國立政治大學資訊管理學系

碩士學位論文

溝通方式對人形機器人信任之影響

The effects of communication approaches on trust towards a humanoid robot

指導教授：簡士鎰 博士、林怡伶 博士

研究生：張卜方 撰

中 華 民 國 110 年 7 月

DOI:10.6814/NCCU202101442

摘要

社交機器人技術已廣泛應用於各種服務環境，通過模仿像人的互動來提供幫助或增強娛樂體驗。先前的研究考慮了各種設計特徵來探索人機關係中的影響，而機器人在交互過程中提供幫助的方式很少被討論。本研究將人形機器人應用在購物環境中並作為銷售人員的角色，目的為探討機器人助理的哪種溝通方式對顧客更有利。為了實現研究目標，提出了以信任概念為核心的理論模型，並設計不同級別的服務主動性（主動與被動）和表達行為的類型（中性與親密），透過影片的形式展示機器人的互動回饋，線上進行了兩個階段的實驗。首先，每個實驗條件下所設計的操作在第一階段中得到驗證，而在正式研究中，感知親密性會受到不同風格的表達行為的影響，並指出可能存在對人形機器人的人際感知。結果揭示了我們提出的結構模型之間的正相關性，表明當機器人以更主動的方式行事並且被認為更親密時，使用者會同時從認知與情感的面向更信任該機器人，並進而提升使用意願。

關鍵詞：人機交互；親密互動；主動性；認知信任；情感信任

DOI:10.6814/NCCU202101442

Abstract

Social robotics have been widely applied in diverse service contexts to provide assistance or enhance entertainment experience through imitating humanlike interaction. Previous research took a variety of design features into consideration to explore the influence in human-robot relationships, while the robot's manner of providing assistance during interaction was rarely discussed. The purpose of this study is to investigate which communication approaches of a robotic assistant would be more favorable for customers since applying the humanoid robot in the shopping context as the role of a salesperson. The theoretical model focusing on the concept of trust is proposed to achieve the research objectives. Different levels of service proactivity (*proactive vs. reactive*) and types of expressive behaviors (*neutral vs. intimate*) are developed and empirically validate. Two survey sessions are conducted online through presenting the robot responses in several videos. The manipulations designed for each experimental condition are first validated in the preliminary study. In the formal study, perceived intimacy can be successfully affected by different styles of expressive behaviors, noting that there may be interpersonal perception towards the humanoid robot. The results reveal positive correlations between our proposed structural model, providing strong evidence that the users are more willing to trust in the robot when it behaves in the more proactive manner and is perceived more intimate.

Keywords: human-humanoid robot interaction; intimate communication; proactivity; cognitive trust; emotional trust

DOI:10.6814/NCCU202101442

Table of Contents

DOI:10.6814/NCCU202101442

DOI:10.6814/NCCU202101442

Tables

DOI:10.6814/NCCU202101442

Figures

DOI:10.6814/NCCU202101442

Chapter 1 Introduction

1.1 Background and Motivation

Robotic applications have been widely implemented to achieve specific purpose in numerous fields in recent decades. In the early development, robotics were primarily designed to provide merely physical support; for example, surgical robotics assist in enhancing human capabilities to perform delicate operations in medical discipline (Camarillo et al., 2004), and industrial robotic arms can increase productivity by performing automotive manufacturing (Brogårdh, 2007). With the advancement of technology, various types of usage are applied to contexts of daily lives which contain intensive interaction between human and technologies to provide novel services and improve user experiences. For instance, Amazon Go, the unmanned retail store opened in 2016, relies on its emerging technology to build up a different shopping experience from usual, which a customer does not need to wait in line for checkout. Companies in China, as well as 7-Eleven in Taiwan, kept up with this new retail reality; however, the trend hit a dead end soon due to not only technological constraints but also lack of interpersonal interaction causing less willingness to revisit once the effect of novelty disappeared[1].

Recently, effort devoted developing robotic systems started to focus on facilitating human-robot interaction, which then brought about the design of humanoid robots with humanlike features, such as gestures (Huang & Mutlu, 2013; Salem et al., 2013) and eye gaze (Mutlu et al., 2006) to simulate the interaction scenarios between human and human. Broadbent et al. (2013) stated that robots with humanlike facial appearance found to be more trustworthy and sociable. Research also shows that perceived anthropomorphism leads to a positive interaction experience (Duffy, 2003), as well as

[1] https://www.cheers.com.tw/article/article.action?id=5094304

DOI:10.6814/NCCU202101442

positively impacts trust and compliance with a robot (Natarajan & Gombolay, 2020). Such humanoid robots are responsible to provide assistance and service through social interaction and have been trialed in diverse service contexts, such as a rehabilitative therapist (Winkle et al., 2018), a companion in elderly care (Abdi et al., 2018), an education tutor (Alemi et al., 2014), an assistant in a public space (Iwamura et al., 2011; Kaipainen et al., 2018; Pan et al., 2015), or a guidance with advertisement purpose in a shopping mall (Kanda et al., 2010; Shiomi et al., 2013). These studies indicate that a humanoid robot has substantial advantages on commercial contexts.

1.2 Research Methods and Questions

To develop an appropriate human-robot interactive scheme, it is important to understand the elements that affect a user's willingness to interact with a robot application as well as the factors that contribute to a successful human- humanoid robot interaction. Researchers have not only focused on objective performance indicators but also evaluated the importance of subjective perception (De Graaf & Ben Allouch, 2013). To be more specific in commerce context, for example, interpersonal relationships between salespeople and customers are observed to be relevant to sales performance (Keillor et al., 2000). There has been evidence that a robot's behaviors have an impact on human perception and consequent outcomes; however, how to appropriately leverage a robot to enhance the customer experience in the shopping process and benefit from it remains unclear. As the robot is applied as social interactants, it is therefore critical to further explore the influence of interpersonal factor (e.g., intimacy) on human-humanoid robot interaction. Similarly, customer trust has also been widely discussed its importance in developing buyer-seller relationships (Chai et al., 2015; Morgan & Hunt, 1994; Sichtmann, 2007). Trust can be separated to cognitive trust and emotional trust conceptually (Komiak & Benbasat, 2004), which is further adequate to

DOI:10.6814/NCCU202101442

account for predicting customer decisions as it involves both reasoning and feeling, in turn to be an antecedent of intention behaviors.

The proposed research is based on trust and technology adoption by investigating the effects of a robot's communication strategies in different levels of service proactivity (proactive vs. reactive) and types of expressive behaviors (neutral vs. intimate) on human-humanoid robot interaction. Various human-robot interactive modes are developed and will be empirically examined via the online survey session. The following research questions were constructed:

RQ1: Can a humanoid robot act as a salesperson and provide interpersonal interaction?

RQ2: How do a humanoid robot's communication approaches affect human-robot trust relationship and encourage customers' usage willingness?

Chapter 2 Literature Review

There are more and more studies explore into the employment of humanoid robots in public settings, for example, Kaipainen et al. (2018) focused on identifying hedonic user experiences evoked by a social robot in the city service point. It has been further investigated consequences of engaging users on a social level by technologies. In addition to offering information and physical assistance, a field study considered the use of the robot as a salesperson in the department store and resulted in selling clothes to customers successfully through providing personal purchasing advice (Watanabe et al., 2015), suggesting that humanoid robots would have potential in the role of salespeople with the function of persuading customers to purchase recommended products. However, there is little evidence focusing on whether the deployment of robotic salesperson could elicit positive shopping experience and thus bring benefits to

DOI:10.6814/NCCU202101442

retailers through stimulating actual purchasing behaviors.

2.1 Social presence

As the humanoid robots have been considered to play a role of service representative to face the users directly, they are designed with human-like features to facilitate the interaction. Social presence refers to the sense of being with someone else and the consequent salience of the interpersonal relationships (Parker et al., 1978), which theorizes that humans naturally interact with machines in a social manner (Nass & Moon, 2000). This characteristic encourages the usage of avatar interface in online services complementing the lack of face-to-face interaction (Wang et al., 2016), which is a positive antecedent of trust and reflects the belief that there is an assistive agent to talk to (Gefen & Straub, 2003). Similarly, research has explored robot expressiveness extensively to simulate the interaction more realistically between humans. Increasing sociability with rich expressivity is beneficial to build an emotional connection and trust (Martelaro et al., 2016). Researchers proposed that when customers treat the robot as a social entity more during an interaction, the positive effect on perception of warmth and competence would be larger, and thus led to higher customer satisfaction (van Doorn et al., 2017). The concept of social presence stands for the abilities of social responses in interactions, and communication mediums have been considered as a critical approach for online service delivery. The more humanlike features, such as humorous slang conversational patterns rather than pure medical terms, are exhibited by such advisory agents, the more people are attracted and drawn closer, and thus causes a positive impact on consumer reuse intentions (Li & Mao, 2015). Therefore, we mainly focus on the communication behaviors for the socially interactive robot as the agent for merchants and the development of relationship in this research.

2.2 Intimacy in HRI

Perceived value is identified as overall assessment from how the individual

DOI:10.6814/NCCU202101442

perceives what is given from a service provider (Chiu et al., 2012). Research conducted in either offline or online shopping context has considered these constructs of perceived value as key predictors of customer satisfaction, loyalty and behavioral intentions (Ben Mimoun & Poncin, 2015; Chiu et al., 2014; Yoo et al., 2010). Similar to the concept of perceived value, research in human-robot interaction has focused on effects of human perception. De Graaf & Ben Allouch (2013) proposed a general exploration of impact of potential determinants on the acceptance of social robots. Focusing on the user evaluation factors, both rational and affective aspects was designated to be a variables classification approach and suggested to held significant evidence to explain why users may accept a social robot. Subsequently, how users perceived from interaction with a robot appeared to be influential factors for acceptance of social robotics.

Building rapport with customers is an essential ability to enhance trust in buyer-seller relationship (Campbell et al., 2006). Intimacy viewed as an indicator of closeness in interpersonal relations has been referred as a key evaluative perception for relationship with a service supplier (Brock & Zhou, 2012). According to Bringle and Prager (1996), the concept of intimacy is composed from the perception of positive feelings and understanding, and behaviors included shared experiences and physical expression during social interaction. Establishing friendly relationship with a social robot would increase user intention to continue interacting with it (Kanda et al., 2007); moreover, similar results were found in the field study conducted in the shopping mall that development of relationships with the robot positively affected people shopping behaviors as well as visiting frequency (Kanda et al., 2010). Accordingly, perceived intimacy is summarized in the present study as the feeling that others are cordial and caring when interacting with service providers. As the humanoid robots are expected to be designed as social interactants in our study, it is therefore necessary to examine their

DOI:10.6814/NCCU202101442

social abilities through investigating how communication behaviors would affect customers' perception of intimacy.

2.3 Communication design of a robot

In the commercial field, advertising is a kind of marketing strategy promoting specific products to customers through various media channels. From a social aspect, researchers emphasized the role of advertising which influences the consciousness of a potential customer to believe they need the products and further to purchase these products (Kapustina et al., 2019). Another personal promotion approach, such as a recommender system, provides a set of product selection likely interesting to a customer. Consequently, it plays a vital role of affecting conversion rate by persuading users to accept its suggestion for additional purchases, and then increases profit for retailers (Cremonesi et al., 2012). According to Fogg's (1998) definition of persuasion as "an attempt to shape, reinforce, or change behaviors, feelings, or thoughts about an issue, object, or action", persuasive ability of the sales robot is a critical attribute to successfully be implemented with the purpose of providing purchasing advice and engendering purchasing behaviors in the offline store context.

Prior research has been concentrated on how persuasiveness of a humanoid robot would be affected through a variety of manipulations. For example, participants tended to follow instructions, even an unusual request such as placing a pile of book into a garbage can, from the physically present robot rather than the robot in video-displayed form, which suggested that physical presence of a robot contributed to higher compliance (Bainbridge et al., 2008). A research carried out by Chidambaram et al. (2012) explored the extent how nonverbal cues of a robot influence human compliance. The result showed that participants were more likely persuaded and tended to accept the suggestions of changing initial rankings of particular items from the robot with

DOI:10.6814/NCCU202101442

bodily cues and vocal cues.

Besides leveraging physical features of the humanoid robot to convince users, Winkle et al. (2019) designed the content of robot's dialogue to maximize peripheral cues based on the Elaboration Likelihood Model (ELM), and found that goodwill and similarity strategies had the impact on participants compliance behavior but showed no difference on subjective perception. Similarly, Saunderson & Nejat (2019) adopted ten types of Compliance-Gaining Behaviors and used two of them simultaneously in order to compare the persuasive effectiveness. The humanoid robot had more persuasive influence when showing affect (disclosure the robot's emotion) or logical (explain why the robot suggests) behaviors. The aforementioned studies using strategies in human-human interaction to achieve the purpose of persuasion.

Moreover, interaction scheme is also a considering factor broadly investigated how it affect the interaction between human and robots in several studies. Horstmann et al. (2018) investigated the effect of either functional and social interaction styles and whether a robot verbally objected or not. The result provided evidence that the users complied more with robot voicing an objection against being switched off and perceived more likable towards the robot under social condition, in which the interaction was more intimate by characterizing the wording with personal opinions and the use of humor. Schulz et al. (2018) explored the efficiency and preference for the robot by combining different interaction styles with different action types of on-table tasks. After a series of experiments, the result demonstrated that a tradeoff occurred between task performance and user perception. The completion time was shorter for the autonomous mode in all conditions, while participants preferred robot-led interactions with information for more complex tasks and human-led strategies if the tasks required joint action.

DOI:10.6814/NCCU202101442

Although considerable design strategies have been used on social robots in order to achieve intended purpose, conversational interaction is utilized as a major communication approach and plays a vital role in facilitating the interaction among users and humanoid robot, which in turn to be an essential functionality implemented for a robot in shopping context (Gross et al., 2009; Iwamura et al., 2011; Kanda et al., 2010). With regard to dialogue-based design, conversation content from the robot led to different levels of user perception and task engagement (Zafari et al., 2019), and conveyed intimacy through specific verbal communication such as self-disclosure (Kanda et al., 2010; Matsuyama et al., 2016). Since nonverbal behavioral attributes have also shown to be effective in communication and subsequently engender user behavior changes (Chidambaram et al., 2012), research manipulating conversation content and bodily behaviors simultaneously which explored how users perceived the virtual tourist counselor with different verbal and nonverbal behavioral cues with various interaction modalities (Potdevin et al., 2018). The results indicated the intimate behaviors with verbal and nonverbal cues received higher ratings on perceived intimacy. In addition to what the robot presents, when to convey support in a decision-making context and how the timing impacts user perception are examined as well (Kraus et al., 2020; Peng et al., 2019). For example, Peng et al. (2019) compared the effect of proactive manners provided by a robot assistant on customers' shopping experience. The results showed that the robot under the high-proactivity condition was deemed inappropriate due to the robot intruding into users' decision spaces, whereas the medium-proactivitive robot was more favorable since the robot verified users' needs before taking any actions. Therefore, we infer that what the robot manifest in and when it behaves during interaction with users would both be influential factors simultaneously and even cause interactive effects, while the prior research investigated

DOI:10.6814/NCCU202101442

the effects of communicative behaviors from varying aspects separately.

According to the importance of the communication between salespeople and customers which may in turn affect purchasing decisions, this study explores how the application of communication design features, specifically the combination of different levels of proactivity and different styles of expressive behaviors, impact the interaction experience and users' perception of a humanoid shopping robot.

2.4 Trust

Trust has been a key determinant in the relationship between a salesperson and a customer, which was found to have an advantageous effect on customer attitudes, intentions, and behaviors (Swan et al., 1999). Research in the implementation of shopping assistants as decision aids largely focused on provoking users' trust which in turn became motivation of utilizing the service and accepting its shopping advice (Chattaraman et al., 2019; Wang et al., 2016). As robots are more and more commonly used alongside humans, trust has also been a topic broadly discussed in human-robot interaction (Hancock et al., 2011). Relevant works not only explore various design characteristics including anthropomorphic appearance and interactive behaviors as antecedents of trust (Natarajan & Gombolay, 2020), but also involve consequences such as intention to work with or follow instructions from the robot (Aroyo et al., 2018; You & Robert, 2018). In addition to be considered as a relational construct, trust has been conceptualized as two distinct dimensions, namely, cognitive trust and emotional trust, which were originally emphasized by McAllister (1995). Extended from the context of interpersonal communication, both aspects of trust were investigated in research of recommendation agents (Komiak & Benbasat, 2006).

Cognitive trust is defined as willingness of a customer to rely on a service provider based on users' rational assessment with respect to attributes of competence,

DOI:10.6814/NCCU202101442

benevolence, and integrity (Komiak & Benbasat, 2004). As known to be knowledge-driven trusting belief, this form of trust refers to expectations of the functional aspect that the technological artifact such as online recommendation agent intends to consider a customer's interest and possesses the ability to perform specific tasks following a set of principles as well. Relevant research in e-commerce context has concentrated on exploring the effects of perceptions regarding characteristics of various stakeholders (Chen & Dhillon, 2003) and design features (Wang & Benbasat, 2007) particularly on cognitive trust.

Emotional trust is identified as subjective feelings of security and comfort about relying on a service provider (Komiak & Benbasat, 2004). In contrast to reasoning and understanding, this dimension of trust refers to the other approach to assess trustworthiness of the recommendation agent arising from users' affective responses including warmth and perceived closeness provoked during interaction with the recommendation agent (Wang et al., 2016). In other words, emotional trust may be perceived beyond reasonable knowledge, and is decidedly more confined to interaction experience based on emotions.

Chapter 3 Hypothesis Development

The study aims to investigate the applicability as well as potential benefits of the humanoid robot in a shopping context. To validate how the robot assists customers with purchasing advice would elicit more positive response and willingness to accept it, hypotheses are formulated from the perspective of trust. Consequently, the purposed research model includes perceived proactivity, perceived intimacy, cognitive trust, emotional trust and intention to adopt advice from the robot. A summary of these arguments and the potential relationships is constructed in Figure 3-1.

DOI:10.6814/NCCU202101442

A field study developed the guiding robot for general task of providing particular information and implemented the designed system in a mall. The result revealed that the behaviors of proactively approaching to people and offering services received positive impressions from the visitors (Shiomi et al., 2009). When a robot is designed with proactive communication manner, it may be perceived as closeness and caring what the users are going to do. Under such consideration, a hypothesis is put forward for exploring the correlation:

H1: Perceived proactivity will increase perceived intimacy of the robot.

The users' trust in the capability a social robot was slightly lower when interacted with the highly automatic robot providing its suggestions directly (Rau et al., 2013). However, when the robot still kept decision space and the sense of control for the users, such as providing prompts to let the users choose what to do next, it was perceived more competence and reliability and enhance cognitive trust (Kraus et al., 2020). It can be inferred that cognitive trust would be positively impacted through appropriately proactive strategies. In addition, similar research demonstrated that medium-level proactive robot elicited more positive perception with respect to appropriateness, helpfulness, and desirability in the decision-making process (Peng et al., 2019), which may subsequently increase emotional trust since it is found to be raise by interpersonal likeability of the service provider (Nicholson et al., 2001). Thus, we hypothesize that:

H2: Perceived proactivity will increase cognitive trust in the shopping robot.

H3: Perceived proactivity will increase emotional trust in the shopping robot.

People make emotional investments in trust relationships where the partner expresses genuine care, which implies that the emotional ties linking individuals can provide the basis for trust (McAllister, 1995). Developing appropriate rapport implies that the staff is committed to the customer's best interest (Crosby et al., 1990), which

DOI:10.6814/NCCU202101442

in turn enhances trust toward staff members (Yim et al., 2008). As the robot is designed to imitate the role of a salesperson in the store, research has highlighted the importance of building relationship with customers. Corresponding to the definition of emotional trust constructed from affective experience with and social attachment to the service provider (Wang et al., 2016), it can be then inferred that intimacy would have positive correlation with trust, especially of the emotional aspect. Meanwhile, when the users interacted with the social-oriented and more engaging digital assistant in the e-tail site, cognitive trust showed significantly different compared to those under task-oriented one (Chattaraman et al., 2019). Therefore, we hypothesize that:

H4: Perceived intimacy will increase emotional trust in the shopping robot.

H5: Perceived intimacy will increase cognitive trust in the shopping robot.

Before trustees invest in interaction with a trustor, their expectation of trustor's reliability and dependability has to be satisfied (McAllister, 1995). Research also suggested that users were willing to rely on it from feelings of secure and comfortable since trust in recommendation agents was established grounded on rational reasons such as functional performance, especially in the commerce context (Komiak & Benbasat, 2003; Komiak & Benbasat, 2006). Keeping in line with the findings in the prior research, the hypothesis is constructed that:

H6: Cognitive trust will positively affect emotional trust.

A user's usage intention which is the extent of someone willing to depend on a system has been widely investigated as an indicator of acceptance and adoption in the related fields. Gaudiello et al. (2016) suggested that trust has been considered as a main indicator of acceptance of the robot as well as evoke positive attitudes toward the robot, which then detected to positively influence behavioral intention to interact with the robot (De Graaf & Ben Allouch, 2013; You & Robert, 2018). As this study attempts to

DOI:10.6814/NCCU202101442

investigate the effects of assigning the robot as a salesperson, the relevant results revealing that overall trust influence the intention of purchasing behaviors (Chen & Dhillon, 2003; Zboja & Voorhees, 2006). There is little discussion about clearly recognizing cognitive trust and emotional trust in the research field of human-robot interaction. However, since the robot exhibits similar functionality with a recommendation agent where trust has been distinguished in cognitive and emotional dimensions in previous research, it can also be examined the effects of trust in robot from these two subtly different aspects:

H7: Cognitive trust will enhance customers' usage intention.

H8: Emotional trust will enhance customers' usage intention.

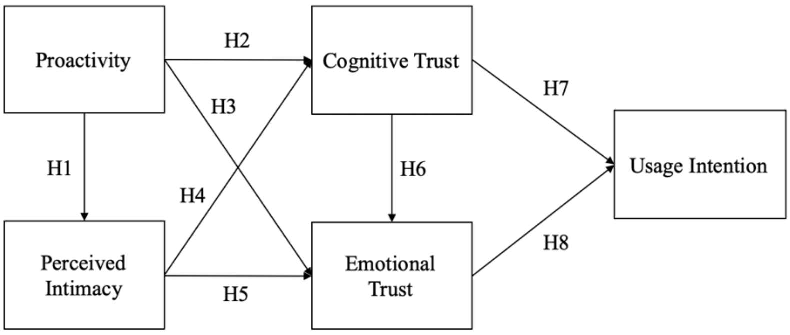


Figure 3-1 Theoretical hypotheses model

Chapter 4 Research Methodology

Online surveys were conducted to empirically validate the experimental conditions and its consequent effects. Two levels of service proactivity (proactive vs. reactive) and two types of expressive behaviors (neutral vs. intimate) are used in a humanoid robot for a shopping context. Proactive behaviors can be defined as a robot initiates an anticipatory action in advance (i.e., proactive) or reacting after receiving a user request (i.e., reactive) (Nothdurft et al., 2015). The task-related information was provided in

DOI:10.6814/NCCU202101442

the neutral condition, whereas the emotion-related content was supported in the intimate condition. In addition, a robot's verbal and nonverbal cues were used to enhance perceived intimacy (Potdevin et al., 2018).

4.1 Experimental designs

The humanoid robot Pepper[2] was used in this research. Four experimental conditions were designed primarily by manipulating the types of proactive and expressive behaviors in the human-humanoid robot interaction.

4.1.1 Proactivity

Peng et al.'s (2019) investigated what effects of proactivity had in the context of decision-making support. Results indicated that the most proactive manner of a robotic assistant was deemed as less appropriate because of its intrusion into participants' decision space, while feelings of control was more preferred. Similar outcomes were discovered intervention behavior was considered as too obtrusive and less trusted than behaving in medium-level proactive manner (Kraus et al., 2020). Accordingly, we followed the principles described in prior studies to design robot's proactive behaviors:

Reactive: A robot only responded upon the explicit request from a user and provided a complete set of choices for the user to decide practically by herself.

Proactive: A robot actively introduced its functionalities, asked a user whether needs assistance and provided supports or recommendations. Moreover, the robot also helped narrow down the selections.

4.1.2 Expressive behaviors

The formulation standards are based on Potdevin et al. (2018) in designing intimate behavioral cues for online embodied conversational agents. In the verbal aspect, the robot provided only task-related information in the neutral condition;

[2] https://www.softbankrobotics.com/emea/en/pepper

DOI:10.6814/NCCU202101442

whereas three intimacy-related factors were considered in the intimate condition, including honesty and genuineness, positivity, and mutual comprehension. Accordingly, the developed robotic agent utilized active voice (such as “I”) and supported shared opinions, subjective advice, and comprehensive information to a participant to strengthen the human-robot intimate relationship. For example, when a user selected a particular sport category, the robot would respond “I also like playing basketball! It is a healthy sport.” Or, when a participant chose a shoe product, the robot would recommend “I think they are suitable for hiking, you will not regret buying them” in the intimate condition.

For the nonverbal cues, gazes and gestures were chosen to operationalize since the limitations of inability to manifest facial expressions. The use of eye contact allowed the robot to be perceived as engaging in the social interaction and responding to human (Heenan et al., 2014); additionally, its frequency led to significant effects on performance in a story recall task (Mutlu et al., 2006) and stronger attentiveness to the task and feelings of groupness (Mutlu et al., 2009). Therefore, in our experiment, the shopping robot in neutral condition was designed with static gaze, which makes eye contact once during greeting to the participant and looks straight ahead in the rest of interaction. In the intimate condition, the robot shifted its gaze either toward the participant or toward the display screen when referring the recommended item in the intimate condition. Gestures has been commonly used in research of human-humanoid robot interaction. The design factors involving size, speed, and frequency of gestures found to affect user impressions (Kim et al., 2008). In the neutral condition, the robot uses gestures only to attract participants’ attention to read or perceive necessary information.; on the other hand, the robot expresses more frequent and different kinds of gestures along with verbal cues in the intimate condition. In brief, difference between

DOI:10.6814/NCCU202101442

the neutral and intimate condition is mainly about the manipulations of expressing frequency. The video screenshots and script samples designed for each condition with proactive manner are shown in

Table 4-1.

The differences between neutral and intimate conditions were achieved through simple change of behavioral cues with no functional changes, participants under both conditions receive the same page displayed on the screen in front of the robot's chest as well as same justifications from the robot.

Table 4-1 Video Screenshots and script samples

Condition	**Neutral**	**Intimate**
Video Screenshot		
Script	Only these sizes are in stock currently. Do you want to take a look at other pairs of shoes in the store?	You have a good taste in choosing shoes! But I'm sorry that only these sizes are in stock currently. Would you like to take a look at other pairs of shoes in the store?

4.2 Manipulation checks

Since there was lack of criteria to confirm the designs for proactivity and the interactive behaviors, the online video surveys where a participant was presented with all conditions through multiple videos were conducted to empirically validate the manipulations of each experimental condition and examine the effects of different

DOI:10.6814/NCCU202101442

interaction approaches. Two levels of service proactivity (proactive vs. reactive) and two types of expressive behaviors (neutral vs. intimate) were used in a humanoid robot for a shopping context.

4.2.1 Participants and survey procedure

A variety of questionnaires were used to measure attitudinal and perception differences. The survey not only ensured whether each condition met the design and could be recognized by participants but also examined the perception of intimacy. The questionnaire was adapted from the relational communication scale (Burgoon & Hale, 1987) for manipulation check of expressive behaviors style and the virtual intimacy scale (Potdevin et al., 2021) for evaluating intimacy. Several items measuring proactivity were constructed according to the designed proactive behaviors and using "more proactive" in the description. Items were modified to be better suitable for the present study and were translated to Chinese. Additionally, there was an open-ended question about how the participant made the judgement. The complete questionnaire is shown in English version in Appendix A.

Unlike prior studies that usually adopted the Likert scale for subjects to score the perception, the questionnaire in this study replaces the narratives with choice questions (Which robot was more proactive in introducing products to customers?). The questionnaire is conducted in a comparative way and could be divided into three parts, including 1) reactive + neutral (Robot A) vs. reactive + intimate (Robot B) and 2) proactive + neutral (Robot C) vs. proactive + intimate (Robot D) for distinguishing communicative style, and 3) proactive + intimate (Robot E) vs. reactive + intimate (Robot F) for differentiating the level of proactivity. Before getting into the formal session, participants had to watch two clips of videos simulating the shoe shopping scenario and try to compare the difference. The robot with different behaviors according

DOI:10.6814/NCCU202101442

to the experimental condition performs a series of shopping processes, such as greeting customers, introducing the shoes in detail, providing assistance, recommending another pair of shoes, and promoting additional products before checking out.

In this study, a total of 58 participants were recruited (36 male and 22 female). Most participants (89.7%) aged between 21 and 25 years old. While the average score of the item measuring familiarity with using computers and technology was 4.36 (ranging from 1 for "very unfamiliar" to 5 for "very familiar"), the average score reported the familiarity with using robots was 2.58. In addition, more than half of participants (53.8%) have never used humanoid robots. Table 4-2 represented demographic characteristic of participants.

Table 4-2 Demographic characteristics of participants (manipulation checks)

Category		Number of respondents	(%)
Gender	Male	36	62.1%
	Female	22	37.9%
Age	21-25	52	89.7%
	26-30	5	8.6%
	More than 40	1	1.7%
Educational background	Information Science	44	75.9%
	Engineering	4	6.9%
	Management	6	10.3%
	Mathematics	1	1.7%
	Art	1	1.7%
	Social Psychology	1	1.7%
	Law and Political Science	1	1.7%
How familiar are you with using computers and technology?	1 (very unfamiliar)	0	0%
	2	0	0%
	3	5	8.6%
	4	27	46.6%
	5 (very familiar)	26	44.8%

DOI:10.6814/NCCU202101442

How familiar are you with using robots?	1 (very unfamiliar)	12	20.7%
	2	15	25.9%
	3	18	31%
	4	11	19%
	5 (very familiar)	2	3.4%
Frequency of using embodied humanoid robot	Never	37	53.8%
	More than once a year	21	36.2%
	More than once every three months	0	0%
	More than once a month	0	0%

4.2.2 Data analysis and results

The scales were on an acceptably reliable level with Cronbach's α values greater than the threshold value of .70 (see Appendix A). One item in task-oriented subscale ("ST_3: Which robot was more helpful for the shopping task?") was deleted to achieve better reliability.

In order to enable the significance analysis, several data conversion calculating the scores obtained under each condition was made by following rules. Since the participants were asked to choose from three options (Robot A/C/E, Robot B/D/F, and No difference), 1 point for an item if a participant chose the target robot; otherwise, the item would get 0 points if choosing other options. For example, if the participant chose the option "Robot B" or "No difference", the item would be recorded as 0 points when calculating the score of Robot A (reactive + neutral) and so on. Item scores for each construct were then averaged to create composite scores for each dimension as well. The conversion example of perceived intimacy for reactive + neutral condition was showed in Figure 4-1. The above table was the original questionnaire response, and the one below was the result after conversion. In this way, score of items could be obtained from the participants' choices for manipulations under each corresponding condition. Consequently, the responses converted to corresponding score of each condition were

DOI:10.6814/NCCU202101442

derived from the questionnaire in this study.

Part 1	I_1	I_2	I_3	I_4	I_5
	No difference	No difference	Robot B	Robot A	Robot B

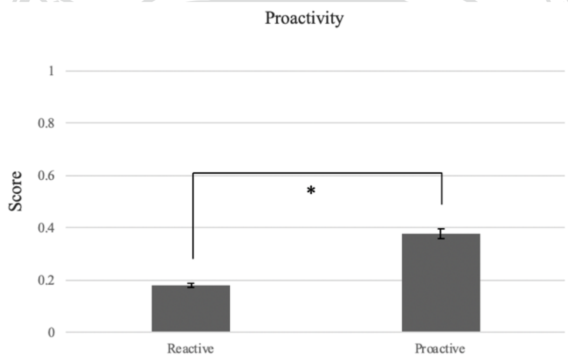
Condition	Proactivity	Style	I_1	I_2	I_3	I_4	I_5	Mean_I
RN	reactive	neutral	0	0	0	1	0	0.2

Figure 4-1 Questionnaire conversion

The data analysis in this section was conducted on the software SPSS Statics 25. First of all, manipulation checks were conducted for types of proactive and expressive behaviors. Paired sample t-tests were adopted since the responses were collected from the matched sample designed questionnaire. Figure 4-2 showed the statistical results of the perception in terms of the robot's proactivity. Outcomes confirmed that the robot designed with the proactive manner (*M* = .38, *SD* = .44) was evaluated significantly more active than the one with the reactive manner (*M* = .18, *SD* = .32; p < .05). As for the robot's expressive behaviors, the results were shown in Figure 4-3. Manipulated with reactive manner (Figure 4-3a), the robot was significantly perceived more task-oriented in the neutral condition (*M* = .55, *SD* = .32) than in the intimate condition (*M* = .26, *SD* = .28; *p* < .001), while the perception of social-oriented was rated significantly higher in the intimate condition (*M* = .89, *SD* = .28) than in the neutral condition (*M* = .07, *SD* = .22; *p* < .001). Similar results were found when the robot was proactive (Figure 4-3b), average task-oriented score was significantly higher in the neutral condition (*M* = .46, *SD* = .34) than in the intimate condition (*M* = .25, *SD* = .31; *p* < .01), and the intimate robot (*M* = .89, *SD* = .27) was chose to be significantly more social-oriented than the neutral one (*M* = .05, *SD* = .21; *p* < .001).

DOI:10.6814/NCCU202101442

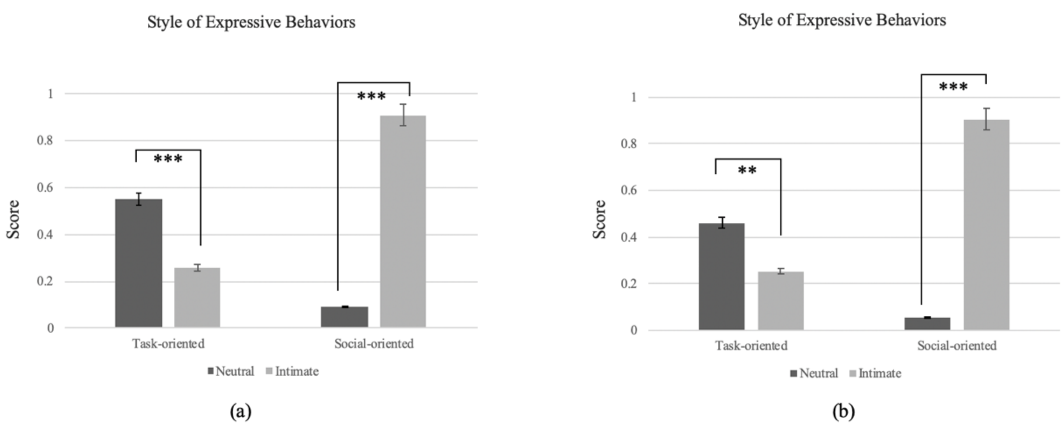
Furthermore, the interpretation of the collected data could also be supported by feedback of the open question concerning how to make the judgment and choose the corresponding robot, such as "*The way Robot D displays makes me feel as if it wants to build friendships with me, while Robot C gives instructions in a more standard way to complete the task.*" For the comparison of proactivity, several participants identified the robot as more proactive due to the behaviors of reminding the corresponding function on each page and recommending another pair of shoes when lacking the particular size. In summary, participants pointed out designed differences between robots, indicating that the manipulations of proactivity and style of expressive behaviors were effective and could be recognized by the participants.



(* : significant at the .05 level; ** : significant at the .01 level; *** : significant at the .001 level)

Figure 4-2 Means and 95% CI error bars for distinguishing the level of proactivity

DOI:10.6814/NCCU202101442



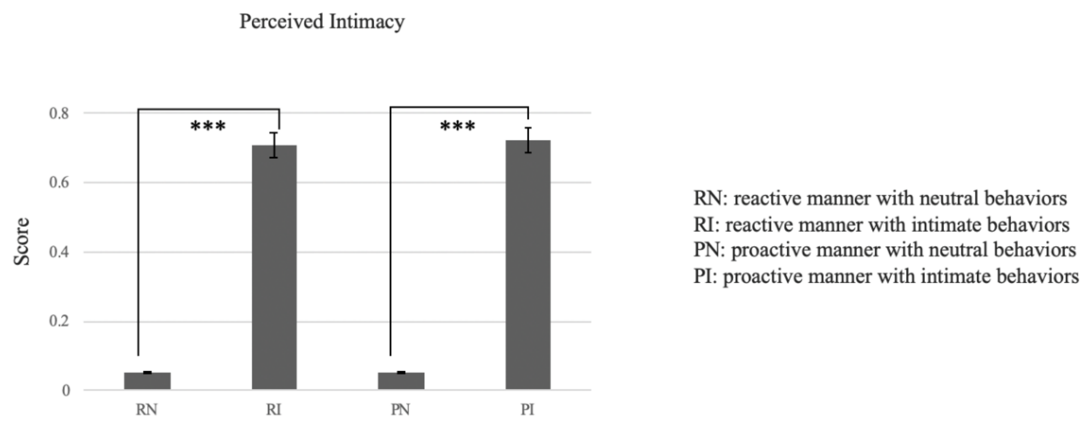
(* : significant at the .05 level; ** : significant at the .01 level; *** : significant at the .001 level)

Figure 4-3 Means and 95% CI error bars for distinguishing the style of expressive behaviors with (a) reactive and (b) proactive manner

Although the responses were converted to corresponding score, they were still the results of pairwise comparison. Through paired sample t-tests as well, we examined whether different style of expressive behaviors would elicit the user perception of intimacy and have significant effects on it during communication. As presented in Figure 4-4, no matter with reactive or proactive manner, the average scores of perceived intimacy were significant higher ($p < .001$) when the robot employed intimate expressive behaviors as compared to the neutral condition ($M_{PN} = .05$, $SD_{PN} = .18$ vs. $M_{PI} = .70$, $SD_{PI} = .29$; $M_{AN} = .07$, $SD_{AN} = .18$ vs. $M_{AI} = .72$, $SD_{AI} = .30$). Moreover, no significant difference of perceived intimacy was found between the reactive ($M_{PI} = .18$, $SD_{PI} = .31$) and proactive conditions ($M_{AI} = .30$, $SD_{AI} = .35$; $p = 0.1$) when the robot interacted accompanying intimate behaviors from the third part of the questionnaire (Figure 4-5). The explanation could be found in the feedback from the participants. For instance, "*Robot B expresses its emotions and opinions (I think…)*" and "*Robot B has more gesture, and what it says is more anthropomorphic. I feel it is more approachable.*" Consequently, it can be verified that the social-oriented interaction style, manipulated in the intimate condition of expressive behaviors, caused main effects on the perception

DOI:10.6814/NCCU202101442

of intimacy.



(* : significant at the .05 level; ** : significant at the .01 level; *** : significant at the .001 level)

Figure 4-4 Means and 95% CI error bars of perceived intimacy comparing by interaction style

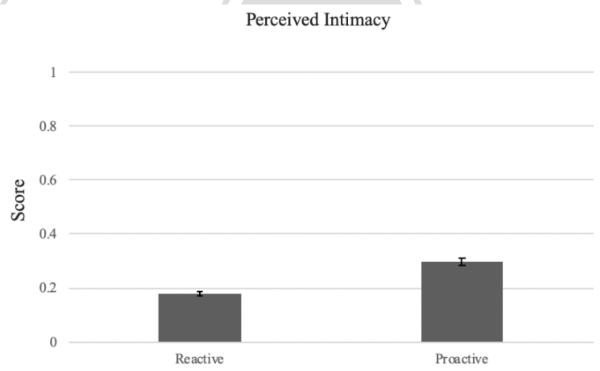


Figure 4-5 Means and 95% CI error bars of perceived intimacy comparing by proactivity levels

According to the statistical results and the feedback, the participants identified which robot was more proactive in interacting with the customer; however, there was an average of 43% responses of “No difference” for each item of the proactivity construct. Most participants reported that they were more focus on what the robot behaved and its verbal contents when introducing products. The possible reason may be that the proactivity manipulation of the robot, including giving a prompt of what can the user do next and whether it needed to be triggered by the operator, was too

DOI:10.6814/NCCU202101442

inconspicuous to be easily ignored by the participants. Additionally, the participants were only asked to watch videos of interaction processes between a robot and a customer without any operations, which may become another reason to explain the aforementioned results.

Based on the previous results of examining the manipulations, the other online survey was subsequently designed in the first-person perspective. It was carried out in order to validate the previous findings as well as further explore effects of different communication approaches via more actual interaction with the shopping robot.

4.3 Formal study

A two (proactivity: reactive and proactive) by two (intimacy: neutral and intimate) between-subject design experiment was conducted to examine how a robot provided purchasing advice affected the perceived trust as well as user intention to use. The main independent variable in this research was the communication approach of the robot, composing with proactive manner and expressive behaviors, which was the way of how a user received the information from the robot acting as a shopping assistant.

4.3.1 Experimental setup

In order to provide more practical interaction with the robot, the experimental website for purchasing shoes was developed and published through GitHub pages. Figure 4-6 illustrates the designed layout for the interface. The top of the webpage showed the task information and what pair of shoes the participant had selected. Displaying on the left side, the responses of the robot were presented by the way of video, playing automatically once participants entered the corresponding webpage. The scripts for each experimental condition are listed in Appendix C in the order of the main task procedure. Participants were asked to operate on the right side for performing a series of shopping process. The relevant features of shoes were collected from Nike and

DOI:10.6814/NCCU202101442

Decathlon sports websites. Moreover, two personas were created including an avatar, gender, occupation, and short introduction of their interests in sports, respectively. One of those described a female office worker who liked to go hiking on vacations, while the other was a male college student passionate about playing basketball. In this way, the participants could have a target of the task and were motivated to view this experiment as a serious shopping experience session.

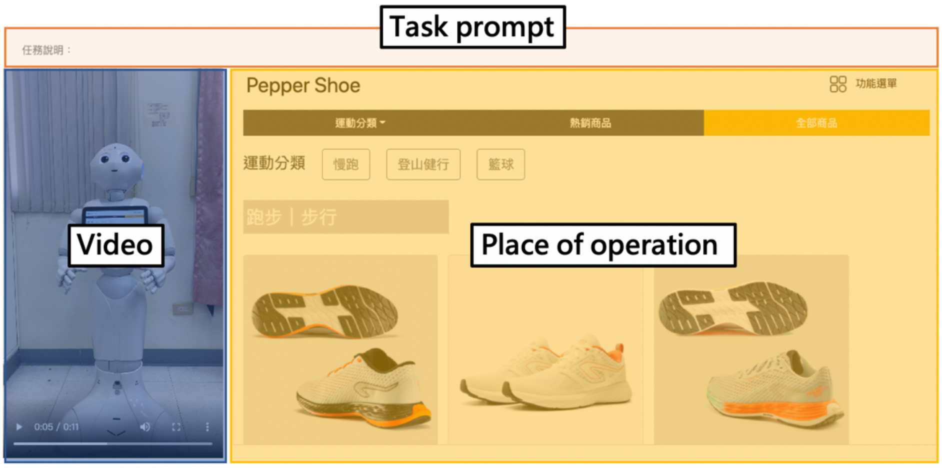


Figure 4-6 Layout of the webpages

4.3.2 Experiment Procedure

The experimental settings were designed in a shoe shopping scenario which possess various features retaining the complexity of making decisions. The present study was conducted online through distributing the website (integrating with the questionnaire) in several Facebook groups. First of all, a participant was introduced briefly about the experiment and filled out a pre-test questionnaire including demographics information and an open-ended question about imagination about what the potential role of robotics in a public area or a store could be before the formal experiment. After the questionnaire and the instruction session, each participant received the information of a persona and was assigned to one experimental condition

DOI:10.6814/NCCU202101442

randomly. The main shopping task is that selecting product as a gift for the given persona, and the robot acts as a salesperson offers assistances through the corresponding communication approaches. In the experiment process, the participant may face the problem such as lack of particular size; consequently, the robot would suggest the participant choose another pair of shoes by showing a list of recommended shoes proactively or reactively. Before checking out, the robot would further promote participants to purchase additional products. Such behaviors that whether to comply with suggestions from the robot can be used to examine potential influence after interacting with an assigned robot. The overall experiment task procedure is demonstrated in Figure 4-7. At the end of the experiment, a post questionnaire was used to evaluate participants' perception of the robot during shopping interaction as well as their subsequent usage intention.

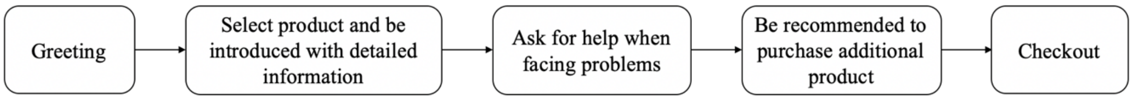


Figure 4-7 Task procedure

4.3.3 Measurements

Both objective and subjective measures were collected to characterize the effects among the experimental designs. From the system records, the completion time was calculated by the total time the participants spent for the main shopping task (from the welcoming webpage to the ending of saying goodbye). Whether a participant chose to purchase an additional product was recorded as well in order to investigate the effects through the participants' behaviors. The proposed post questionnaire was to measure cognitive trust (Wang et al., 2016; Wang & Benbasat, 2008), emotional trust (Komiak

DOI:10.6814/NCCU202101442

& Benbasat, 2006), and the usage intention (Venkatesh et al., 2000). Additionally, the questionnaire also included several items for measuring proactivity and evaluating the extent of perceived intimacy which were used in the previous study. Items translated to Chinese were modified in terms of conforming the context of the present study and were rated on a 7-point Likert scale (1 for strongly disagree, 7 for strongly agree). The complete questionnaire is provided in English version in Appendix B.

4.3.4 Data analysis and results

A total of 222 participants took part in the online experiment. After inspecting the time period recorded for the main shoe shopping task, several responses were eliminated due to the completion time was shorter than the sum of all corresponding videos. There were 215 responses remaining for the subsequent analysis, 54 for *reactive + neutral* condition (RN), 54 for *reactive + intimate* condition (RI), 52 for *proactive + neutral* condition (PN), and 55 for *proactive + intimate* condition (PI). The demographic of the participants is summarized in Table 4-3.

Table 4-3 Demographic characteristics of all participants (formal study)

Category		Number of respondents	(%)
Gender	Male	59	27.4%
	Female	156	72.6%
Age	Less than 21	31	14.4%
	21 - 25	127	59.1%
	26 - 30	32	14.9%
	31 - 35	9	4.2%
	36 - 40	7	3.2%
	41 - 45	3	1.4%
	More than 45	6	2.8%
Educational level	Senior high school	5	2.3%
	Bachelor's degree	141	65.6%
	Graduate institute	69	32.1%

DOI:10.6814/NCCU202101442

Shopping habits (multiple choices)	Shopping alone	187	-
	Discussing with friends	86	-
	Asking the staff	43	-
Frequency of buying shoes online	Never	55	25.6%
	More than once a year	102	47.4%
	More than once every six months	37	17.2%
	More than once every three months	14	6.5%
	More than once a month	7	3.3%
Willingness of accepting recommendation from the website	1 (very unwilling)	2	0.9%
	2	42	19.5%
	3	92	42.8%
	4	70	32.6%
	5 (very willing)	9	4.2%
Have you seen humanoid robots in the real world?	Yes	137	63.7%
	No	78	36.3%
Have you used a humanoid robot?	Yes	67	31.2%
	No	148	68.8%

Objective measures

To confirm whether the subjects fully participated in the experiment, the total time of the main task was recorded. In addition, this metric can be an evaluative indicator of user engagement as well. A significant effect was found (F (3, 211) = 3.089, p < .05), such that the average completion time significantly increased in the PI condition (M = 261.89) than in the RN condition (M = 196.13). As seen in Figure 4-8, the participants spent more time interacting with the more proactive and intimate robot. Nevertheless, the results may only interpret as being consistent with the experimental designs, but no evidence was found to support the engaging behaviors. The other objective measure, behaviors of purchasing an additional product, was compared by performing a Chi-Square Independence test since the data was gathered in the binary form. Surprisingly,

DOI:10.6814/NCCU202101442

the results revealed that no significant difference was found from the four experimental conditions (χ^2 (3) = 1.884, p = .597). There were 25.9%, 35.2%, 28.8%, and 36.4% participants adding an additional product to their orders in the RN, RI, PN, and PI condition, respectively (Figure 4-9). Although the analysis results did not attain a significant level, the proportion of participants likely to buy more products was higher in the intimate conditions.

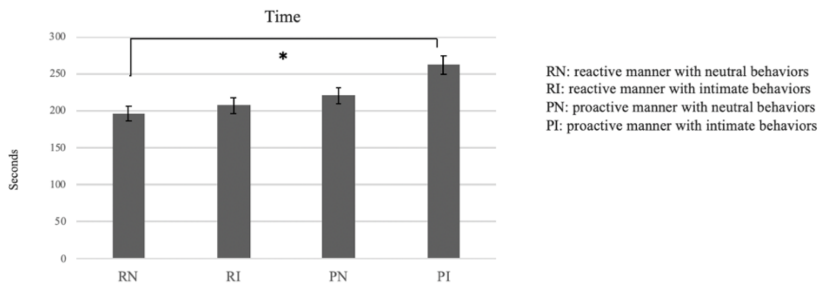


Figure 4-8 Average task completion time of each condition

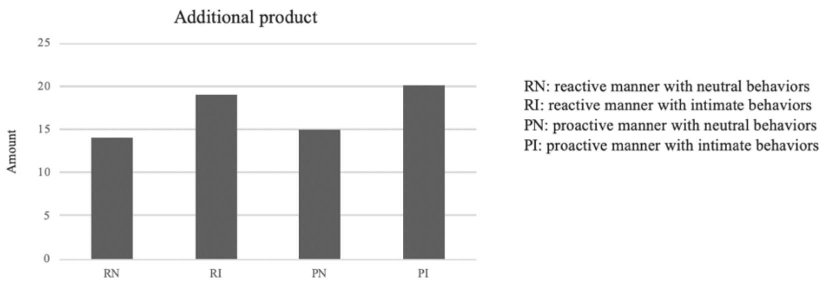


Figure 4-9 Amounts of participants purchasing an additional product

Measurement model

The data analysis was considered to examine the proposed theoretical model using the partial least squares structural equation modeling (PLS-SEM) supported on the software SmartPLS 3.0. PLS approaches provide assessments of both measurement models through reliability and validity and a structural model through analyzing constructs relationships. Reliability should be verified by Cronbach's α that the value of each construct should exceed .70. The convergent validity of the measurement was

DOI:10.6814/NCCU202101442

assessed following the criterions that every item loading should reach at least .50, the composite reliability (CR) value for a construct should exceed 070, and the average variance extracted (AVE) should be above .50 for adequate convergence (Fornell & Larcker, 1981). As shown in Table 4-4, each assessment indicator satisfied the threshold value, indicating appropriate internal consistency of all constructs. Besides, the square root values of AVE of each latent variable were greater than the correlation coefficients between itself and another one, which ascertained the acceptable discriminant validity of the measurement (Table 4-5).

Table 4-4 Construct reliability and convergent validity

Construct	Item	Item loading	AVE	C.R.	Cronbach's α
Proactivity	P_1	0.79	0.61	0.86	0.78
	P_2	0.70			
	P_3	0.72			
	P_4	0.89			
Perceived intimacy	PI_1	0.82	0.65	0.90	0.87
	PI_2	0.73			
	PI_3	0.85			
	PI_4	0.77			
	PI_5	0.86			
Cognitive Trust	CT_1	0.82	0.65	0.93	0.90
	CT_2	0.86			
	CT_3	0.83			
	CT_4	0.83			
	CT_5	0.85			
	CT_6	0.67			
	CT_7	0.74			
	CT_8	0.58			
	CT_9	0.67			
	CT_10	0.65			
Emotional Trust	ET_1	0.91	0.82	0.93	0.89
	ET_2	0.90			
	ET_3	0.91			

DOI:10.6814/NCCU202101442

Intention	INT_1	0.96	0.92	0.97	0.95
	INT_2	0.97			
	INT_3	0.94			

Table 4-5 Inter-construct correlations and discriminant validity

Construct	1	2	3	4	5
1. Proactivity	**0.78**				
2. Perceived Intimacy	0.55	**0.81**			
3. Cognitive Trust	0.51	0.60	**0.73**		
4. Emotional Trust	0.40	0.64	0.68	**0.91**	
5. Intention	0.19	0.27	0.50	0.54	**0.96**

Structural model

The structural model was then analyzed to investigate the significance and relationships hypothesized by bootstrapping with 5000 resamples. Considering the fitness of the proposed model, the index of SRMR was 0.078 which was within the tolerance level (Hu & Bentler, 1998). Figure 4-10 demonstrates the model evaluations with the path coefficients, significance level, and the determination coefficients. The hypotheses of positive relationships proposed for this study received statistical support, except for H3.

From the testing results, perceived proactivity may positively evoke the perception of intimacy to the robot as well, in support of H1 (β = .55, p < .001). As for the effects on trust, perceived proactivity positively influenced trust on the cognitive aspect (β = .26, p < .001) but did not do so on the emotional aspect (β = -.07, p > .05). Hence, H2 was supported while H3 was not supported. The significant effects emerged from perceived intimacy to emotional trust (β = .40, p < .001) and cognitive trust (β = .46, p < .001), in line with H4 and H5, respectively. The significant positive path of cognitive trust to emotional trust supported H6 (β = .47, p < .001). Cognitive trust would

DOI:10.6814/NCCU202101442

significantly predict the usage intention (*β* = .24, *p* < .01), as would emotional trust (*β* = .38, *p* < .001), providing supports for H7 and H8. The testing results of proposed hypotheses are summarized in Table 4-6.

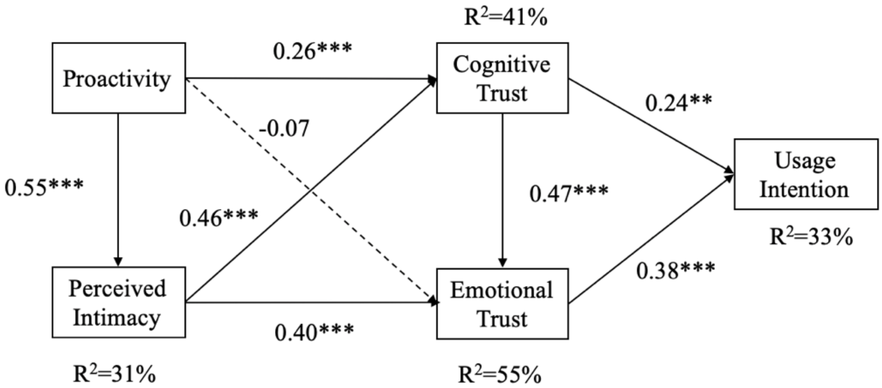


Figure 4-10 Path coefficients and p-values

Table 4-6 Hypotheses testing results

Hypothesis	Supported?
H1: Proactivity → perceived intimacy	Yes
H2: Proactivity → cognitive trust	Yes
H3: Proactivity → emotional trust	No
H4: Perceived Intimacy → emotional trust	Yes
H5: Perceived Intimacy → cognitive trust	Yes
H6: Cognitive trust → emotional trust	Yes
H7: Cognitive trust → usage intention	Yes
H8: Emotional trust → usage intention	Yes

Furthermore, a supplementary examination was conducted to explore for mediating effects on emotional trust. According to the testing procedure (Baron & Kenny, 1986), the direct relationship between proactivity and emotional trust was first estimated alone. The path was found to be significant (*β* = .40, *p* < .001); however, while subsequently taking a potential mediator, namely perceived intimacy, into

DOI:10.6814/NCCU202101442

account to predict emotional trust, the significant effect of proactivity on emotional trust no longer existed. Thus, perceived intimacy fully mediates the effect of proactivity on emotional trust.

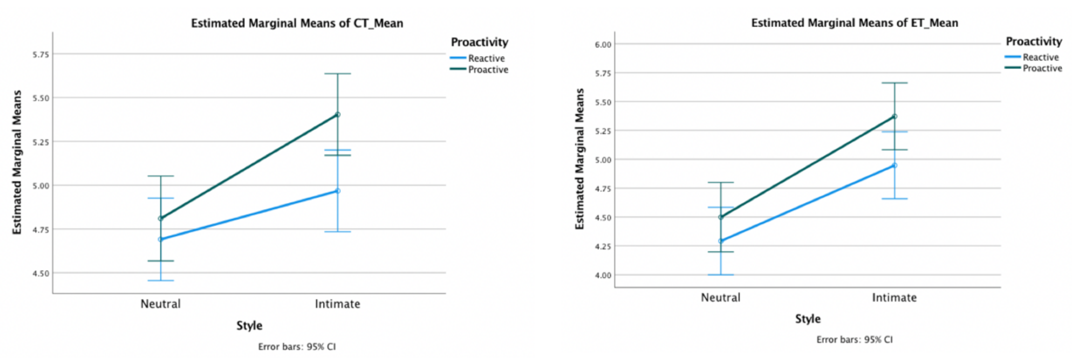
Additional analyses on experimental manipulations

Besides analyzing the overall relationships among proposed structural model from the experiment, manipulation checks were conducted for types of proactive and expressive behaviors to explore whether the perception variables (i.e., perceived proactivity and perceived intimacy) were elicited in the experimental conditions. A two-way analysis of variance (ANOVA) was applied to examine whether the participants had different perceptions for designed manipulations. The significant main effects on proactivity (F = 8.62, p < .01) and intimacy (F = 66.13, p < .001) were found. As expected, the robot designed with the proactive manner was evaluated with significantly higher proactivity scores than the reactive one (M_{reactive} = 4.94, $M_{\text{proactive}}$ = 5.36; F (1,211) = 8.621, p < .01). In terms of perceived intimacy, a significant difference between the neutral and the intimate condition (M_{neutral} = 3.69, M_{intimate} = 4.79; F (1,211) = 66.126, p < .001). In addition, there were also no interaction effects found between levels of service proactivity and types of expressive behavior on these two variables. The results of subjective measures confirmed that our manipulations of communication approaches for the robot were effective.

In addition, we then examined both two aspects of trust under designed communication approaches. There were main effects found of proactivity levels and expression styles, while no significant interaction effects neither on cognitive trust (p = .187) nor on emotional trust (p = .466) (Figure 4-11). However, the results from one-way ANOVA revealed that there were significantly different effects among four experimental conditions (i.e., RN, RI, PN, PI) with regards to both cognitive trust (F

DOI:10.6814/NCCU202101442

(3,211) = 6.809, $p < .001$) and emotional trust (F (3,211) = 10.312, $p < .001$). With further investigation through Bonferroni pairwise comparisons, the significant difference of cognitive trust was found between the PI condition ($M = 5.40$) and the RN condition ($M = 4.69$, $p < .001$), the PN condition ($M = 4.82$, $p < .01$). It can be inferred that when interacting with the robot expressing more intimate behaviors, the users would show more trust based on cognitive assessment to the robot. The such effect seems to be slightly obvious with the proactive manner design, yet there was no statistical support for interaction effects. As for the impact of emotional trust, there were significant higher scores between the PI condition ($M = 5.38$) and the RN condition ($M = 4.30$, $p < .001$), the PN condition ($M = 4.53$, $p < .001$); moreover, between the RI condition ($M = 4.94$) and the RN condition ($M = 4.30$, $p < .01$). The results confirm that the intimate manipulations for higher intimacy bring the effect mostly to the participants when they assess perceived trust emotionally.



(a) (b)

Figure 4-11 Effects of proactivity levels and expression styles on (a) cognitive and (b) emotional trust

Chapter 5 Discussion

5.1 Findings

The research objectives aim to explore how communication approaches involving

DOI:10.6814/NCCU202101442

proactive manner and expressive behaviors would affect the interaction experience when the robot providing assistance. Since there is lack of prescribed evaluation standards for design manipulations, a manipulation check session was conducted to address the issues. According to analysis results, the experimental manipulations of different communication approaches are validated to satisfy our expectations and the perception of intimacy can be elicited by expressing the more social-oriented behaviors, which is consistent with the referent guidelines (Potdevin et al., 2018). The formal experiment was subsequently executed to explore the effects on both cognitive and emotional trust.

From the objective results, the main task completion time and the behaviors of purchasing an additional relevant product were recorded for supplemental analysis. Contrary to the research of utilizing the robots for collaborating functional tasks which has an emphasis on efficiency and performance (Hoffman, 2019; Huang et al., 2015), time-consuming has no negative impacts in this study. The reason may be that manipulating proactivity and intimate behaviors that increase the length of conversation facilitate social interaction in this scenario; therefore, the positive influences on trust and usage intentions are far greater than negative ones possibly caused by taking a long time. Another inferred reason is that the required experimental time is within the acceptable level, so it will not cause a negative impact due to the time spent. Although it seems that the willingness of purchasing an additional product is more affected by the intimate robot, the behavioral results still not reach the statistically significant level. It may be because of directly recommending the specific additional product to the participants instead of providing multiple options, resulting in lacking the motivation for the participants to do so. However, it can be known from the subjective questionnaire that the willingness to use the service increase as the trusting relationships

DOI:10.6814/NCCU202101442

are built, which can therefore bring benefits to merchants.

Regarding to the subjective measures, the results support H1 which predicted an effect of the proactivity manipulation on the perception of intimacy. Although little prior research provides evidence of the correlation between these two variables, the significant effect was found in our design settings. It can be inferred that the participants may perceive the robot as more approachable and caring when it proactively provides information and even assists with alternative choices. For H2 and H3 predicting the effects of perceived proactivity, the results only confirm that cognitive trust in the robot is positively influenced with higher scores for perceived proactivity, which is consistent with the findings of (Kraus et al., 2020) in which the proactive strategy with a notification prior providing assistance has the most positive impact on assessing trust cognitively. While the different proactive behaviors are indicated to cause different effects on user emotional perceptions in previous works, such as trustworthiness, appropriateness, or likability (Peng et al., 2019), the direct prediction for emotional trust did not reach the significant level in the study. The possible reason is that our manipulation retains medium and low level of proactivity drawing on previous results (Peng et al., 2019), which may not be considered too intrusive into the participants' decision spaces and provide nearly the same feelings of comfort in our experimental scenarios. According to H4 and H5, the effects of perceived intimacy on both cognitive trust and emotional trust, which was verified by the model analysis. Similar to previous findings, the robot perceived to be in the interpersonal relationships would be seen as more competent (Häring et al., 2014). A potential feel of comfort is also evoked as long as the user perceives more connected to the robot through rapport building (Baddoura & Venture, 2015; Bellas et al., 2020). Meanwhile, cognitive trust holds a significant and positive effect on emotional trust in line with the prior evidence (Komiak &

DOI:10.6814/NCCU202101442

Benbasat, 2006). In other words, when the users believe the robot acting in their best interests and evaluate the robot as competent with cognitive assessment, they would therefore rely on the assisting robot with emotional feelings during the shopping process. As trust is an important component in human-robot interaction since it has a direct impact of the willingness to accept the information from a robot (Hancock et al., 2011), robot-related characteristics are mainly focused for antecedent factors. It is then proven in the formal study that both concepts of trust would subsequently encourage intention to use the robot, supporting H7 and H8. To our surprise, an additional result reveals that there is a mediating effect of perceived intimacy between proactivity and emotional trust. It supports the assumption that interpersonal emotional bonds may exist during the human-robot interaction.

Further investigation in terms of comparing the ratings in each condition demonstrates that the employment of expressive behaviors has more effects on both trusting constructs, even though different levels of proactivity can be distinguished. The possible interpretation is that the expressive behaviors containing verbal and nonverbal cues are explicitly presented as well as are more obviously perceived by the users.

5.2 Contributions

The robots have been employed with a variety of humanlike features to facilitate human-robot interaction in socially interactive contexts, becoming the role of partners (i.e., like a human being) rather than just functional machines. In this study, we combine proactivity and expressive behaviors simultaneously to provide a more comprehensive manipulations of communication approaches. When the robot behaves in a more proactive manner and is perceived more intimate, the users are more willing to trust in the robot, thereby increasing their intentions to use. The concept of interpersonal perception, namely perceived intimacy, is adopted to investigate social relationships between human and robots. As intimacy with a humanoid robot can be perceived by the

DOI:10.6814/NCCU202101442

interactants, there may be potential to build relationships emotionally in order to facilitate human-robot interaction. Based on the importance of the practicality and the user acceptance, relevant literature has mainly focused on measuring overall trust. However, this study examines cognitive and emotional dimensions of trust separately, which are found in research of e-commerce applications, since the robot in this study is designed similarly to the role of digital shopping assistants. The relationship of trust is successfully explored from different perspectives in HRI research field. Furthermore, an interesting result is found that perceived intimacy plays the role of a full mediator between proactivity and emotional trust, in other words, proactive behaviors will first raise perceived intimacy before further building emotional trust with the robot.

Besides the subjective results from the perception scale, the open-ended feedback with respect to the roles and functions of humanoid robots in public places or stores was gathered in the pre-test questionnaire. When people encounter a humanoid robot in public places, the most expectations for the robot are to be able to communicate and interact with humans in needed: "*Usually acting the role of receptionist*" and "*Responsible for services and functions related to guiding customer and providing information,*" for example. These responses confirm our experimental settings envisioned for the humanoid robot application and provide suggestions for robot design. It can be concluded that deploying an assisting robot with social-oriented behaviors in proactive manner would be effective for pleasant customer experience and beneficial for the service providers in such scenarios containing highly interactive process.

5.3 Limitations and future works

There are some limitations in our proposed experiment that could be considered in the future work. First, according to the feedback obtained from the initial manipulation checks phase, a participant stated that he preferred Robot C (proactive + neutral) more due to efficiency, although he evaluated the other one (proactive + intimate) in

DOI:10.6814/NCCU202101442

comparison as more intimate. Therefore, the potential moderating effects of personality traits which are not strictly included in our research can be considered as an influential factor.

Second, corresponding recorded videos are displayed on each experimental webpage as a medium for interaction in this research, while the virtual animated avatars are prevalent in online applications (Blascovich & Bailenson, 2011). However, these two methods are characterized by their own features. For example, videos can present the applications of robots in the real environment, while animated avatars can be dynamically altered with the enormous flexibility since they are digitally rendered. Therefore, future works could further compare the different effects on user perceptions or behaviors after interacting with the agent between these two types of presentations.

Third, although the direction of influence is modeled from cognitive trust to emotional trust in this study since the robot mainly provides online guidance services, a potential for reverse causation increases in the interpersonal relationships as the affective connections matures (McAllister, 1995), which in turn makes the emotional-driven element the dominant factor. Hence, there may be bidirectional relationships between cognition and affect in which is worthy to further investigate.

Last but not least, the research can be seen as the preliminary results of the feasibility of using a humanoid robot as a salesperson; however, the process is carefully controlled for conducting the experiment online. Since the robots possess advantages of physical presence to be more persuasive and valuable to user interaction (Kiesler et al., 2008; J. Li, 2015), future works should plan to carry out field experiments in real-word shopping settings. In addition to self-reported evaluation, more observation data can be collected through actual interaction for enriching the results and bringing a more comprehensive point of view on the users' experience and reactions to investigate the

DOI:10.6814/NCCU202101442

feasibility of providing services through humanoid robots.

Chapter 6 Conclusion

We propose the usage of a humanoid robot as a salesperson since there may be a trend of unmanned store. Hence, this study demonstrates whether building up intimate relationship could increase trust regarding the robot providing assistance in the shopping context. Two survey sessions were conducted online through presenting the robot responses in several videos corresponding to the designed system. In both studies, perceived intimacy can be successfully affected by different styles of expressive behaviors, indicating that there may be interpersonal relationships building with the humanoid robots. From the objective measures, the results are not so ideal for deeper and stronger interpretation since there are no significant effects in terms of comparing the task completion time and the behaviors of purchasing more products. However, subjective results reveal positive correlations between our proposed structural model, demonstrating that the users are more willing to trust in the robot both cognitively and emotionally when it behaves in a more proactive manner and is perceived more intimate. This study attempts to provide perspectives upon applicability of a service robot in commerce domain; to be more specific, utilizing a physical humanoid robot in a retailing store as a salesperson in charge of notifying customers of sales information and providing personal purchasing advice. It is expected to clarify the important role of communication patterns in human-humanoid robot interaction; however, further explorations are needed for verifying the generality of applications for providing supports in an interactive way.

DOI:10.6814/NCCU202101442

Reference

Abdi, J., Al-Hindawi, A., Ng, T., & Vizcaychipi, M. P. (2018). Scoping review on the use of socially assistive robot technology in elderly care. *BMJ Open*, *8*(2).

Alemi, M., Meghdari, A., & Ghazisaedy, M. (2014). Employing humanoid robots for teaching english language in iranian junior high-schools. *International Journal of Humanoid Robotics*.

Aroyo, A. M., Rea, F., Sandini, G., & Sciutti, A. (2018). Trust and social engineering in human robot interaction: Will a robot make you disclose sensitive information, conform to its recommendations or gamble? *IEEE Robotics and Automation Letters*, *3*(4), 3701–3708.

Baddoura, R., & Venture, G. (2015). This robot is sociable: Close-up on the gestures and measured motion of a human responding to a proactive robot. *International Journal of Social Robotics*.

Bainbridge, W. A., Hart, J., Kim, E. S., & Scassellati, B. (2008). The effect of presence on human-robot interaction. *Proceedings of the 17th IEEE International Symposium on Robot and Human Interactive Communication, RO-MAN*, 701–706.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*.

Bellas, A., Perrin, S., Malone, B., Rogers, K., Lucas, G., Phillips, E., Tossell, C., & Visser, E. De. (2020). Rapport building with social robots as a method for improving mission debriefing in human-robot teams. *2020 Systems and Information Engineering Design Symposium, SIEDS 2020*.

Ben Mimoun, M. S., & Poncin, I. (2015). A valued agent: How ECAs affect website

DOI:10.6814/NCCU202101442

customers' satisfaction and behaviors. *Journal of Retailing and Consumer Services*.

Blascovich, J., & Bailenson, J. (2011). Infinite reality: Avatars, eternal Life, new worlds, and the dawn of the virtual revolution. *Presence: Teleoperators and Virtual Environments*.

Bringle, R. G., & Prager, K. J. (1996). The psychology of intimacy. *Journal of Marriage and the Family*.

Broadbent, E., Kumar, V., Li, X., Sollers, J., Stafford, R. Q., MacDonald, B. A., & Wegner, D. M. (2013). Robots with display screens: A Robot with a more humanlike face display is perceived to have more mind and a better personality. *PLoS ONE*.

Brock, J. K. U., & Zhou, J. Y. (2012). Customer intimacy. *Journal of Business and Industrial Marketing*.

Brogårdh, T. (2007). Present and future robot control development-An industrial perspective. *Annual Reviews in Control*.

Burgoon, J. K., & Hale, J. L. (1987). Validation and measurement of the fundamental themes of relational communication. *Communication Monographs*, *54*(1), 19–41.

Camarillo, D. B., Krummel, T. M., & Salisbury, J. K. (2004). Robotic technology in surgery: Past, present, and future. *American Journal of Surgery*.

Campbell, K. S., Davis, L., & Skinner, L. (2006). Rapport management during the exploration phase of the salesperson-customer relationship. *Journal of Personal Selling and Sales Management*.

Chai, J. C. Y., Malhotra, N. K., & Alpert, F. (2015). A two-dimensional model of trust-value-loyalty in service relationships. *Journal of Retailing and Consumer Services*.

Chattaraman, V., Kwon, W. S., Gilbert, J. E., & Ross, K. (2019). Should AI-Based,

DOI:10.6814/NCCU202101442

conversational digital assistants employ social- or task-oriented interaction style? A task-competency and reciprocity perspective for older adults. *Computers in Human Behavior*.

Chen, S., & Dhillon, G. (2003). Interpreting dimensions of consumer trust in e-commerce. *Information Technology and Management*.

Chidambaram, V., Chiang, Y. H., & Mutlu, B. (2012). Designing persuasive robots: How robots might persuade people using vocal and nonverbal cues. *HRI'12 - Proceedings of the 7th Annual ACM/IEEE International Conference on Human-Robot Interaction*, 293–300.

Chiu, C. M., Hsu, M. H., Lai, H., & Chang, C. M. (2012). Re-examining the influence of trust on online repeat purchase intention: The moderating role of habit and its antecedents. *Decision Support Systems*.

Chiu, C. M., Wang, E. T. G., Fang, Y. H., & Huang, H. Y. (2014). Understanding customers' repeat purchase intentions in B2C e-commerce: The roles of utilitarian value, hedonic value and perceived risk. *Information Systems Journal*.

Cremonesi, P., Garzotto, F., & Turrin, R. (2012). Investigating the persuasion potential of recommender systems from a quality perspective: An empirical study. In *ACM Transactions on Interactive Intelligent Systems*.

Crosby, L. A., Evans, K. R., & Cowles, D. (1990). Relationship quality in services selling: An interpersonal influence perspective. *Journal of Marketing*.

De Graaf, M. M. A., & Ben Allouch, S. (2013). Exploring influencing variables for the acceptance of social robots. *Robotics and Autonomous Systems*.

Duffy, B. R. (2003). Anthropomorphism and the social robot. *Robotics and Autonomous Systems*, *42*(3–4), 177–190.

Fogg, B. J. (1998). Persuasive computers: Perspectives and research directions.

DOI:10.6814/NCCU202101442

Conference on Human Factors in Computing Systems - Proceedings.

Fornell, C., & Larcker, D. F. (1981). Structural Equation Models with Unobservable Variables and Measurement Error: Algebra and Statistics. *Journal of Marketing Research*.

Gaudiello, I., Zibetti, E., Lefort, S., Chetouani, M., & Ivaldi, S. (2016). Trust as indicator of robot functional and social acceptance. An experimental study on user conformation to iCub answers. *Computers in Human Behavior*.

Gefen, & Straub. (2003). Managing User Trust in B2C e-Services. *E-Service Journal*, *2*(2).

Gross, H. M., Boehme, H., Schroeter, C., Mueller, S., Koenig, A., Einhorn, E., Martin, C., Merten, M., & Bley, A. (2009). TOOMAS: Interactive shopping guide robots in everyday use - Final implementation and experiences from long-term field trials. *2009 IEEE/RSJ International Conference on Intelligent Robots and Systems, IROS 2009*.

Hancock, P. A., Billings, D. R., Schaefer, K. E., Chen, J. Y. C., De Visser, E. J., & Parasuraman, R. (2011). A meta-analysis of factors affecting trust in human-robot interaction. *Human Factors*.

Häring, M., Kuchenbrandt, D., & André, E. (2014). Would you like to play with me? How robots' group membership and task features influence human-robot interaction. *ACM/IEEE International Conference on Human-Robot Interaction*.

Heenan, B., Greenberg, S., Manesh, S. A., & Sharlin, E. (2014). Designing social greetings in human robot interaction. *Proceedings of the Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques, DIS*.

Hoffman, G. (2019). Evaluating Fluency in Human-Robot Collaboration. *IEEE Transactions on Human-Machine Systems*.

DOI:10.6814/NCCU202101442

Horstmann, A. C., Bock, N., Linhuber, E., Szczuka, J. M., Straßmann, C., & Krämer, N. C. (2018). Do a robot's social skills and its objection discourage interactants from switching the robot off? *PLoS ONE*.

Hu, L. T., & Bentler, P. M. (1998). Fit indices in covariance structure modeling: sensitivity to underparameterized model misspecification. *Psychological Methods*.

Huang, C.-M., Cakmak, M., & Mutlu, B. (2015). Adaptive coordination strategies for human-robot handovers. *Robotics: Science and Systems*.

Huang, C.-M., & Mutlu, B. (2013). Modeling and evaluating narrative gestures for humanlike robots. *Robotics: Science and Systems*, 57–64.

Iwamura, Y., Shiomi, M., Kanda, T., Ishiguro, H., & Hagita, N. (2011). Do elderly people prefer a conversational humanoid as a shopping assistant partner in supermarkets? *HRI 2011 - Proceedings of the 6th ACM/IEEE International Conference on Human-Robot Interaction*, 449–457.

Kaipainen, K., Ahtinen, A., & Hiltunen, A. (2018). "Nice surprise, more present than a machine" Experiences evoked by a social robot for guidance and edutainment at a city service point. *ACM International Conference Proceeding Series*, 163–171.

Kanda, T., Sato, R., Saiwaki, N., & Ishiguro, H. (2007). A two-month field trial in an elementary school for long-term human-robot interaction. *IEEE Transactions on Robotics*.

Kanda, T., Shiomi, M., Miyashita, Z., Ishiguro, H., & Hagita, N. (2010). A communication robot in a shopping mall. *IEEE Transactions on Robotics*.

Kapustina, L. M., Agababaev, M. S., & Drevalev, A. A. (2019). *Advertising concepts evolution and benefits of promotion robots in the digital economy*. *240*(Sicni 2018), 485–490.

Keillor, B. D., Parker, R. S., & Pettijohn, C. E. (2000). Relationship-oriented

DOI:10.6814/NCCU202101442

characteristics and individual salesperson performance. *Journal of Business and Industrial Marketing*.

Kiesler, S., Powers, A., Fussell, S. R., & Torrey, C. (2008). Anthropomorphic interactions with a robot and robot-like agent. *Social Cognition*.

Kim, H., Kwak, S. S., & Kim, M. (2008). Personality design of sociable robots by control of gesture design factors. *Proceedings of the 17th IEEE International Symposium on Robot and Human Interactive Communication, RO-MAN*.

Komiak, S. X., & Benbasat, I. (2004). Understanding customer trust in agent-mediated electronic commerce, web-mediated electronic commerce, and traditional commerce. *Information Technology and Management*.

Komiak, S. X., & Benbasat, I. (2006). The effects of personalization and familiarity on trust and adoption of recommendation agents. *MIS Quarterly: Management Information Systems*.

Kraus, M., Wagner, N., & Minker, W. (2020). Effects of proactive dialogue strategies on human-computer trust. *UMAP 2020 - Proceedings of the 28th ACM Conference on User Modeling, Adaptation and Personalization*.

Li, J. (2015). The benefit of being physically present: A survey of experimental works comparing copresent robots, telepresent robots and virtual agents. *International Journal of Human Computer Studies*, *77*, 23–37.

Li, M., & Mao, J. (2015). Hedonic or utilitarian? Exploring the impact of communication style alignment on user's perception of virtual health advisory services. *International Journal of Information Management*, *35*(2), 229–243.

Martelaro, N., Nneji, V. C., Ju, W., & Hinds, P. (2016). Tell me more: Designing HRI to encourage more trust, disclosure, and companionship. *ACM/IEEE International Conference on Human-Robot Interaction*, *2016-April*.

DOI:10.6814/NCCU202101442

Matsuyama, Y., Bhardwaj, A., Zhao, R., Romeo, O., Akoju, S., & Cassell, J. (2016). Socially-aware animated intelligent personal assistant agent. *Proceedings of the 17th Annual Meeting of the Special Interest Group on Discourse and Dialogue*, 224–227.

McAllister, D. J. (1995). Affect- and cognition-based trust as foundations for interpersonal cooperation in organizations. *Academy of Management Journal*.

Morgan, R. M., & Hunt, S. D. (1994). The commitment-trust theory of relationship marketing. *Journal of Marketing*.

Mutlu, B., Forlizzi, J., & Hodgins, J. (2006). A storytelling robot: Modeling and evaluation of human-like gaze behavior. *Proceedings of the 2006 6th IEEE-RAS International Conference on Humanoid Robots, HUMANOIDS*, 518–523.

Mutlu, B., Shiwa, T., Kanda, T., Ishiguro, H., & Hagita, N. (2009). Footing in human-robot conversations : How robots might shape participant roles using gaze cues. *Proceedings of the 4th ACM/IEEE International Conference on Human Robot Interaction*.

Nass, C., & Moon, Y. (2000). Machines and mindlessness: Social responses to computers. *Journal of Social Issues*, *56*(1).

Natarajan, M., & Gombolay, M. (2020). Effects of anthropomorphism and accountability on trust in human robot interaction. In *ACM/IEEE International Conference on Human-Robot Interaction* (pp. 33–42).

Nicholson, C. Y., Compeau, L. D., & Sethi, R. (2001). The role of interpersonal liking in building trust in long-term channel relationships. *Journal of the Academy of Marketing Science*.

Nothdurft, F., Ultes, S., & Minker, W. (2015). Finding appropriate interaction strategies for proactive dialogue systems — An open quest. *Proceedings of the 2nd*

DOI:10.6814/NCCU202101442

European and the 5th Nordic Symposium on Multimodal Communication, August 6-8, 2014, Tartu, Estonia.

Pan, Y., Okada, H., Uchiyama, T., & Suzuki, K. (2015). On the reaction to robot's speech in a hotel public space. *International Journal of Social Robotics*.

Parker, E. B., Short, J., Williams, E., & Christie, B. (1978). The Social Psychology of Telecommunications. *Contemporary Sociology*.

Peng, Z., Kwon, Y., Lu, J., Wu, Z., & Ma, X. (2019). Design and evaluation of service robot's proactivity in decision-making support process. *Conference on Human Factors in Computing Systems - Proceedings*, 1–13.

Potdevin, D., Clavel, C., & Sabouret, N. (2018). Virtual intimacy, this little something between us: A study about human perception of intimate behaviors in embodied conversational agents. *Proceedings of the 18th International Conference on Intelligent Virtual Agents, IVA 2018*.

Potdevin, D., Clavel, C., & Sabouret, N. (2021). Virtual intimacy in human-embodied conversational agent interactions: The influence of multimodality on its perception. *Journal on Multimodal User Interfaces*.

Rau, P. L. P., Li, Y., & Liu, J. (2013). Effects of a social robot's autonomy and group orientation on human decision-making. *Advances in Human-Computer Interaction*.

Salem, M., Eyssel, F., Rohlfing, K., Kopp, S., & Joublin, F. (2013). To err is human(-like): Effects of robot gesture on perceived anthropomorphism and likability. *International Journal of Social Robotics*, *5*(3), 313–323.

Saunderson, S., & Nejat, G. (2019). It would make me happy if you used my guess: Comparing robot persuasive strategies in social human-robot interaction. *IEEE Robotics and Automation Letters*.

DOI:10.6814/NCCU202101442

Schulz, R., Kratzer, P., & Toussaint, M. (2018). Preferred interaction styles for human-robot collaboration vary over tasks with different action types. *Frontiers in Neurorobotics*.

Shiomi, M., Kanda, T., Glas, D. F., Satake, S., Ishiguro, H., & Hagita, N. (2009). Field trial of networked social robots in a shopping mall. *2009 IEEE/RSJ International Conference on Intelligent Robots and Systems, IROS 2009*, 2846–2853.

Shiomi, M., Shinozawa, K., Nakagawa, Y., Miyashita, T., Sakamoto, T., Terakubo, T., Ishiguro, H., & Hagita, N. (2013). Recommendation effects of a social robot for advertisement-use context in a shopping mall. *International Journal of Social Robotics*.

Sichtmann, C. (2007). An analysis of antecedents and consequences of trust in a corporate brand. *European Journal of Marketing*.

Swan, J. E., Bowers, M. R., & Richardson, L. D. (1999). Customer trust in the salesperson: An integrative review and meta-analysis of the empirical literature. *Journal of Business Research*.

van Doorn, J., Mende, M., Noble, S. M., Hulland, J., Ostrom, A. L., Grewal, D., & Petersen, J. A. (2017). Domo arigato mr. roboto: Emergence of automated social presence in organizational frontlines and customers' service experiences. *Journal of Service Research*.

Venkatesh; Viaswanath, & Davis; Fred D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*.

Wang, W., & Benbasat, I. (2007). Recommendation agents for electronic commerce: Effects of explanation facilities on trusting beliefs. *Journal of Management Information Systems*.

DOI:10.6814/NCCU202101442

Wang, W., & Benbasat, I. (2008). Attributions of trust in decision support technologies: A study of recommendation agents for e-commerce. *Journal of Management Information Systems*.

Wang, W., Qiu, L., Kim, D., & Benbasat, I. (2016). Effects of rational and social appeals of online recommendation agents on cognition- and affect-based trust. *Decision Support Systems*.

Watanabe, M., Ogawa, K., & Ishiguro, H. (2015). Can androids be salespeople in the real world? *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*, 781–788.

Winkle, K., Caleb-Solly, P., Turton, A., & Bremner, P. (2018). Social robots for engagement in rehabilitative therapies: Design implications from a study with therapists. *ACM/IEEE International Conference on Human-Robot Interaction*.

Winkle, K., Lemaignan, S., Caleb-Solly, P., Leonards, U., Turton, A., & Bremner, P. (2019). Effective persuasion strategies for socially assistive robots. *ACM/IEEE International Conference on Human-Robot Interaction*.

Yim, C. K., Tse, D. K., & Chan, K. W. (2008). Strengthening customer loyalty through intimacy and passion: Roles of customer-firm affection and customer-staff relationships in services. *Journal of Marketing Research*.

Yoo, W. S., Lee, Y., & Park, J. K. (2010). The role of interactivity in e-tailing: Creating value and increasing satisfaction. *Journal of Retailing and Consumer Services*.

You, S., & Robert, L. P. (2018). Human-robot similarity and willingness to work with a robotic co-worker. *ACM/IEEE International Conference on Human-Robot Interaction*.

Zafari, S., Schwaninger, I., Hirschmanner, M., Schmidbauer, C., Weiss, A., & Koeszegi, S. T. (2019). "You are Doing so great!" - The effect of a robot's interaction style

DOI:10.6814/NCCU202101442

on self-efficacy in HRI. *2019 28th IEEE International Conference on Robot and Human Interactive Communication, RO-MAN 2019*.

Zboja, J. J., & Voorhees, C. M. (2006). The impact of brand trust and satisfaction on retailer repurchase intentions. *Journal of Services Marketing*.

DOI:10.6814/NCCU202101442

Appendix A

Construct	Item	Cronbach's α
Proactivity		0.86
P_1	Which robot was more proactive in introducing products to customers?	
P_2	Which robot was more proactive in solving the problems encountered by customers?	
P_3	Which robot was more proactive in letting customers understand the function of the robot?	
P_4	Overall, which robot was more proactive in providing services to customers?	
Communication style		
Task-oriented		0.71
ST_1	Which interaction of the robot with customers was mainly task-related?	
ST_2	Which robot was more focused on helping customers complete the shopping task?	
ST_3 [a]	Which robot was more helpful for the shopping task?	
Social-oriented		0.96
SS_1	Which robot would like to establish a relationship with customers?	
SS_2	Which robot was more intensely involved in interaction with customers?	
SS_3	Which robot gave its opinions to customers?	
Perceived Intimacy		0.91
PI_1	Which robot would share its emotions with customers?	
PI_2	Which robot was kind and friendly to customers?	
PI_3	Which robot attempted to get closer to the customer?	
PI_4	Which robot understood the customer's ideas and knew what the customer wants?	
PI_5	Which robot cares about customers?	
Other	How did you make the judgment and choice? (For example: based on robot actions, sentences, timing of action, etc.) or other ideas.	

[a] Item deleted after reliability analysis

DOI:10.6814/NCCU202101442

Appendix B

Construct	Item	Cronbach's α
Proactivity		0.78
P_1	The robot proactively recommended products to me.	
P_2	The robot proactively helped me solve the problems I encountered.	
P_3	The robot proactively let me understand how to operate the function of the website.	
P_4	Overall, the robot proactively provided services to me.	
Perceived Intimacy		0.87
PI_1	The robot shared its emotions with me.	
PI_2	The robot was kind and friendly to me.	
PI_3	The robot attempted to get closer to me.	
PI_4	The robot understood my ideas and knew what I wanted.	
PI_5	The robot behaved caring about me.	
Cognitive Trust		0.91
CT_1	The robot was competent and effective in interacting with me.	
CT_2	The robot performed its role of providing assistances well.	
CT_3	Overall, the robot was capable and proficient.	
CT_4	In general, the robot was informative.	
CT_5	If I required help, the robot would do its best to help me.	
CT_6	I believe that the robot would act in my best interest.	
CT_7	The robot wanted to understand my needs and preferences.	
CT_8	I would characterize the robot as being honest.	
CT_9	The robot provided unbiased product recommendations.	
CT_10	I consider the robot to be of integrity.	
Emotional Trust		0.89
ET_1	I feel secure about relying on the robot during the shopping process.	
ET_2	I feel comfortable about relying on the robot during the shopping process.	
ET_3	I feel content about relying on the robot during the shopping process.	

DOI:10.6814/NCCU202101442

Behavioral Intention		0.95
Int_1	Assuming I have access to the robot again, I intend to use it.	
Int_2	Assuming I have access to the robot again, I predict that I would use it.	
Int_3	I am very interested in using such robots again in the future.	

DOI:10.6814/NCCU202101442

Appendix C

		Reactive + Neutral (RN)	Reactive + Intimate (RI)	Proactive + Neutral (PN)	Proactive + Intimate (RN)
Greeting		Welcome!	Welcome! I am Pepper, your customer service robot.	Welcome! If any problem encountered during the shopping process, please ask for it at any time.	Welcome! I am Pepper, your customer service robot. If you encounter any problem during the shopping process, please feel free to ask me.
Preference	Selection	-	-	What kind of shoes are you looking for today? Please select the type of sports.	What are you looking for today? Do you like jogging, hiking or do you play basketball?
	Result			Here are the flagship [sport] shoes. Which one do you like?	[e.g. I feel the same that it helps me relax when taking a walk in nature.] I recommend these flagship [sport] shoes. Which one would you like?
Product List	All product	(After greeting page) Here is a list of all	(After greeting page) Let me show you all the	Here is a list of all products. Please select the	Let me show you all the products in the store. To

DOI:10.6814/NCCU202101442

		products.	products in the store.	type of sports for product sorting.	view the products more quickly, you can select the type of sports above to filter them.
	Hot sales	Here are the best-selling products in this month.	Let me show you some best-selling products in this month.	Here are the best-selling products in this month. Or select the type of sports above for product sorting.	Let me show you some best-selling products in this month. You may like these. Or you can also select the type of sports above to filter them.
	Category	Here are shoes suitable for [sport].	I think [e.g. hiking is a refreshing leisure activity]. I found these shoes. Which one would you like?	Here are shoes suitable for [sport]. Which one do you like? Please click on the product to see more details.	I found these shoes suitable for [sport]. Which one would you like? Just click on the product you are interested in, and I can show you more details.
Product	Initiation	This is [product name].	This is [product name] of your choice.	This is [product name]. Please click "More information" for detailed introduction. If you want to purchase these shoes, please click the "Get	This is [product name] of your choice. You can click "More information" to let me introduce this pair of shoes to you. If you like this pair of shoes, just click the

DOI:10.6814/NCCU202101442

				product location" button.	"Get product location" button.
	Introduction	[Product introduction] These shoes are suitable for withstanding long distances of outdoor walking. (example)	[Product introduction] If you are planning a long trip, I think these shoes are definitely a good option. (example)	[Product introduction] These shoes are suitable for withstanding long distances of outdoor walking. (example)	[Product introduction] If you are planning a long trip, I think these shoes are definitely a good option. (example)
	Inquire	This product is located on the left-hand side of the first row.	You can find this product on the left-hand side of the first row.	This product is located on the left-hand side of the first row.	You can find this product on the left-hand side of the first row.
Lack of size		Only these sizes are in stock currently. Do you want to take a look at other pairs of shoes in the store?	You have a good taste in choosing shoes! But I'm sorry that only these sizes are in stock currently. Would you like to take a look at other pairs of shoes in the store?	Only these sizes are in stock currently. Do you want to take a look at other [sport] shoes in the store?	You have a good taste in choosing shoes! But I'm sorry that only these sizes are in stock currently. Would you like to take a look at other [sport] shoes in the store?
Recommendation		Here are other flagship products for [sport].	You can also consider these flagship products for [sport]. I think they will be your good choice.	These flagship products emphasize [e.g. the comfort when hiking].	Here are flagship products emphasizing [e.g. the comfort when hiking]. I think they will be your good choice.

DOI:10.6814/NCCU202101442

Additional purchase	Do you want to purchase another product of [sport]?	Would you like to purchase another product of [sport]?	Do you want to purchase another product of [sport]? This sunscreen hat with big brim is recommended. (according to what sport category the selected product belongs to)	Would you like to purchase another product of [sport]? I recommend this sunscreen hat because you won't have to be afraid of strong sunlight when hiking with it. (according to what sport category the selected product belongs to)
Checkout	Please place the product on the table and choose the payment method.	Please put your selected product on the table and choose the payment method.	Please place the product on the table and choose the payment method.	Please put your selected product on the table and choose the payment method.
Goodbye	Payment completed. Thank you for coming!	You've completed your purchasing. Thanks for coming. I'm glad to be at your service. Have a nice day!	Payment completed. Thank you for coming!	You've completed your purchasing. Thanks for coming. I'm glad to be at your service. Have a nice day!

DOI:10.6814/NCCU202101442