Personality in the Human Robot Interaction Literature: A Review and Brief Critique

Completed Research

Lionel P. Robert Jr.
University of Michigan
lprobert@umich.edu

Abstract

Personality have been identified as an important facilitator of human robot interaction. Despite this, the research on personality in the human robot interaction literature remains fragmented and lacks a coherent framework. This makes it difficult for scholars to comprehend what is known and what is not. This paper reviews the literature on personality and robots. This review: (1) highlights three major research areas, (2) identifies gaps to be addressed and (3) presents major conclusions from the literature.

Keywords

Robot, Human–Robot Interaction, Personality, EPA Robots, HRI.

Introduction

Robots — physical and virtual technologies that engage in embodied actions — are now being used in organizations to both replace and complement humans (You and Robert, 2018a). This requires robots to interact with an organization's employees and customers. To better facilitate these interactions many researchers have sought to identify factors that promote the interactions between humans and robots. Interactions between humans and robots can be defined in terms of the outcomes associated with those interactions (You and Robert 2017). Such outcomes include acceptance, trust or emotional attachment to the robot. Personality is a vital factor in understanding these interactions (Gockley and Matarić 2006; Goetz and Kiesler 2002; Syrdal et al. 2007). Personality comprises someone's behaviors, cognitions and emotions derived from both biological and social factors (Hall and Lindzey 1957).

The research on personality and human robot interaction (HRI) remains fragmented and lacks a coherent framework. This makes it difficult to understand what we know and identify what we do not. To address this shortcoming, this paper reviews the literature on personality and embodied physical action (EPA) robots. This paper focused on EPA robots because their physical embodiment invokes strong emotional reactions that lead individuals to project personalities and treat them as humans (You and Robert, 2018b). Therefore, personality is likely to be central to interactions with EPA robots.

In this paper we investigate the current state of the empirical research on personality in HRI research, discuss the unique role of personality in HRI and offer guidance for future research. This review offers several contributions. First, it highlights three research thrust areas in the literature. Two, it derives and presents major insights from the literature. Finally, it identifies gaps that need to be addressed.

Related Works

Theories of personality assert that traits can predict human emotions and behaviors (Peeters et al. 2006). Personality traits are used as a label to describe a specific set of traits believed to be the best predictors of an individual's behavior (Tasa et al. 2011). Personality is now considered a core construct in understanding human behavior (Goyal et al. 2008; Li et al. 2014; Srinivasan et al. 2010).

The big five personality traits are the most widely used (Li et al. 2014). OCEAN, representing openness to experience, conscientiousness, extraversion/introversion, agreeableness and neuroticism, is used to represent the personality traits. Openness to experience represents the degree to which someone is imaginative, curious and broadminded (McCrae and Costa 1997). Conscientiousness reflects the extent that individuals are careful, deliberative and self-aware of their actions (Tasa et al. 2011). Extraversion is the extent to which an individual is assertive, outgoing, talkative and sociable. Introversion is the degree to which someone enjoys being alone and is the opposite of extraversion (Driskell et al. 2006). Agreeableness reflects the extent to which someone is cooperative and friendly (Peeters et al. 2006). Neuroticism can be viewed as the degree to which someone is easily angered, not well-adjusted, insecure and lacks self-confidence (Driskell et al. 2006). Neuroticism is the opposite of emotional stability, which describes someone who is calm and well-adjusted (Peeters et al. 2006).

Literature Review

In this review we employed several search engines: Google Scholar, ACM Digital Library, IEEE Xplore, EBSCO Business and Psyc Database. The search keywords were "human robot interaction" and "robot" in relation to personality. The search was conducted in December 2017. Therefore, the review includes articles up to 2016. We identified 129 articles. We evaluated their abstracts against the following criteria.

Inclusion Criteria. Studies were included if they (1) were empirical studies using EPA robots, (2) measured human and/or robot personality and (3) were published in English-language outlets.

Exclusion Criteria. Studies were excluded if they (1) focused on embodied virtual action (EVA) (i.e. virtual agents), (2) focused on telepresence robots, (3) did not include a study with humans or (4) focused only on negative attitudes toward robots (NARS). NARS is used as a control variable in many studies.

Only 53 articles (43%) met all of the criteria in the evaluation. Most of the articles excluded were technical papers (54%). These papers focused on technical approaches to manipulating robot personality without a corresponding empirical study. Another set of papers that also overlapped with this category included papers examining EVA robots (45%). The remaining excluded articles focused on NARS.

Publication Venues

The publication venues of the 53 included articles were as follows: 64.1% were published in conferences while 35.8% were published in journals and 1.8% in a book chapter. The IEEE International Symposium on Robot and Human Interactive Communication (ROMAN) accounted for the most included articles, with 20.7% of all the articles and a little over 32.3% of the conference publications. This was followed by the HRI conference, which accounted for 15.1% of all the articles and 23.5% of the conference publications. Publication dates ranged from 2005 to 2016.

Personality Measures

Table 1 presents a summary matrix table of the literature. The big five personality traits were by far the most widely used measures. Nearly 90% of the articles employed some measure of one or more of the five personality traits. Measures of extraversion/introversion were the most popular.

Outcome Measures

Dependent measures of human robot interactions varied but measures of acceptance were the most popular (39.5%). This included acceptance via survey, preference, use or duration of interaction time with the robot. Trust or related constructs were next (32.%) followed by affect (feelings or emotions), towards the robot (22.6%). Several other outcomes were equally represented, such as distance one is comfortable interacting with robots (9.4%), perceptions of the robots personality (9.4%). Most studies had more than one outcome.

Research Thrust Areas

Research on the influence of personality on human robot interaction has been examined across a wide variety of topics. However, this literature can be categorized as addressing one of four research thrusts. Thrust area 1: Human Personality and Human Robot Interactions. Thrust area 2: Robot Personality and Human–Robot Interaction. Thrust area 3: Human–Robot Personality Similarity and/or Complementarity. Thrust area 4: Facilitating Robot Personality. This paper focuses on the first three thrust areas. Figure 1 presents a summary of the research in the form of an integrative model, the Human–Robot Integrative Personality(H-RIP)Model.

Personality Predictor	Moderator(s)	Outcome
Thrust Area 1		
Human Personality *Big 5:* Cruz-Maya & Tapus 2016a, Cruz-Maya & Tapus 2016b, Damholdt et al. 2015, Gockley & Matari´c 2006, Haring et al. 2013, 2014, 2015, Looije et al. 2010, Kimoto et al. 2016, Park et al. 2012, Salem, et al. 2015, Sandoval et al. 2016, Sehili et al. 2014, Syrdal et al. 2006, Syrdal et al. 2007, Takayama & Pantofaru 2009, Walters et al. 2008 *Other Measures:* Chidambaram et al. 2012, De Ruyter et al. 2005, Nomura et al. 2007, 2008, Walters et al. 2005.		**Acceptance:** Cruz-Maya & Tapus 2016a, De Ruyter et al. 2005, Haring et al. 2015, Kimoto et al. 2016, Looije et al. 2010, Nomura et al. 2008, Park et al. 2012, Salem, et al. 2015, Sehili et al. 2014, Walters et al. 2008. **Affective:** Damholdt et al. 2015, Salem, e al., 2015. **Distance:** Nomura et al. 2007, Syrdal et al. 2006, Syrdal et al. 2007, Takayama & Pantofaru 2009, Walters et al. 2005. **Learning:** Cruz-Maya & Tapus 2016b **Trust:** Chidambaram et al. 2012, Cruz-Maya & Tapus 2016a, Gockley & Mataric 2006, Haring et al. 2013, 2014, Looije et al. 2010, Salem et al. 2015, Sandoval et al. 2016. **Humanlike:** Park et al. 2012, Salem et al. 2015. **Human Performance:** Cruz-Maya & Tapus 2016a.
Thrust Area 2		
Robot Personality *Big 5:* Goetz and Kiesler 2002, Gu et al. 2015, Hwang et al. 2013, Leuwerink 2012, Meerbeek et al. 2006, 2008, Ogawa et al. 2009, Park et al. 2012, Tay et al. 2014. *Myers-Briggs Personality:* Kim et al. 2008. *Other Measures:* Kaniarasu & Steinfeld 2014, Moshkina & Arkin 2005, Powers & Kiesler 2006.	**Interaction Type** Leuwerink 2012 **Role & Gender** Tay et al. 2014	**Acceptance:** Meerbeek et al. 2006, 2008, Moshkina & Arkin 2005, Tay et al. 2014. **Affective:** Gu et al. 2015, Hwang et al. 2013, Moshkina & Arkin 2005, Kim et al. 2008, Tay et al. 2014, Yamashita et al. 2016 **Trust:** Leuwerink 2012, Meerbeek et al. 2008, Tay et al. 2014, Kaniarasu & Steinfeld 2014, Kim et al. 2008, Ogawa et al. 2009, Powers & Kiesler 2006. **Robot Personality:** Broadbent et al. 2013, Cauchard et al. 2016, Hwang et al. 2013, Ogawa et al. 2009, Yamashita et al. 2016.
Thrust Area 3		
Human Robot Personality-Similarity Aly & Tapus 2013, 2016, Andrist et al. 2015, Celiktutan & Gunes 2015, Dang & Tapus 2015, de Graaf & Ben Allouch 2014, Joosse et al. 2013, Mileounis et al. 2015, Niculescu et al. 2013, So et al. 2008, Tapus, et al. 2008, Woods et al. 2005, 2007. **Human Robot Personality- Complementarity** Celiktutan & Gunes 2015, Lee et al. 2006.	**Demographics** Woods et al. 2005 **Human Personality** Joosse et al. 2013 Tapus et al. 2008 Woods et al. 2005 **Task Type** Joosse et al. 2013	**Acceptance:** Aly & Tapus 2013, 2016, Dang & Tapus 2015, Joosse et al. 2013, Niculescu et al. 2013, So et al. 2008, Tapus et al. 2008. **Affective**: Celiktutan & Gunes 2015, Lee et al. 2006, Mileounis et al. 2015, Niculescu et al. 2013. **Feeling of Similarity:** de Graaf & Ben Allouch 2014, Woods et al. 2005, 2007. **Performance:** Andrist et al. 2015, Dang & Tapus 2015 **Trust:** Andrist et al. 2015, Niculescu et al. 2013

Table 1. Summary Matrix

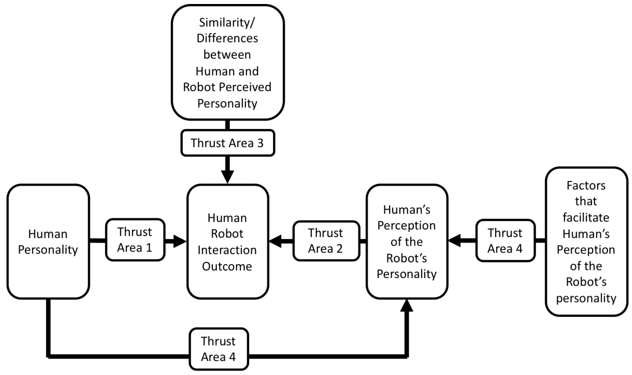

Figure 1. Human–Robot Integrative Personality (H-RIP) Model

Thrust Area 1: Human Personality and Human Robot Interactions

Thrust area 1 consisted of 41.5% of all the articles in the review. Extroversion and introversion were by far the most commonly used personality. Extroverts were more comfortable with robots coming closer (Gockley and Matarić 2006; Syrdal et al. 2007) and felt psychologically closer to robots (Salem et al. 2015). Extroverts were also more likely to humanize robots. Humanizing robots can be defined as "the representation of robots as humans and/or to attribute human-like qualities to robots" (Robert 2017 p. 1). In particular, Salem et al. (2015) found that extroverts were more likely to not only anthropomorphize robots but also believe that robots held uniquely human qualities. Extroverts were more comfortable with autonomous robots, whereas introverts preferred to be in control of the robot (Syrdal et al. 2006). Introverts also preferred robots that were more mechanical-looking rather than those that were more humanoid looking (Walters et al. 2008). However, there were mixed findings with regard to whether extroverts trusted robots more than introverts. One study found a strong positive relationship between extroversion and trust in robots (Haring et al. 2013), but at least one study did not (Salem et al. 2015).

Researchers in several studies examined other big five personality traits. Low neuroticism/high emotional stability was positively correlated with humanizing robots and with feelings of psychological closeness and likability toward robots (Salem et al. 2015). Neurotic individuals (i.e. lower emotional stability) tended to prefer mechanical-looking robots compared to humanoid-looking robots (Walters et al. 2008). In addition, at least one study found no significant effects associated with any of the big five personality traits. Gockley and Matarić (2006) studied how human personality impacts the ability of robots to motivate humans to exercise. They found that none of the big five personality traits had any relationships to the ability of robots to motivate humans to exercise.

A study not employing the big 5 explored the role of assertiveness on whether humans took advice from robots. Chidambaram et al. (2012) examined the influence of human's assertiveness on the perceptions of whether humans complied with the robot's suggestions. Human assertiveness was not related to compliance but was negatively related to perceived robot persuasiveness.

Thrust Area 2: Robot Personality and Human–Robot Interactions

Thrust area 2 consisted of 30.5% of all the articles in the review. Similar to thrust area 1, extroversion and introversion were the most common significant predictors. Extroverted robots made a more positive impression on humans, were considered to be more playful and made humans laugh and smile more than introverted robots (Goetz and Kiesler 2002; Kim et al. 2008). Likewise, introverted robots made a less positive impression and were viewed as much more serious, less playful and less enjoyable.

Researchers in two studies examined possible moderators between the impact of extroversion and human–robot interactions. Leuwerink (2012) examined whether the type of interaction (group vs. dyadic) influenced the impact of the robot's extroversion and introversion personality. The introverted robot was perceived as more intelligent in a group interaction, but the extraverted robot was perceived as more intelligent in a dyadic interaction. Tay, Jung and Park (2014) investigated whether occupational role (security vs. health care) and gender (male vs. female) influenced the impact of the robot's extroverted and introverted personalities. Participants had a more positive response to the extroverted health care robot than the introverted health care robot. However, participants had a more positive response to the introverted security robot than the extroverted security robot.

Other studies examined the impact of non-big-five robot personality traits. Moshkina and Arkin (2005) examined whether a robot's display of personality would increase its ease of use, pleasantness of interaction, attachment and moods associated with the robot. Results show that a robot's display of personality did increase ease of use and decreased negative moods. There was no significant difference with regard to pleasantness of interaction, attachment or increases in positive mood. Powers and Kiesler (2006) investigated the impact of non-big-five robot personality traits such as sociability, knowledge and dominance. They found that two personality traits — being knowledgeable and being sociable — mediated the impact of robot physical appearance and whether individuals took the robot's advice.

Thrust Area 3: Human–Robot Personality Similarity/Differences

Thrust area 3 consisted of roughly 28% of all the articles in the review. Once again, extroversion and introversion were the most common significant predictors. Aly and Tapus (2016) found that humans prefer robots that have a similar personality to theirs; extroverts preferred extroverted robots and introverts preferred introverted robots. Tapus, Tapus and Matarić (2008) also examined similarity between humans and robots with regard to extroversion and introversion. Extroverts preferred to interact more with robots that displayed behavior consistent with an extrovert, while introverts preferred to interact more with robots that displayed behaviors consistent with an introvert; at the same time, humans tended to believe that their personality was different from the robot's (Woods et al. 2005; 2007). However, Lee et al. (2006) examined whether humans prefer robots that are similar or different from them (i.e. complementary) in their personality. They found that individuals prefer robots that have different personalities from their own. Taken together, there are results supporting the benefits of both similarities and differences.

Researchers in one study attempted to explain when humans might prefer robots with similar vs. different personalities. Joosse et al. (2013) examined whether the task of the robot as well as the type of human personality moderate when humans prefer robots that have a similar or different personalities to their own. The authors examined the preference of extroverts and introverts on robots that performed two tasks: a cleaning task and a tour guide task. Generally, extroverts trusted the extroverted robot more than the introverted robot, while introverts trust both the introverted and extroverted robot equally. For the cleaning task, however, introverts trusted the extroverted robot more, while extroverts trusted both the introverted and extroverted robots equally. But for the tour guide task both preferred extroverted robots.

Results of the Literature Review

Major Findings

We derived three major findings from the literature review, listed next. There is also empirical evidence with regard to other findings, but these insights represent the most consistent and generalizable results.

1. Extroverts seem to respond more favorably when interacting with robots.
2. Humans respond more favorably to extroverted robots, but this relationship is moderated.
3. Humans respond favorably to robots with similar and/or different personalities from them.

Critique of the Major Findings

According to the articles we reviewed, a number of personality traits can be important. The levels of empirical support found for each personality trait vary considerably. Nonetheless, the literature suggests that extroversion plays a key role in understanding human–robot interactions. Extroverts are more receptive to robots and humans are more open to extroverted robots. There are several possible explanations for the findings related to extroversion. First, extroversion as a human trait is a strong predictor of whether someone will engage with someone else (Peeters et al. 2006). Based on the current literature, this effect seems to translate over to human–robot interactions.

Another explanation is that extroversion as a robot trait is easier to display in robots and may be more salient in shorter interaction times. Researchers have investigated behaviors such as making the robot louder, exaggerating its body movements or having it smile to display an extroverted personality (see Kim et al. 2008; Leuwerink 2012). However, it is less clear how to have the robot display behavior that would indicate openness to experiences or many other traits. To do so might require advanced technological approaches that many social science researchers typically do not employ. The current literature has also relied primarily on experimental studies conducted over a short duration of time. The impacts of other more subtle traits might not be salient in such a short time.

The importance of robot extroversion in many studies might also be the result of the social nature of the interactions involved in the studies. Researchers in several studies have found evidence of moderators on the impact of robot personality on human robot interactions. For example, extroversion was found to be less important when a robot was a security robot rather than a health care robot (Tay et al. 2014). According to Tay et al. (2014), humans expect health care providers to be more social or outgoing, which is less true for security providers. If more studies had examined less-social-oriented interactions between humans and robots, extroversion might not have been so important.

Unfortunately, we know little about the influence of moderators on the impacts of human personality on human robot interactions. The social nature of the task in these studies might also make extroversion more important. For example, humans engaging robots with regard to receiving technical knowledge from the robot might make the human's trait of conscientiousness more important and extraversion less important to determining their trust in the robot. In short, the focus on social interactions might help to explain the importance of extraversion as a human trait.

A small but growing number of studies are focusing on the impact of similar vs. different human and robot personalities. This literature has the potential to reframe the discussion around the importance of both human and robot personalities. Nonetheless, there is still a need to explore the impacts of human and robot personalities separately from similar vs. different personalities. Robots do not always know what particular personality a human may have; therefore, it is still important to explore the impact of human and robot personalities separately from this thrust area.

Gaps Across All Research Thrust Areas

Despite the importance of personality in human–robot interaction and the efforts of many scholars, there are several major gaps. Next we present three of the important gaps in the literature. These include gaps in context, research approaches and personality traits. We discuss these in greater detail below.

Gaps in Context: Taking Context into Consideration

No study examined the effects of context on the impacts of human and robot personality. Context has been shown to be important to understanding many different phenomena of interest across research domains. Home and work settings represent two types of context in the human–robot interaction literature. It is easy to imagine that robot personality might be more or less important for home robots than for robots used at work. Gaps in context are likely to hide important contingency variables needed to better understand the impact of personality on human–robot interaction.

Gaps in Research Approaches: Leaving the Lab

Gaps in research approaches present a major challenge to the generalizability of the results in the literature. There were four major gaps with regard to research approaches. First, most of the studies took an experimental approach.. Second, robots are expected to play a major role in the health care industry, but there is a lack of studies in that context (Broadbent et al. 2009). Third, a related shortcoming is the lack of studies over time. Prior literature has highlighted the influence of appropriation over time in understanding human–technology interaction. Yet no work has been done to understand how the impact of personality might change over time. Fourth, although some studies conducted interviews to supplement or complement quantitative analysis, little effort has been made to employed a qualitative approach as the primary method or analysis. Yet, qualitative approaches provide a unique and rich set of insights.

Gaps in Personality Traits Examined: Beyond the Big Five

Most of the studies examined one or more of the big five personality traits, with extraversion/introversion being the most popular. However, there are many other types of personality measures. For example, only one study claimed to employ the Myers Briggs personality test (see Kim et al. 2008). It is not always clear why most studies have focused on the big five.

Limitations

This literature review has several limitations. First and foremost, no literature review is ever completely inclusive. In particular, we limited this review to English-speaking journals and articles. In this literature review we did not include studies examining EVA robots. Because of space limitations, the paper did not discuss thrust Area 4: Facilitating Robot Personality.

Conclusion

Robots are becoming important to our society and both human and robot personalities are vital to understanding effective human–robot interaction. This literature review highlights important gaps and is therefore an excellent starting point.

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