**			**	

Notes: The name of the robot opponent: 0 = Michael, 1 = jdrx894.
*p < .05;
*p < .01

8 | SUMMARY AND CONCLUDING DISCUSSION

We examined in three separate studies whether previous media exposure to robots is associated with attitudes and trust toward robots. In Study 1, we analyzed the association between prior robot media exposure and attitude and trust toward robots using the sample of Finnish care work professionals. In Study 2, we focused on the association between prior robot media exposure and attitude toward robots with two separate national samples of US respondents. In Study 3, we addressed the association between prior media exposure and trust toward robots through the trust game among one sample of US respondents. Furthermore, Study 2 aimed to replicate the attitude-related results obtained in Study 1, and Study 3 desired to validate the trust-related preliminary findings from Study 1.

The Study 1 results give support for our H1 among the Finnish care work professionals. We found prior media exposure to robots, from both fact- and fiction-based sources, to be associated with more positive general attitudes toward robots. The Study 2 results verified H1, stating that prior overall media exposure to robots is associated with more positive general attitude toward robots using the sample of adult US respondents. The finding suggests that if people recall seeing, hearing, or reading about robots in multiple different types of channels, they tend to perceive robots more favorably in general. This is in line with the persuasion theories of familiarity principle and mere-exposure theory (Reis et al., 2011; Zajonc, 1968) and multiple source effect (Harkins & Petty, 1981). However, comparing fiction- and fact-based media exposure revealed that, among US respondents, only fiction explained the outcome in the end.

In Study 1, fact-based channels had a connection to the trust dimension emphasizing safety in firsthand user situations. The Study 3 results verified our second hypothesis (H2) and our preliminary findings from Study 1 regarding robot exposure through multiple fact-based media outlets and higher trust toward robots using the US sample. The findings suggest that if people recall seeing, hearing, or reading about robots in channels commonly associated with providing reliable information about real-life events, they also tend to show more trusting behavior toward robots. This is in line with the theoretical notions in trust theories about cognitive and calculative bases of trust (McAllister, 1995) and the previous literature (Hancock et al., 2011, 2020; Lee & See, 2004; Li et al., 2008; Schaefer et al., 2016). The results about overall prior media exposure to robots were also similar to the findings about attitudes and in line with theories about the effect that overall exposure has on attitudes (Reis et al., 2011; Zajonc, 1968).

The results of the overall media effect on the perceptions of robots are in line with the previous findings (Appel et al., 2016; de Graaf et al., 2016; Mara & Appel, 2015; Sundar et al., 2016) and researchers proposing that cultural variation in attitudes is due to differences in media coverage (Li et al., 2010; Turja & Oksanen, 2019). Eurobarometer's (2017) findings regarding robots and AI were also in line with our findings. Dividing media exposure in fiction- and fact-based media outlets revealed that more extensive fact-based media exposure to robots was connected to higher trust toward robots. However, the connection of fact-based exposure with the attitudes found in Study 1 did not replicate in Study 2 with US respondents. Therefore, only fiction-based media exposure explained the positive attitude toward robots consistently in both studies, which is in line with Mara and Appel's (2015) previous findings regarding eeriness. In addition, in line with Sundar et al.' (2016) previous finding that recalling multiple portrayals of robots decreased anxiety toward robots, our results support that positivity toward robots is stronger when people have been exposed to robots from multiple sources.

A possible reason for the inconsistent results could be that even though the participants from Studies 1 and 2 were identically asked about their general attitude toward robots, the survey for the target group in Study 1 was designed for care workers and otherwise addressed issues regarding care robots. This might have steered Study 1 participants' attitude assessment process more toward a specific robot type or a context where it would be used and thus caused them to rely more on fact-based information channels and robot representations to base their general attitude assessment on. It could also be due to the systematic cognitive evaluations being more effective when the person is interested in the issue beforehand and the route appealing to affective features when the issue is unfamiliar, as suggested in ELM research (Petty et al., 1983; Petty & Cacioppo, 1986). Previous research stresses the influence of contextual and cultural factors in attitudes toward robots (Li et al., 2010; Turja & Oksanen, 2019) and AI (Shin, 2021a). In line with the research on cognitive processes in AI attitude formation (Shin, 2021a), depending on the context of the experience, people could emphasize different aspects when evaluating advanced technology.

8.1 | Theoretical and practical implications

Based on our findings, more extensive overall media exposure to robots prior to the study is connected to more positive attitudes toward robots and higher trust in robots. These findings were in line with what we expected based on the mere-exposure effect and familiarity principle (Reis et al., 2011; Zajonc, 1968). Other persuasion theories ELM (Petty et al., 1983), HSM (Chaiken, 1980), narrative transportation theory (Gerrig, 1993), and cognitive dissonance theory (Festinger, 1957) also suggest that perceptions of robots could be affected by both fiction- and more reality-based media. Although we found evidence supporting this, comparing the effects of different media sources also revealed differences that could provide new information for theories aiming to explain the cognitive processes of attitude formation with dual information processing in the context of robot technologies (Shin, 2021b, 2021e).

Considering the dual-processing theories of persuasion (Chaiken, 1980; Petty et al., 1983) and cultivation theory of media effects (Gerbner et al., 2002; Potter, 2014), it could be argued based on our findings that fiction-based robot information adds to the overall exposure cultivating the general attitude toward robots, but fact-based robot information activates the more careful and systematic information processing and leads to more profound perception of trust. It seems to take more than a positive view toward an artificial agent before one can also consider it trustworthy. In their reviews, Hancock et al. (2011, 2020) concluded that the technology's attributes exceed any user- or context-related factors when it comes to trusting robots. Attitudes are formed more easily and are grounded on the previous experiences and mental images about the robots, but to trust robots, one needs more extensive information about the specific form of technology. This is emphasized in our studies where participants have little or no firsthand experience with robots.

The media has been criticized for exaggerating the capabilities, intelligence, autonomy, and maturity of the robots currently manufactured (Van Aerschot & Parviainen, 2020). Our results imply that, despite all the media hype surrounding robots, people are not easily persuaded into trusting robots even though their general attitudes toward robots may become more positive the more they come across robots in the media. However, media exposure has a role in people's perceptions of robots, not just on the anticipated qualities or behavior of robots but also in postadoption situations in longitudinal interactions with robots (de Graaf et al., 2016).

The findings in this article will increase our knowledge on the effects of various information sources on people's attitudes and trust toward robots. This information is useful considering that antecedent factors such as social influence and attitudes in turn influence the intentions and actual use of new technology (Hwang et al., 2021; Shin, 2021e; Venkatesh et al., 2003). As human–robot interaction also involves robots reacting to human behavior, research on perceptions of robots also benefits the development of robots with advanced social features. While trust is usually an implicit and thus non-observable attitude to robots, more complex emotion-detecting robots are under development. In future robots can detect human user's trust and intentions from their gestures and expressions (Hancock et al., 2020; Saheb Jam et al., 2021; Spezialetti et al., 2020), making this research topic even more important in the efforts of improving human–robot interaction and robot acceptance.

8.2 | Limitations and strengths

Our studies are limited by their representativeness and cross-sectional survey design, and they do not consider the likability or content of the media exposure events prior to the study. Due to the cross-sectional data that our findings are based on, future research should consider longitudinal designs to examine the causality of the media effects on people's perceptions of robots. The gender distribution in Study 1 differed from the US samples, which can be explained by the predominantly female field of the care workers of Study 1. For this reason, it was extremely important that we controlled the confounding effect of gender in our analyses. However, finding similar results regardless of a different cultural background gives reliability to our studies, considering that culture and collective beliefs among different groups of people are factors that are acknowledged to affect trust toward robots (Hancock et al., 2020) and AI (Shin, 2021a). In addition, our studies included people from different occupational fields and sociodemographics while utilizing various methodologies to assess perceptions of robots.

9 | CONCLUSION

Our results strengthen previous research findings arguing that media has a significant role on people's thinking of various topics regardless of cultural background or other individual factors. Our studies expand the utilization of persuasion theories in the context of technology acceptance by deploying cultivation theory, mere-exposure effect, and dual-processing theories to examine both fiction- and fact-based media effects on the perceptions of robots. Based on our findings, fictive robot information is a part of the overall media exposure effect that affects people's general attitude toward robots, but only fact-based media information seems to provide a sufficient base for building trust in robots. The role of different media channels on people's perceptions of robots should be recognized when mediating information about new technology and designing or implementing them for actual use.

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CONFLICT OF INTEREST

None of the authors have a conflict of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the authors upon reasonable request.

ETHICS STATEMENT

The Academic Ethics Committee of Tampere University stated that our research does not include any ethical problems. All participants gave their informed consent prior to their inclusion in the study. Our study conforms to the standards of the Declaration of Helsinki. We hold permission to the materials we use in our study.

ORCID

Nina Savela https://orcid.org/0000-0002-7042-6889
Tuuli Turja https://orcid.org/0000-0001-7815-9511
Rita Latikka https://orcid.org/0000-0003-3798-0017
Atte Oksanen https://orcid.org/0000-0003-4143-5580

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AUTHOR BIOGRAPHIES

Nina Savela (MSocSci) is a doctoral researcher of social psychology in the Faculty of Social Sciences of Tampere University. Savela's research interests involve social and psychological factors in human–technology interaction and the societal impact of emerging technologies.

Tuuli Turja (PhD) works as a researcher at Tampere University in the Faculty of Social Sciences. Her research focuses on social and motivation psychology of changing work and myths in service work robotization.

Rita Latikka (MSocSci) is currently a project researcher and PhD Student at the Faculty of Social Sciences, Tampere University, Finland. Her research interests include social well-being impacts of intelligent and social networking technologies, such as social robots and social media.

Atte Oksanen is a professor of social psychology and the leader of Emerging Technologies Lab. His research focuses on emerging technologies, social interaction, and deviant behavior online. Oksanen has led major cross-national projects over his career and his recent research projects investigate the increasing role of intelligent technologies in everyday life.

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