How Might Robots Change Us? Mechanisms Underlying Health Persuasion in Human-Robot Interaction from A Relationship Perspective: A Position Paper

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Abstract

The application of social robots in persuading people to change health behaviors is an increasing research topic. However, little is known in what ways, and under what conditions, effective health persuasion can be achieved in human-robot interaction (HRI). This position paper presents a conceptual model that integrates interpersonal relationship theories to postulate a mechanism through which social robots can change people's health behaviors. In this paper, we first briefly describe the two interpersonal relationship theories we selectively focus on, namely social control and interdependence theory, and we discuss the possibility of people forming relationships with social robots. Then, we propose the conceptual model depicting the potential positive and negative influence of social robots' health persuasion on people's psychological and behavioral reactions and the modulating role of human-robot relationships. Finally, we discuss the implications of this model for future research.

Keywords

Social Robot, Health Persuasion, Health Behavior Change, Social Control, Human-Robot Relationship.

1. Introduction

Social robots have been considered as meaningful and influential social actors in many aspects of people's daily lives, one of which is to persuade people to change their health behaviors. In recent years, research on using social robots for health persuasion has received increasing attention and yielded inspiring empirical findings. For instance, studies have shown that social robots are capable of motivating physical activity in older adults (e.g., [1–3]) and young adults (e.g., [4, 5]), encouraging weight management (e.g., [6]), prompting water consumption (e.g., [7, 8]), facilitating breaks from sedentary work (e.g., [9]), and persuading children to eat more fruits and vegetables (e.g., [10]). However, despite these promising findings, mechanisms through which the health persuasion of social robots influences people's health behaviors are not completely understood yet. Although the field of persuasive technology has contributed significantly to understanding the persuasive effects of various technologies on people's health and well-being, little evidence actually supports the generalization of these results to the domain of social robots.

In fact, social robots are fundamentally different from any other technologies. According to Naneva et al. [11], three unique features set social robots apart. First, social robots possess a physical structure that closely resembles the appearance of a human or other living being. Second, they incorporate social cues that evoke a sense of social presence. Third, they have (multimodel) social interfaces that allow for both verbal and non-verbal communication. As a result, once a social robot has entered a social environment, people tend to react intuitively to them in a manner akin to interpersonal interactions, and even further, form socioemotional relationships with them [12]. Many researchers support the notion that social robots are perceived not merely as "technologies" but rather as "relational artifacts" [13] that may induce people to develop social

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relationships with them [14]. As such, if we expect social robots to be successful in persuasion, we must incorporate the relational nature of HRI and rely on robust relationship theories to derive reasonable inferences. However, to date, research on health persuasion by social robots generally has not incorporated many relationship theories, and as a result, little is known in what ways, and in what conditions, a positive health outcome can be achieved by HRI. In light of this, this position paper proposes a theoretical foundation that might be able to predict the persuasive effects of social robots on people's health behaviors, especially from the perspective of relationship theories. In the remainder of the paper, we first provide a brief overview of two relationship theories – social control and interdependence theory, which have clear relevance for health behaviors and outcomes, and we argue that the key principles of these two theories might also hold for human-robot relationships. We then provide an initial conceptual model to postulate people's possible reactions to social robot's health persuasion and incorporate human-robot relationship as a core moderator. We finally discuss how this model may inform future innovative research in the domain of health persuasive social robots.

2. Health Behavior Change in Interpersonal Relationships: Social Control and Interdependence Theory

Interpersonal relationships are widely acknowledged as significant influencing factors for people's health behaviors. One essential social exchange process driving such influence is social control, more specifically, health-related social control. Health-related social control refers to deliberate attempts initiated by social network members to regulate one's health-related behaviors, such as constraining one's health-damaging behaviors or encouraging health-enhancing behaviors [15]. Such attempts manifest in a variety of everyday expressions such as "Why don't you come for a run? [16] ", "Two beers are enough for you tonight [17]" or "Don't eat all those calories [18]." Since the 20th century, such social phenomena have been extensively investigated in sociology and social psychology, and their results generally demonstrated that social control has "dual effects". Specifically, depending on the specific communication strategies used by the social control provider, social control leads to both positive and negative consequences. On the one hand, positive social control strategies, such as expressing liking, caring, and using rational logic, tend to elicit greater health behavior change in recipients. On the other hand, negative social control strategies, involving criticism, threats, and guilt or fear induction, are typically associated with a series of undesirable behaviors, such as disregarding the influence, hiding unhealthy behaviors, or even changing toward opposite directions [15–20]. Moreover, according to the mediational model [21], the associations between social control and health behaviors are largely mediated by people's affective reactions. Specifically, positive affect mediates the association between positive social control and health behavior change. For example, when someone is encouraged by another person to engage in a run, they may experience positive affect such as a feeling of being cared for, which may make them more likely to take positive actions [22]. In contrast, the "backfiring" effects related to negative social control are mediated by negative affect such as anger and resentment, as well as psychological reactance [17]. For example, someone may feel that their freedom is being threatened if the other person criticizes their eating habits, which may prompt them to eat even more unhealthy food as a way of restoring their lost freedom.

The quality of relationships between interactants is another contextual factor that is profoundly important to the effects of social control. Research indicates that the closer the relationship between the initiator of social control and the recipients, the more positively the recipients tend to respond [23]. Such an influencing pattern can be explained by interdependence theory [24], which is another major theory accounting for the influence of close relationships on health behaviors. According to this theory, high-quality dyadic relationships, characterized by high-level closeness and mutual interdependence, such as committed romantic partners or best friends, are more likely to facilitate successful health-related social control over each other. This is because people in closer relationships often internally undergo a "transformation of motivation" during their decision-making [24]. This means that people tend to prioritize the needs and wishes of their close others and are willing to do something beneficial for (the relationship with) them [25]. In health persuasion, even if a social control strategy may sometimes feel pressuring and contradict one's original intentions, people can still comply voluntarily because they cognitively ascribe health behaviors as meaningful for their important ones or their relationship [23]. For example, a woman might stop smoking because her boyfriend complains about the smell of her breath [22] and a boy might reduce alcohol consumption because his girlfriend doesn't want him to drink. In such situations, when social control is initiated by close partners, people tend to react positively and change their behaviors, not only because of their self-oriented interests but also due to deeper motives that are more "relationship-oriented" [26]. Based on this behavior change mechanism in interpersonal relationships, one might envision that if humans can have a close relationship with a robot, people would also be more receptive to the health persuasion from the robot. Before this can happen, a preliminary question arises: Is it possible for humans to establish any relationship with robots?

3. Human-Robot Relationship

Research on human-robot relationships is yet another new and inconclusive field. The basic theoretical foundation of this field is the "computers are social actors" (CASA) paradigm (or the media equation theory), which suggests humans tend to react intuitively to computers in interpersonal ways if the computer exhibits social cues, such as languages, gaze, and facial expressions [27]. This inherent tendency is assumed to exist because human brains have not evolved to distinguish mediated simulations [28]. Additionally, social agency theory contends that people's social responses tend to increase with the increment of available social cues in robots [29]. Based on these theories, it seems plausible for people to readily establish a relationship with social robots analogous to interpersonal relationships, given that social robots emulate a high level of lifelike social behaviors. However, such an assumption is still debated yet, with two major opposing camps of opinions. On the one hand, some contend that the sociability of a robot is intrinsically deceptive because a robot is essentially controlled by humans and does not have any fundamental desires that characterize a truly social being [30]. As such, a genuine relationship that requires moral equals seems to be impossible between humans and robots.

On the other hand, some argue that this moral asymmetry does not preclude the existence of a human-robot relationship [31]. Even though robots might be fundamentally human-controlled, ample empirical evidence shows that people do initiate and commit to something relational with robots, even if they are fully aware that the robots are not real. Such relationships might manifest in various kinds of psychological constructs, such as companionship, as evidenced by people's intrinsic satisfaction and enjoyment when engaging in shared activities (e.g., playing games) with a robot (e.g., [32]); closeness or attachment, as evidenced by peoples' intuition to share initiate life stories and secrets to a robot (i.e., self-disclosure) (e.g., [33]); and even deeper affection, as evidenced by people experiencing grief and frustration following the loss of a robot (e.g., [34]). Altogether, we have plenty of reasons to believe in the possibility of establishing human-robot relationships. Although such relationships remain a novel and highly ambiguous concept that has not been sufficiently defined in any theories, it seems reasonable to tentatively conceptualize it as a type of emotional bond that humans unilaterally invest in a robot. Although it remains another open question whether a human would undergo a "transformation of motivation" in a human-robot relationship similar to what they would in interpersonal relationships, we can believe that the emotional bonds between humans and robots would also allow a further impact on people's cognitive, emotional, and behavioral reactions when the robot they are bonded with tries to persuade them to change their health behaviors.

4. Conceptual Model

According to the social control and interdependence theory, social control strategies and relationship quality operate together to predict people's health behavior change within interpersonal relationships. Additionally, theories such as the CASA paradigm suggest that it is plausible for humans to form socioemotional relationships with social robots. Considering these points, we propose that effective health persuasion in HRI would also rely on two key factors: effective health persuasive strategies and the presence of a meaningful human-robot relationship as a contextual moderator. We contend that these two factors will jointly contribute to the persuasive impact of a social robot on people's health behavior change. Figure 1 illustrates the conceptual model depicting the influencing mechanism we have formulated.

First, this model aligns with the mediational model of health-related social control [21] and highlights both positive and negative persuasive consequences that may arise from HRI. On the one hand, we propose that positive social control initiated by a robot, such as showing liking, caring, and using rational logic, is likely to predict positive psychological responses such as positive affect. The positive affect, in turn, is associated with people taking positive health behavior changes. On the other hand, when people experience negative social control from a robot, such as criticism or threats, they may show unintended behaviors such as ignoring the robot, disengaging from the interaction with the robot, hiding their unhealthy behaviors or even acting in ways contrary to what is advocated. We propose that these negative pathways would also be mediated by negative psychological reactions such as negative affect and psychological reactance.

More importantly, we propose that human-robot relationship might serve as an important moderating factor in both the positive and negative pathways, as the relationship constructs such as companionship and closeness might enhance people's receptivity to the social control from robots, and more ideally, trigger a "transformation of motivation" that predisposes people to serve the needs or desires expressed by their "robot partners". As a result, human-robot relationships would (1) magnify the positive outcomes associated with positive social control, and (2) serve as a buffer against the negative effects associated with negative social control.

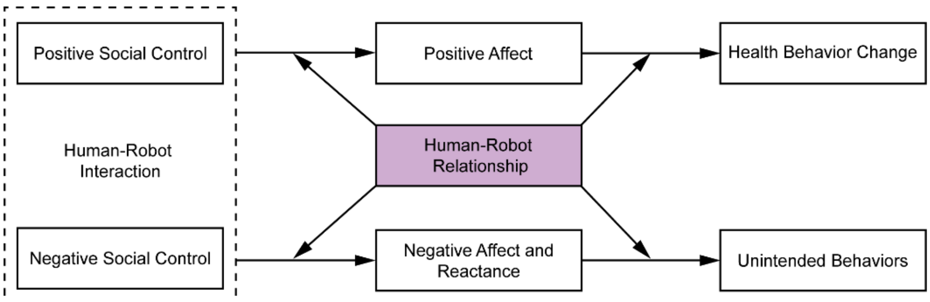

Figure1: Conceptual model of the mechanism underlying health persuasion in human-robot interaction, built based on the mediational model of health-related social control [21].

5. Discussion

How this model will inform future HRI research? First, our model highlights both the positive and negative consequences that may arise from health persuasion through social robots. As such, it facilitates a more rigorous and holistic understanding of the health persuasive effects in HRI and may thus prompt more critical research in this domain. For example, while much current existing HRI research has examined certain types of positive health persuasive strategies (e.g., showing goodwill or expertise [35]), little is yet known about the "dark-side" stories, for example, what might happen if a robot were to unintentionally use negative strategies such as threatening or criticizing people? Where is the exact boundary between positive and negative persuasive strategies that deserve special attention? What kind of strategies should be resolutely eliminated? In order to further advance the understanding of the persuasive mechanism in HRI, and also to prevent our future robots from being unintentionally designed to bring unexpected detrimental effects, we suggest more future studies should further explore and consolidate the negative influencing patterns.

Second, our model offers a new perspective on how human-robot relationships might play a role in the behavior change process. Understanding this association is essential for developing more effective social robot-based interventions. For example, this model may inspire HRI researchers and designers to deploy more relationship-oriented social activities (such as self-disclosure) in the persuasion process rather than solely relying on verbal-based persuasive messages. To achieve this goal, future research should delve into the nuanced psychological processes related to human-robot relationships, including specific relationship constructs, design determinants, corresponding measures, and the temporal dynamics of the relationship.

In conclusion, this position paper has focused on uncovering the health persuasion process in HRI from a relationship perspective. By incorporating social control theory and interdependence theory, this paper proposed an initial conceptual model that predicts how social robots may impact people's health behavior change. We postulate that the health persuasion of social robots can induce both positive and negative psychological and behavioral consequences, and we underscore the modulating role of human-robot relationships in such dual influences. This paper might serve as a prelude for future research to further expand our knowledge of how HRI and human-robot relationships can be leveraged to impact our health and well-being.

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