

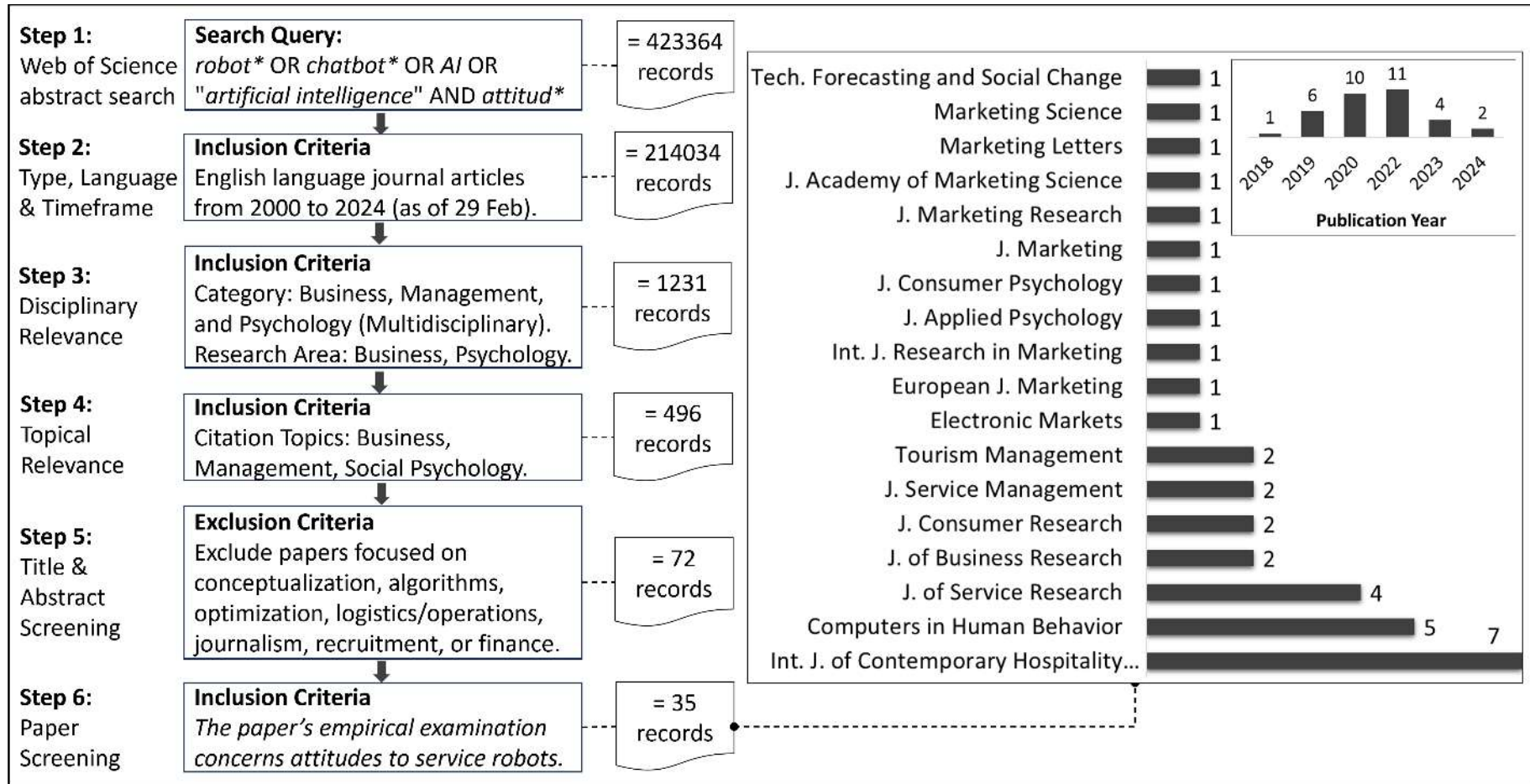
***SOCIETAL ATTITUDES TOWARD SERVICE ROBOTS:  
ADORE, ABHOR, IGNORE OR UNSURE?***

Web Appendices

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Appendix A: Systematic literature review procedure and descriptives



## Appendix B: Tabulated review of multidisciplinary empirical literature and research gaps

Source	Description	Structure (Gap 1)	Stability (Gap 2)	Attitude Level (Gap 3)	Multimethod (Gap 4)	Robots (Gap 5)	Interaction (Gap 5)	Key Findings
Akdim, Belanche, and Flavián (2023)	Customers' explicit and implicit attitudes to hospitality service robots' degree of humanlike appearance.	Positive Negative	Untested	Individual	Qualitative and experimental	Multiple	Imagined	Service robots with high (low) degree of humanlike appearance elicit positive (negative) attitudes (conscious and unconscious) from customers.
Belanche, Casaló, and Flavián (2021)	Customer attributions of firms' motivations for implementing hospitality service robots.	Positive	Untested	Individual	No	Multiple	Imagined	Affinity towards the service robot positively affects service improvement attribution, and negatively affects cost-reduction attribution.
Binesh and Baloglu (2023)	Attitude towards hotel service robots based on operational area.	Positive Negative	Untested	Population	No	N/A	Imagined	One negative (laggards) and two positive (early adopters and optimists) clusters are identified based on comfort level with service robots performing different functions in a hotel and their overall optimism about service robots.
Čaić, Odekerken-Schröder, and Mahr (2018)	Service robot roles in a socially assistive elderly care context.	Positive Negative	Untested	Individual	No	Single	Actual	Service robots can play positive (enabler, ally, extended self) or negative (intruder, replacement, deactivator) roles for value co-creation/co-destruction in elderly care services.
Castelo et al. (2023)	Customer beliefs about firms' motivation for introducing service robots.	Positive Negative	Untested	Individual	Field and lab studies	Multiple	Actual and Imagined	People respond negatively to service robots because they believe that firms deploy them as a cost saving measure. The negative reaction is eliminated if customers are given price discounts from the cost savings, or if the robot-delivered service is superior.

**Appendix B: Tabulated review of multidisciplinary empirical literature and research gaps (continued)**

Source	Description	Structure (Gap 1)	Stability (Gap 2)	Attitude Level (Gap 3)	Multimethod (Gap 4)	Robots (Gap 5)	Interaction (Gap 5)	Key Findings
Cha (2020)	Customer intention to use robot restaurants in South Korea.	Positive	Untested	Individual	No	Single	Actual	Hedonically and socially motivated consumer innovativeness positively influence attitude formation.
Choi, Mattila, and Bolton (2021)	The influence of warmth and competence perceptions of service robots on service failure and recovery situations.	Positive	Untested	Individual	Multiple experiments	Multiple	Imagined	Humanoid (vs. non-humanoid) robot service failures lead to greater dissatisfaction due to lack of warmth perceptions. However, humanoid (vs. non-humanoid) robots are able to recover the situation through sincere apologies and explanations.
Christou, Simillidou, and Stylianou (2020)	Perceptions of anthropomorphic robots in the tourism industry	Positive Negative	Untested	Individual	No	Multiple	Actual and Imagined	Participants share frustration, sadness, and anger about service robots, but also express positive attitude towards humanlike robots.
Chung et al. (2020)	Customer perceptions of chatbot services in the luxury sector.	Positive	Untested	Individual	No	Single	Imagined	Chatbots' interaction, entertainment, trendiness, customization, and problem-solving ability are perceived as positive attributes.
Crolic et al. (2022)	Customer responses to anthropomorphic chatbots in services.	Positive Negative	Untested	Individual	Field and lab studies	Multiple	Actual and Imagined	Customers disfavor anthropomorphic chatbots if they enter a service situation in an angry state, due to inflated prior expectations.
Dang and Liu (2021)	Investigating ambivalent attitudes to robots in the US and China.	Positive Negative Ambivalent	Ambivalent attitudes reported in both samples.	Individual	Cross-cultural study of the US and China	Single	Imagined	Robots with high (vs. low) mental abilities induced more ambivalent attitudes. Authors criticize the bipolar negative-positive conceptualization and call for ambivalent attitudes to be treated separately. US participants are more ambivalent than Chinese.

**Appendix B: Tabulated review of multidisciplinary empirical literature and research gaps (continued)**

Source	Description	Structure (Gap 1)	Stability (Gap 2)	Attitude Level (Gap 3)	Multimethod (Gap 4)	Robots (Gap 5)	Interaction (Gap 5)	Key Findings
de Kervenoael et al. (2020)	Customer intention to use hospitality service robots.	Positive	Untested	Individual	Qualitative and quantitative	Single	Imagined	The intention to use a social robot is mainly influenced by the perceived value, while perceived empathy also has a small effect.
Gelbrich, Hagel, and Orsingher (2021)	Emotional support provided by AI-powered digital assistants.	Positive	Untested	Individual	Multiple experiments	Single	Imagined	Emotional support provided by a digital assistant increases perceived warmth, which in turn leads to greater satisfaction and persistence.
Gnambs and Appel (2019)	Examine attitudes towards robots in Europe from 2012 to 2017.	Positive Negative	General attitude is positive in all three waves.	Aggregate	Multi-wave data	N/A	Imagined	The decrease in positive attitudes to robots from 2012-2017 may be due to increase in media attention and public concerns about robots taking jobs.
Guan et al. (2022)	Attitudes towards restaurant service robots in China.	Negative	Untested	Individual	No	Single	Actual	Negative attitude towards robots reduces the positive effect of a robot's service competence on hedonic value.
Han, Deng, and Fan (2023)	Customer mindset and attitudes to anthropomorphic robots in retail.	Positive Negative	Untested	Individual	Multiple experiments	Multiple	Imagined	Customers with competitive (vs. collaborative) mindset are less (vs. more) favorable to humanlike robots.
Ivanov and Webster (2021)	Willingness to pay for tourism and hospitality services delivered by a robot	Positive Negative	Untested	Individual	No	N/A	Imagined	Research finds that a group of customers who are equally willing to pay for robot services compared to human services correlates with positive attitudes towards robots.
Kim, Schmitt, and Thalmann (2019)	Consumer responses to anthropomorphism in robots based on the uncanny valley hypothesis.	Positive	Untested	Individual	Multiple studies	Multiple	Imagined	Anthropomorphic robots increase perceived warmth, but decrease positive attitude. Competence perceptions are not affected, but also do not cause a reduction in positive attitudes.

## Appendix B: Tabulated review of multidisciplinary empirical literature and research gaps (continued)

Source	Description	Structure (Gap 1)	Stability (Gap 2)	Attitude Level (Gap 3)	Multimethod (Gap 4)	Robots (Gap 5)	Interaction (Gap 5)	Key Findings
Lin, Doong, and Eisingerich (2021)	The design and implications of virtual avatars as salespersons.	Positive	Untested	Individual	Multiple studies	Multiple	Imagined	Avatars with greater automated social presence reduce the negative impact of conflict if the avatar's design is weak in cuteness. Humanlike cartoons or avatars can evoke high levels of automated social presence.
Longoni, Bonezzi, and Morewedge (2019)	Consumer resistance to robot medical services.	Negative	Untested	Individual	Multiple studies	Single	Imagined	Robot service is disfavored, even if it is cheaper or better in performance. Matching unique individual characteristics mitigates resistance.
Luo et al. (2019)	Influence of chatbot disclosures on customer purchases.	Negative	Untested	Individual	No	Single	Actual	Disclosing the chatbot's identity prior to interaction decreases the interaction length and reduces purchases because of subjective bias against chatbots.
McLeay et al. (2021)	Perceived innovativeness and ethicality in robots replacing staff.	Positive Negative	Untested	Individual	Two experiments	Single	Imagined	Replacing human service staff with a humanoid robot is perceived as a positive innovation, but also a negative move from an ethical perspective, even in consumers with a high level of openness to change.
Mende et al. (2024)	Service inclusion through AI for stigmatized customers.	Positive	Untested	Individual	Multiple experiments	Multiple	Imagined	Avatar-based personalization can backfire depending on whether the design matches customer's situation and the level of stigma associated.
Mende et al. (2019)	Human-robot interaction's effect on compensatory customer responses.	Negative	Untested	Individual	Field and lab studies	Multiple	Actual and Imagined	People demonstrate compensatory responses (e.g., overeat, purchase more status goods, and seek social affiliation) when served by a humanoid service robot due to an underlying discomfort.

## Appendix B: Tabulated review of multidisciplinary empirical literature and research gaps (continued)

Source	Description	Structure (Gap 1)	Stability (Gap 2)	Attitude Level (Gap 3)	Multimethod (Gap 4)	Robots (Gap 5)	Interaction (Gap 5)	Key Findings
Milman, Tasci, and Zhang (2020)	Theme park visitors' attitudes towards service robots.	Positive	Untested	Individual	No	Multiple	Imagined	Perceived human oriented qualities of a robot increases attitude towards the robots' functionality, irrespective of the robots' design.
Mozafari, Weiger, and Hammerschmidt (2022)	How the negative effects of chatbot disclosure can be prevented.	Positive Negative	Untested	Individual	Two experiments	Single	Imagined	Chatbot disclosure has a negative impact on customers in highly critical services. However, in a service failure, disclosure can be positive in terms of customer retention.
Pizzi, Scarpi, and Pantano (2021)	Consumer reactance to AI-based digital assistants' appearance and activation.	Negative	Untested	Individual	Two experiments	Multiple	Imagined	Non-anthropomorphic digital assistants elicit higher psychological reactance, but lead to higher satisfaction. The increase in reactance is alleviated through user activation.
Schindler et al. (2023)	Implications of speaking vs. writing with conversational agents.	Positive	Untested	Individual	Multiple experiments	Multiple	Imagined	Customer satisfaction increases when speaking about hedonic products (by activating feeling-based focus) and writing about utilitarian products (by activating reason-based focus).
Spatola and Wykowska (2021)	The influence need for cognition and need for closure on attitudes to robots.	Negative	Untested	Individual	No	Multiple	Imagined	Individuals' discomfort with ambiguity increases negative attitude to robots, while the need for cognition slightly reduces negativity.
Wilson-Nash, Goode, and Currie (2020)	Young adults' views of relationship management via social media bots.	Positive	Untested	Individual	No	Single	Imagined	Young adults prefer social media bot messengers over email/telephone for simple queries. But human service is preferred for critical requests.
Yam et al. (2021)	How perceptions of robots affect hospitality service failure experiences.	Positive Negative	Untested	Individual	Multiple experiments	Multiple	Actual and Imagined	Anthropomorphism increases satisfaction. Perceived experience mediates the effect, and reduces negative impact of service failures.



**Appendix B: Tabulated review of multidisciplinary empirical literature and research gaps (continued)**

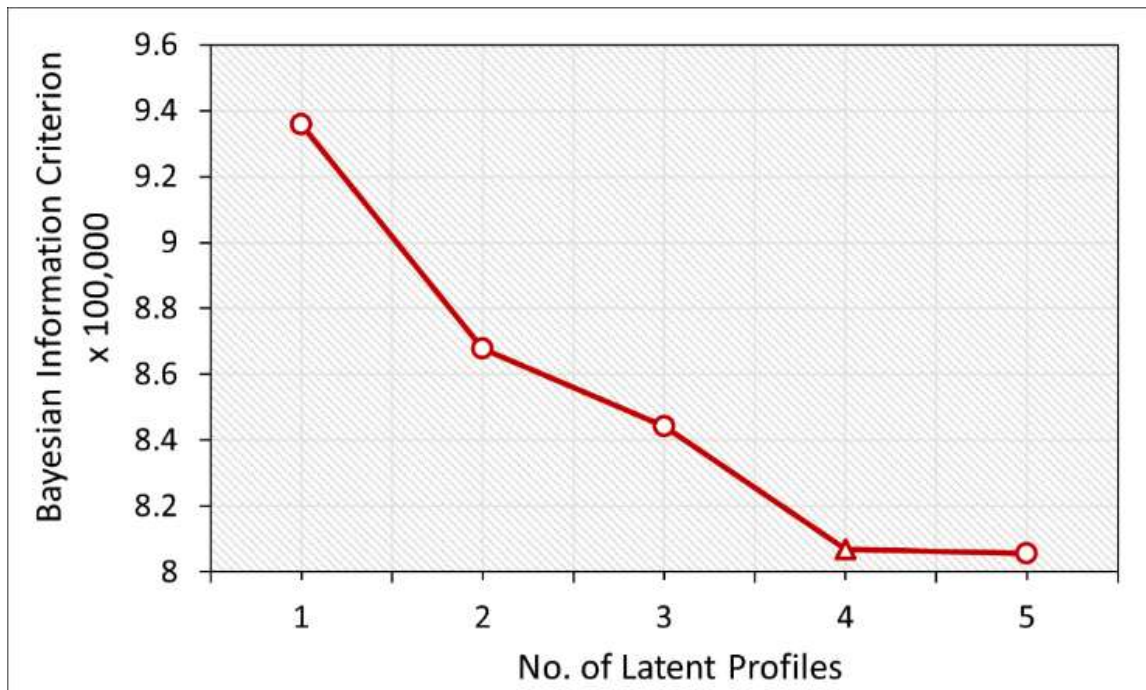
Source	Description	Structure (Gap 1)	Stability (Gap 2)	Attitude Level (Gap 3)	Multimethod (Gap 4)	Robots (Gap 5)	Interaction (Gap 5)	Key Findings
Yoganathan et al. (2021)	Attitudes to humanoid robots (vs. human staff and self-service technology) in hospitality.	Positive Negative	Untested	Individual	Multiple experiments	Multiple	Imagined	Humanoid robots (vs. self-service technology) are perceived as more competent and warm, but only when service employees are absent. The need for interaction with service staff increases perceived risk.
Youn and Jin (2021)	The effect of human-AI relationship type on brand personality perception.	Positive Negative	Untested	Individual	No	Single	Actual	People with positive attitudes perceived the chatbot's brand personality to be more sincere when the chatbot assumed an assistant (vs. friend) role, but those with negative attitudes did not reveal differences.
Yu, Xiong, and Shen (2024)	How customers evaluate a service request rejection by chatbots.	Negative	Untested	Individual	Multiple experiments	Single	Imagined	Service request rejections by chatbots are evaluated less negatively compared to human staff. The effect does not materialize when chatbot reveals apologetic emotions.
Zhu and Chang (2020)	How a robot chef's appearance influences food quality predictions.	Positive	Untested	Individual	No	Multiple	Imagined	A robot chef with humanlike hands was perceived as more warm and more competent, thus, expected to produce better quality food.

### Appendix C: Descriptive overview of variables used in Study 1

Variable	Measurement Description	<i>M</i>	<i>SD</i>	Mode (if categorical)
<b>Perceived Benefits and Risks of Robots:</b>				
Robots help people		3.75	1.18	
Robots steal jobs		3.76	1.30	
Robots do jobs that are too hard or dangerous	5-point scale ( <i>'Totally disagree'</i> to <i>'Totally agree'</i> )	4.21	1.03	
Robots require careful management		4.36	0.90	
<b>Sociodemographics:</b>				
Age	Continuous	50.13	18.20	
Age at full time education ceased		25.37	21.52	
Sex	Female/Male			Female (54.7%)
Occupation	Homemaker, Unemployed, Student, Farmer/Fisher, Self-Employed, Business Owner, High-Skill White Collar, White Collar, Skilled Manual Worker, Manual Worker, Retired/Unable to Work			Retired or unable to work (32.1%)
<b>Technology Use:</b>				
Internet Usage	No internet use (1) – Use every day (7)	5.37	2.28	
Prior experience using robots	Yes/No (yes: respondent has used robots at either work, home, or elsewhere).			No experience (87.8%)

**Appendix D: Statistics for latent profile models from Study 1**

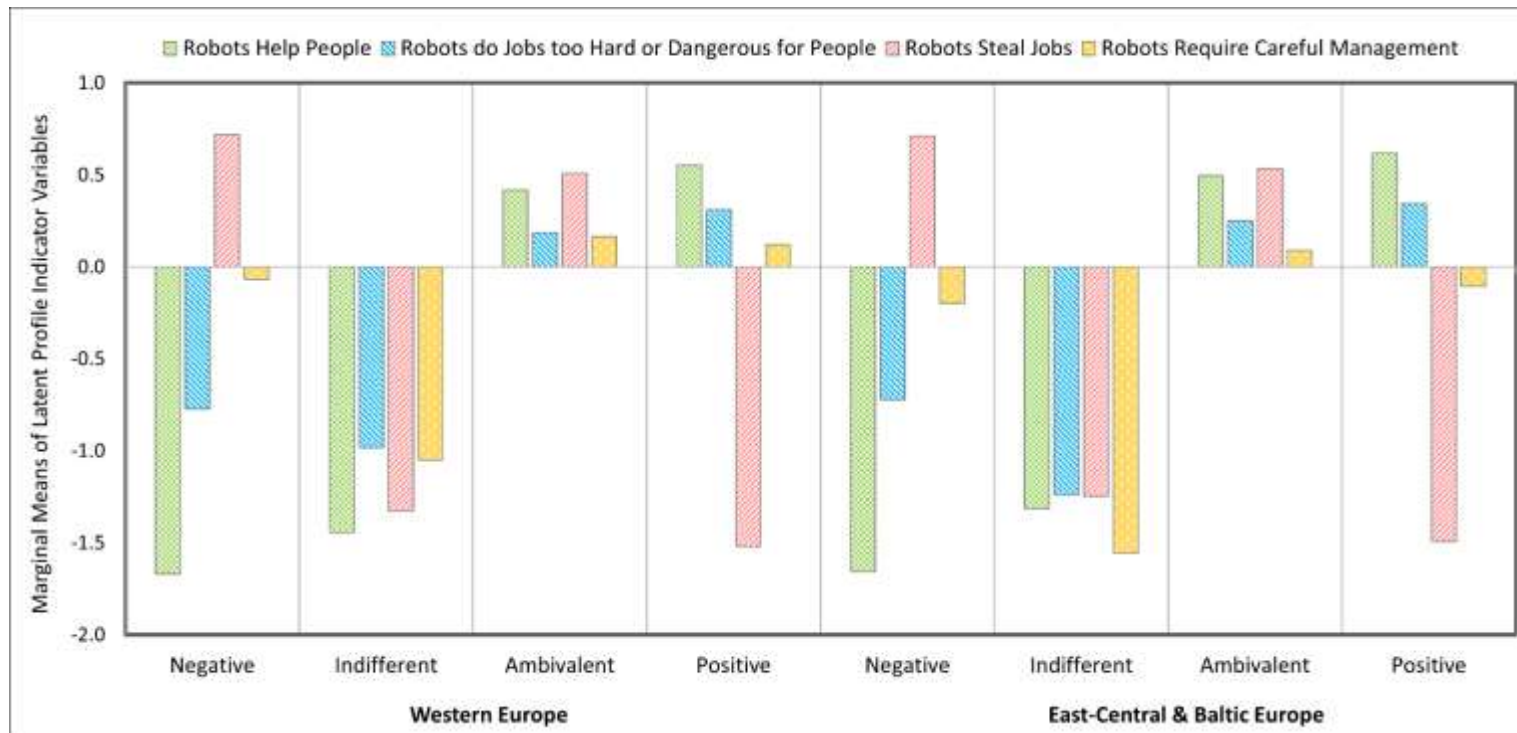
<b>Model Characteristics</b>		<b>Comparative Goodness of Fit Criteria</b>				<b>Output Quality</b>
No. of Latent Profiles	Degrees of Freedom	Bayesian Information Criterion	Akaike Information Criterion	Corrected Akaike Information Criterion	Consistent Akaike Information Criterion	Entropy
1	8	935909.70	935835.10	935835.10	935917.70	N/A
2	13	867726.60	867605.40	867605.40	867739.60	0.96
3	18	844108.60	843940.90	843940.90	844126.60	0.99
4	23	806835.70	806621.30	806621.30	806858.70	0.97
5	28	805701.10	805440.10	805440.10	805729.10	0.93

**Appendix E: BIC plot for Study 1 models**

*Note.* The triangular marker indicates the point of optimum trade-off between model fit and complexity.

## Appendix F: Cross-cultural stability of attitude profiles (S1)

To evaluate whether the attitude profiles are stable across cultural variations among the countries, we grouped the 29 countries into two cultural clusters based on the cultural values theory by Schwartz (2014) and using the country-level scores for seven value dimensions obtained from Schwartz (2008). Although the two groups are not statistically equivalent ( $\Delta\chi^2/df = 2038.40/19$ ;  $p = 0.000$ ), the same pattern of marginal means was observed in the unconstrained model in the Western European countries and the East-Central and Baltic European countries.



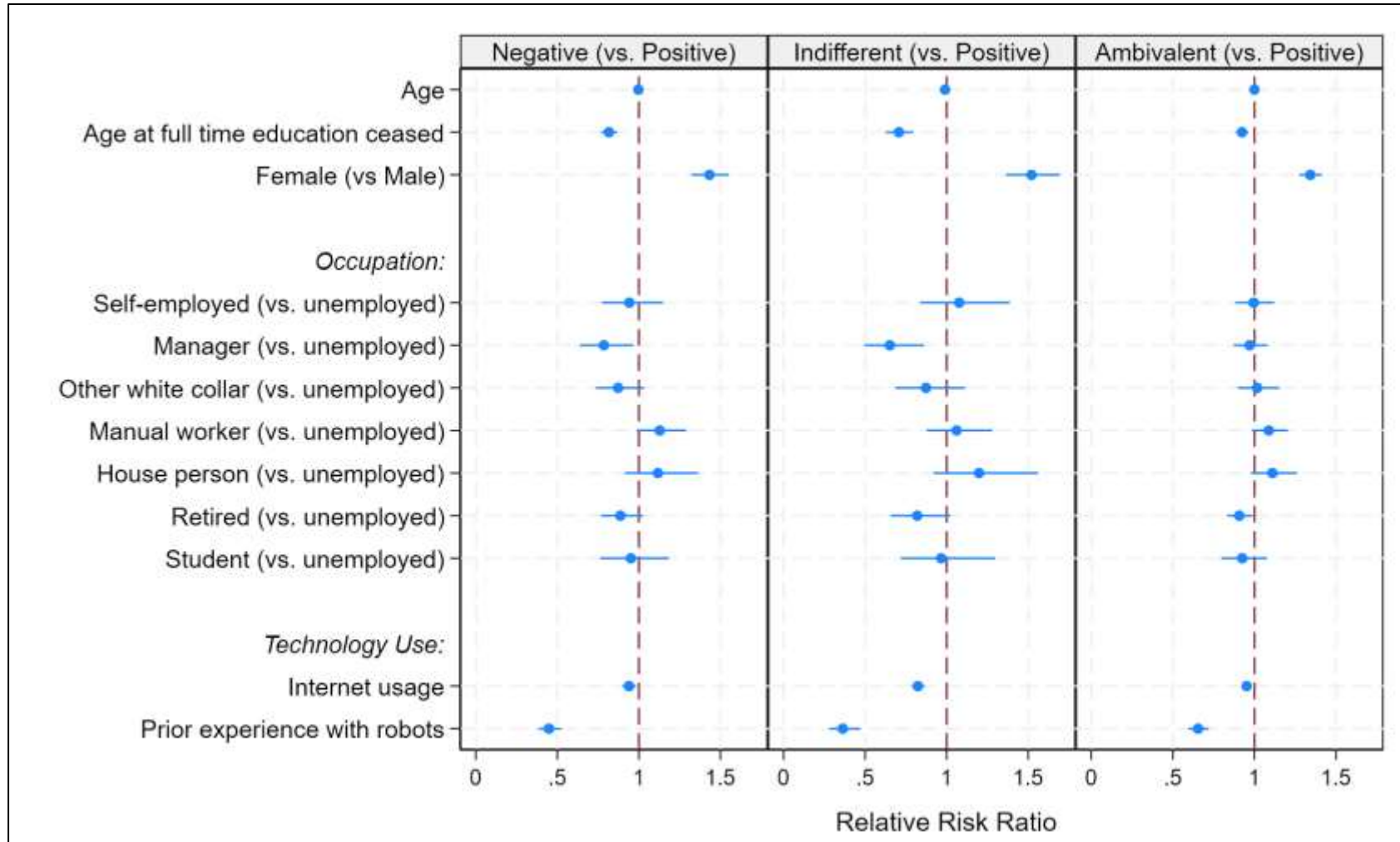
*Notes.* Results are from the unconstrained model where all parameters are allowed to vary freely. Cultural clusters are derived from a two-step clustering of scores for Schwartz's seven value dimensions for each country (average Silhouette score = 0.9).

### Appendix G: Latent profile predictor analysis results (S1)

Predictor	Negative vs. Positive			Indifferent vs. Positive			Ambivalent vs. Positive		
	B	SE	p	B	SE	p	B	SE	p
Age	0.00	0.00	0.28	-0.01	0.00	0.00	0.00	0.00	0.85
Age at full time education ceased	-0.20	0.03	0.00	-0.35	0.06	0.00	-0.08	0.02	0.00
Female (vs. Male)	0.36	0.04	0.00	0.42	0.06	0.00	0.29	0.03	0.00
<i>Occupation:</i>									
Self-employed (vs. unemployed)	-0.06	0.10	0.56	0.07	0.13	0.57	0.00	0.06	0.94
Manager (vs. unemployed)	-0.24	0.11	0.02	-0.43	0.14	0.00	-0.03	0.05	0.59
Other white collar (vs. unemployed)	-0.14	0.09	0.11	-0.14	0.12	0.28	0.02	0.06	0.80
Manual worker (vs. unemployed)	0.12	0.07	0.08	0.06	0.10	0.54	0.08	0.05	0.10
House person (vs. unemployed)	0.11	0.10	0.28	0.18	0.14	0.18	0.10	0.06	0.11
Retired (vs. unemployed)	-0.12	0.07	0.10	-0.20	0.11	0.08	-0.10	0.04	0.03
Student (vs. unemployed)	-0.05	0.11	0.65	-0.03	0.15	0.82	-0.08	0.08	0.31
<i>Technology Use:</i>									
Internet usage	-0.06	0.02	0.01	-0.19	0.02	0.00	-0.05	0.01	0.00
Prior experience with robots	-0.80	0.08	0.00	-1.01	0.13	0.00	-0.42	0.05	0.00

Note. B: Effect coefficient (multinomial logistic). SE: Standard error.

### Appendix H: Effect sizes of attitude profile predictors from the archival data (S1)



Notes. Circles indicate point estimates of effect size, and horizontal bars represent 95% confidence intervals. Confidence intervals greater/less than a relative risk ratio of 1 represent a significant positive/negative association, respectively, between the predictor and a specific attitude profile compared to the *Positive* attitude profile.

## Appendix I: Scales used in Study 2

### Need for Interaction with Service Employees (Cronbach's $\alpha = 0.86$ ):

- Human contact in providing services makes the process enjoyable for the customer.
- I like interacting with the person who provides the service.
- Personal attention by the service employee is very important to me.
- It bothers me to use a machine when I could talk with a person instead.

### Basic Psychological Needs in the use of Technology (Cronbach's $\alpha = 0.82$ ):

#### Autonomy

- I feel I have the ability to influence how I use new technologies.
- I feel that I can use new technologies pretty much the way I want.
- I don't have many opportunities to decide for myself how to use new technologies.

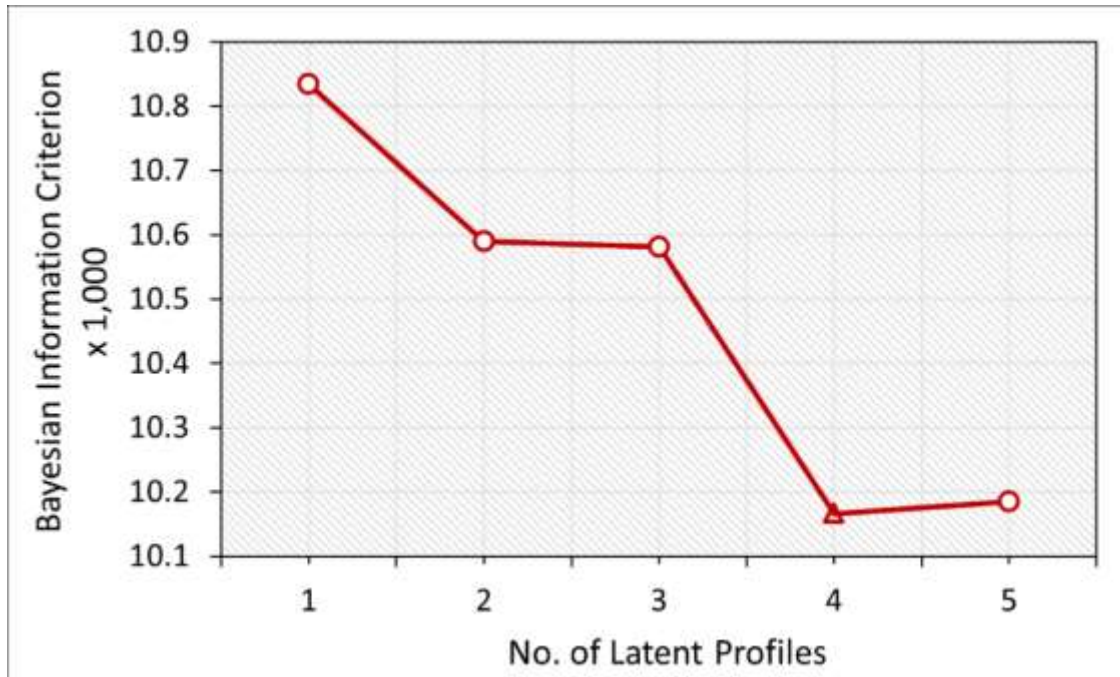
#### Competence

- Other people tell me I am good at using new technologies.
- I don't feel very competent when using new technologies.
- I am better than others at using new technologies.

#### Relatedness

- New technologies give me more opportunities to interact with others.
- I feel close to others when using new technologies.
- I have more opportunities to experience closeness with others when using new technologies.



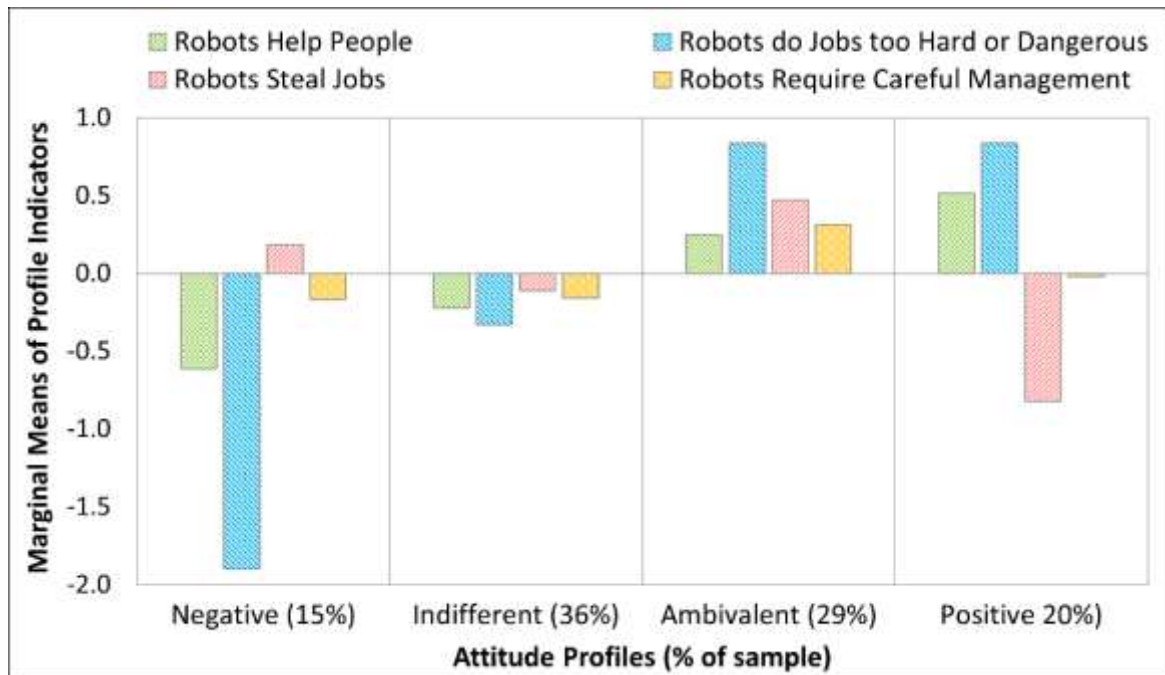
**Appendix J: BIC plot for latent profile models from Study 2**

*Note.* The triangular marker indicates the point of optimum trade-off between model fit and complexity.

**Appendix K: Statistics for latent profile models from Study 2**

<b>Model Characteristics</b>		<b>Comparative Goodness of Fit Criteria</b>				<b>Output Quality</b>
No. of Latent Profiles	Degrees of Freedom	Bayesian Information Criterion	Akaike Information Criterion	Corrected Akaike Information Criterion	Consistent Akaike Information Criterion	Entropy
1	8	10834.71	10795.86	10796.01	10842.71	N/A
2	13	10589.5	10526.37	10526.76	10602.50	0.90
3	18	10581.29	10493.88	10494.61	10599.29	0.60
4	23	10165.78	10054.08	10055.28	10188.78	0.84
5	28	10184.63	10048.64	10050.41	10212.63	0.77

### Appendix L: Attitude profiles derived from Study 2 data



## Appendix M: Interaction with digital human (S3)

### Interaction interface



### Sample interaction recording:

[https://osf.io/rg4aj/?view\\_only=932b5ad8809c44ff92267b79bd308bfb](https://osf.io/rg4aj/?view_only=932b5ad8809c44ff92267b79bd308bfb)

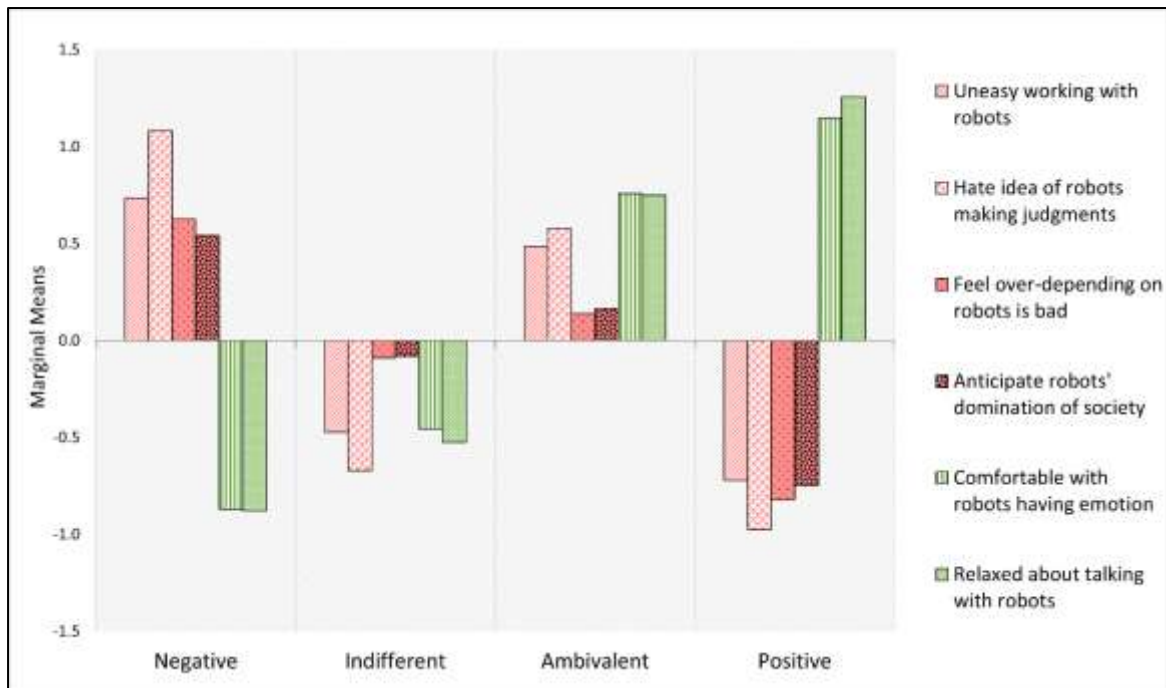
### Basic chat flow:



**Appendix N: List of robot hotels for online reviews data (S4)**

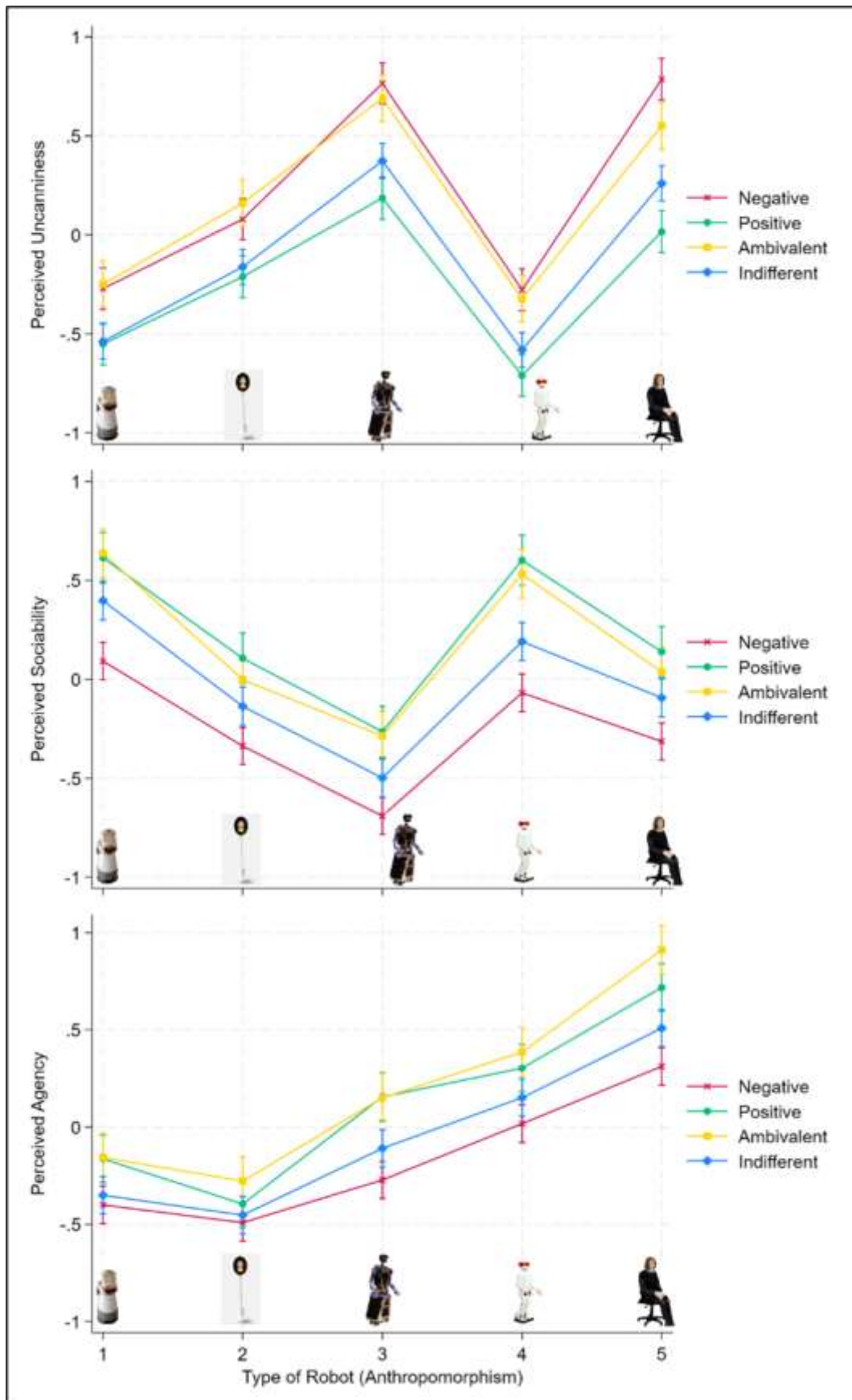
<b>Hotel</b>	<b>Location</b>
Aloft Cupertino	Cupertino (USA)
EMC2, Autograph Collection	Chicago (USA)
H Hotel, Curio Collection by Hilton	Los Angeles (USA)
Henn Na, Huis Ten Bosch	Sasebo, Nagasaki (Japan)
Hilton McLean, Tysons Corner	Virginia (USA)
Hyatt Place Emeryville	San Francisco (USA)
Jen Orchard Gateway by Shangri-La	Singapore
Jen Tanglin by Shangri-La	Singapore
Luma	Times Square, NY (USA)
M Social	Singapore
Monville	Montreal (Canada)
NYX Hotel Munich	Munich (Germany)
Residence Inn by Marriott	LAX (USA)
Sheraton Hotel San Gabriel	San Gabriel, California (USA)
Sonesta San Jose	San Jose, California (USA)
The Westin	Buffalo, NY (USA)
Vdara hotel and spa at ARIA	Las Vegas (USA)
YOTEL	Singapore
YOTEL	New York (USA)
YOTEL	Boston (USA)

### Appendix O: Attitude profiles from Spatola and Wykowska's data (S5)



*Note.* The marginal means are for the variables described in the legend.

### Appendix P: Anthropomorphic effects based on robot type (S5)



**Appendix Q: Average agency, sociability, and uncanniness per attitude profile (S5)**

<b>Outcome Variable</b>	<b>Positive</b>			<b>Ambivalent</b>			<b>Indifferent</b>			<b>Negative</b>		
	<b>B</b>	<b>95% CI</b>		<b>B</b>	<b>95% CI</b>		<b>B</b>	<b>95% CI</b>		<b>B</b>	<b>95% CI</b>	
Agency	0.12*	0.07	0.18	0.19*	0.13	0.25	-0.04	-0.09	0.00	-0.17*	-0.22	-0.12
Sociability	0.24*	0.18	0.30	0.18*	0.11	0.24	-0.03	-0.08	0.02	-0.27*	-0.32	-0.22
Uncanniness	-0.25*	-0.30	-0.19	0.15*	0.09	0.21	-0.13*	-0.18	-0.08	0.23*	0.18	0.28



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