

Cognitive and Affective Trust in Human–Robot Interaction: Effects on Task Delegation

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Abstract

Trust in Human–Robot Interaction (HRI) is a multidimensional construct involving both attitudes (cognitive and affective trust) and behavior (task delegation). In this paper, we experimentally separate the effects of robot competence, autonomy, and personality trait of agreeableness on cognitive trust, affective trust, and task delegation in a task-oriented HRI scenario. We report results from a 2×2×2 between-subjects study (N = 373) showing that competence is the primary driver of both trust attitudes and behavior, whereas personality affects affective trust without influencing delegation. Importantly, autonomy does not exert direct effects but acts as a contextual moderator, improving the impact of competence on cognitive trust and of personality on affective trust. We find that only cognitive trust predicts and mediates task delegation, while affective trust, despite being significantly modulated, does not translate into behavioral trust. These findings provide empirical evidence for a functional dissociation between affective and cognitive trust in HRI and highlight that behavioral trust is predominantly grounded in capability-based evaluations rather than affective factors. These findings clarify the distinct roles of functional and social robot attributes and provide insights for designing trustworthy and effective collaborative robots.

Keywords

Human-Robot Trust, Cognitive Trust, Affective Trust, Cognitive Systems

1. Introduction

Trust is a crucial factor in Human-Robot Interaction (HRI) [1], especially when humans need help of robots by delegating them complex tasks to achieve [2]. More generally, trust is a multi-layered notion, involving both attitude and behavior [3]. HRI research categorizes trust attitude in two dimensions: cognitive trust and affective trust [4]. Cognitive trust is the human attitude to rely on robot capabilities and reliabilities. It is based on rational judgment on robot competence and consistency in achieving a task, which is usually shaped by observations of its performance [5], in addition to information from other sources that are, in turn, considered reliable [6]. In contrast, affective trust is the human attitude based on emotional bonds and feelings towards the robot. It is influenced by robot social behaviors, anthropomorphic characteristics, and the quality of human interaction [7].

Trust attitude is deeply related to trust behavior, with trust attitude being a precondition for the trust behavior [3]. Trust behavior generally matches with task delegation, which implies the transfer of decision-making autonomy and control from a delegator agent (typically a human) to an adopter agent (such as a robot) [8]. In task-oriented HRI scenarios, trustworthy task adoption requires that the robot not only possesses the necessary competence to achieve the desired outcomes, but also demonstrates adaptive autonomy [9]. Perceived agency and autonomy are factors that, if interpreted in a collaborative way, shape humans perception of robots as trustworthy and effective partners [10]. This involves the robot capability to adapt its level of autonomy to the task, the environment, and the human expectations [11]. The robot can adopt a human-delegated task with multiple levels of autonomy [12].

Different studies explored how human trust attitude is affected by the robot competence and, specifically, how competence primarily determines human cognitive trust [4]. Humans are very sensitive to robots task failures [13] and robots who make mistakes result in a lower human cognitive trust [14].

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Observing the robot performance represents the "good rational reasons" for building cognitive trust in robots [15]. Furthermore, robot competence emerges as a key factor in the interaction between humans and robots, playing a crucial role in fostering task delegation [16].

Similarly to the competence, robot autonomy in task adoption can significantly impact human trust, as it may lead to unexpected robot behaviors or changes in the environment [17]. People prefer to interact with robots that exhibit autonomous and proactive behaviors and consider them to be better teammates [18]. However, unexpected robot behaviors, regardless of their success, can unpredictably affect trust due to misalignment with human goals, expectations or prescriptions [19]. Robot autonomy is a critical attribute that influences cognitive, affective trust and task delegation [20].

Since trust attitude pertains both to the outcomes produced by the robot and to the quality of interaction itself, the robot should possess a set of attributes that positively influence its interaction with humans, regardless the observed performance. Specifically, personality has attracted considerable scholarly attention from researchers of HRI [21], since people can attribute personality traits to machines [22]. Multiple works have been made to integrate personality traits into social robots, such as Extroversion [5], Agreeableness [23] and Conscientiousness [24]. Personality traits design involved the manipulation of various robot communication skills, including language modalities, speech styles, and non-verbal behaviors like gestures, facial expressions, posture and body movement [25]. Prior study has showed that both robot and human personality are significant predictors of trust [26]. Recent works explicitly studied the interplay between robot personality traits and both cognitive and affective trust [27, 5]. They showed how robot personality traits as Extroversion and Agreeableness had a significant impact on the level of human affective trust, while confirm that cognitive trust is influenced by a much more performance-related robot features (i.e. competence in achieving a task [27], information disclosure [5]).

This paper presents results of a HRI experiment designed to investigate the interplay between human cognitive and affective trust [4], and characteristics such as competence, autonomy, and specific personality traits of a humanoid robot. In particular, we focused on the impact of the robot competence in executing a task delegated by a human user (a performance-based attribute) and examined two other characteristics: its autonomy in achieving the task and its personality traits. Autonomy refers to the robot decision to act toward goals that, while not explicitly delegated by a human, remain aligned with the human's intentions [28]. Finally, personality traits refers to Agreeableness dimension, as defined by the Big Five personality model [29]. Additionally, the experiment explored how these robot characteristics influence the human decision to delegate new tasks to the robot (i.e. trust behavior). Finally, we investigated the mediating role of cognitive and affective trust in shaping trust behavior.

This work provide a systematic experimental separation of how functional (competence), agentic (autonomy), and social (personality) robot attributes affect cognitive and affective trust. Furthermore, we explicitly connect trust attitudes to behavioral trust by showing that only cognitive trust predicts and mediates task delegation, whereas affective trust—although significantly influenced by robot personality—does not translate into reliance decisions in task-oriented contexts. Third, we demonstrate that autonomy plays a conditional role, acting as an amplifier of other attributes rather than a direct determinant of trust, thereby refining its theoretical interpretation in Human–Robot Interaction.

2. The Experiments

The study was guided by the following experimental hypotheses:

- **H1:** Robot competence positively affects cognitive trust, affective trust, and task delegation, whereas agreeableness increases affective trust only, without significantly influencing cognitive trust or task delegation.
- **H2:** Robot autonomy moderates the positive effects of competence on cognitive trust and of agreeableness on affective trust; moreover, higher autonomy amplifies the impact of competence on task delegation.

- **H3:** Human’s cognitive trust mediates the effect of robot competence, autonomy, personality traits and the human’s delegation of a new task to the robot. Affective trust doesn’t play any mediation role.

In order to test the hypotheses stated above, we designed a $2 \times 2 \times 2$ between-subject experiment manipulating robot competence, autonomy, and agreeableness as independent variables. The dependent variables were human cognitive trust, affective trust, and trust behavior, operationalized as the delegation of a new task to the robot. The experiment involved 373 participants ($F = 162$, $M_{age} = 44.19$, $SD = 13.14$), who interacted virtually with the humanoid robot NAO robot via an online platform to complete a construction task. Data were collected via Qualtrics, using a stratified sample of Italian native speakers recruited by Bilendi (www.Bilendi.com). Participants provided informed consent and were compensated according to standard panel practices (e.g., points or vouchers).

Participants were asked to construct a tower composed of four 3D shapes (cubes and cylinders in different colors) by sequentially delegating actions to the robot (Figure 1). They selected one of two possible goal configurations, each requiring a specific sequence of shapes. Interaction occurred through a web interface displaying both the target configuration (“Goal to Achieve”) and the current state of the construction (Figure 1). Each delegated action, corresponding to the movement of a single tower component, triggered a video in which the robot pressed a corresponding console button, resulting in the movement of a shape within a virtual environment. Figure 2 illustrates the main movements required for the robot to press a button on the console and the resulting effect in the virtual platform. This setup created a consistent mapping between physical robot actions and virtual task outcomes.

Participants were randomly assigned to one of eight experimental conditions derived from the combination of competence, autonomy, and personality. After completing the task, they evaluated the interaction questionnaires measuring cognitive trust, affective trust, and trust behavior.

Robot competence was manipulated based on task success. In the competent condition, the robot correctly selected all pieces required to complete the tower. In the non-competent condition, it placed the first three pieces correctly but selected an incorrect final piece. Importantly, both versions executed identical movements and timing, ensuring that only outcome accuracy differed, consistent with prior HRI research. Autonomy was defined following the Social Adjustable Autonomy framework. In particular we leveraged on two different levels of autonomy: literal help and over help. In the literal condition, the robot executed only explicitly delegated actions, requiring step-by-step user guidance. In the over-help condition, the robot extended beyond instructions by anticipating and performing additional actions necessary to complete the task, thereby exhibiting higher autonomy. Personality was operationalized through behavioral and communicative cues. The agreeable robot used a high-pitched, energetic voice, polite and collaborative language, gestures, and eye contact, providing feedback that emphasized cooperation. The disagreeable robot used a lower-pitched voice, slower speech, minimal verbal content, and hostile or reluctant language, without gestures and while remaining seated, signaling low willingness to collaborate. Apart from these differences, task execution remained identical. A pilot study using the Italian BFI Agreeableness subscale confirmed the effectiveness of the personality manipulation, showing a clear distinction between agreeable and non-agreeable conditions.

Cognitive and affective trust were measured using an adapted version of the Trust Perception Scale–HRI [30]. Task delegation was assessed through a single-item behavioral measure evaluating the degree of control granted to the robot during a new tower-building task. Furthermore, we assessed the participants attitude towards robots by exploiting a short version of the 14-items Negative Attitude towards Robots Scale (NARS) [31]. We evaluated the psychometric properties of all multi-item instruments using confirmatory factor analysis (CFA) for ordinal data (WLSMV) and standard reliability indices.

3. Results

Statistical analyses were conducted in R [32] using Generalized Linear Models to examine the effects of robot competence, autonomy, and personality (agreeableness) on cognitive trust, affective trust, and

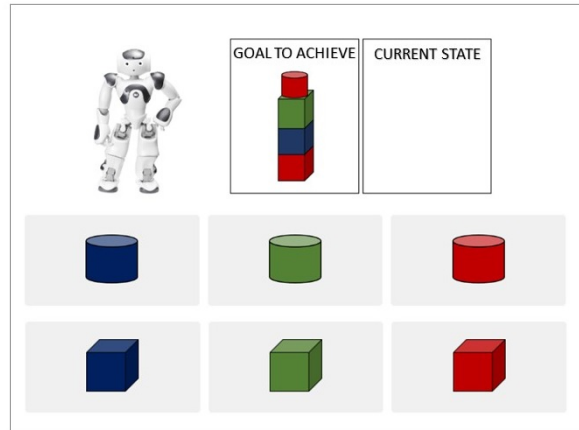


Figure 1: The interface through which the action to be performed by the robot was delegated. The 'Goal to Achieve' section displayed the final tower to be built, while the 'Current State' section illustrated the present state of the construction.

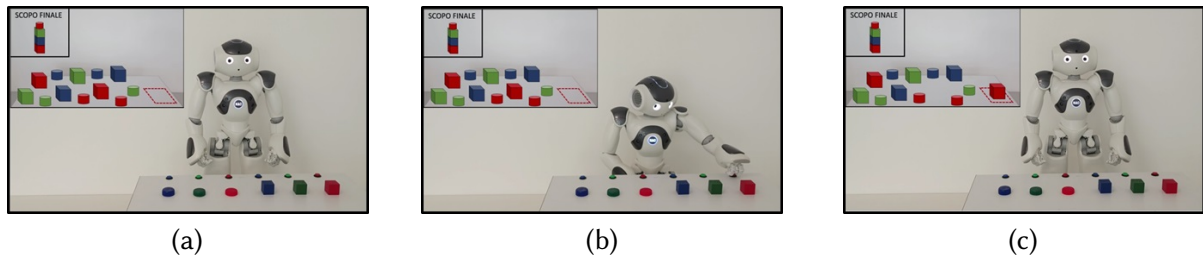


Figure 2: An example of a physical action performed by the robot after human delegation, along with its outcome in the robot virtual working space: (a) The robot communicated its intention to perform the delegated action, (b) the robot approached the console and pressed the button, resulting in the corresponding geometric shape being moved in the virtual workspace (c) the robot returned in the starting position and communicated that the action has been completed. The final result in the web interface was the movement of the piece to the right section of the table, highlighted by a red outline.

task delegation, while controlling for Attitude Toward Robots (ATR). Overall, the results revealed a consistent pattern in which competence emerged as the primary driver across all dependent variables, while autonomy and personality played more conditional roles. First, robot competence had a strong and significant positive effect on cognitive trust ($p < .001$, $d = 1.72$), confirming that users' evaluations of the robot's reliability are mainly grounded in its task performance. Neither autonomy nor personality showed direct effects on cognitive trust. However, a significant interaction between competence and autonomy ($p = .039$) indicated that autonomy increased cognitive trust only when the robot was competent. When the robot failed, autonomy did not improve trust, suggesting that autonomous behavior is valued only when supported by reliable performance. ATR also had a positive effect on cognitive trust ($p < .001$), indicating that participants with more favorable prior attitudes toward robots tended to report higher trust overall, independently of the experimental manipulations (Figure 3).

Affective trust showed a partially different pattern. Both competence and personality had significant positive effects ($ps < .001$), with agreeable robots eliciting higher affective trust and competent robots being evaluated more positively also at an emotional level. In contrast, autonomy did not have a direct effect. However, a significant interaction between personality and autonomy ($p = .033$) revealed that autonomy increased affective trust only when the robot was disagreeable, suggesting a compensatory effect. For agreeable robots, affective trust remained consistently high regardless of autonomy. ATR again positively predicted affective trust ($p < .001$), but did not interact with any of the experimental factors (Figure 4).

Task delegation, used as a behavioral measure of trust, was primarily driven by competence. Parti-

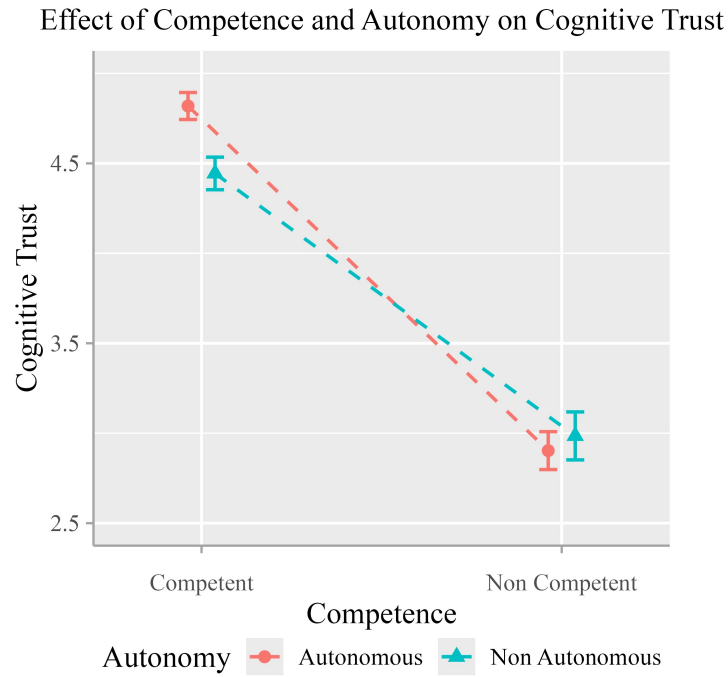


Figure 3: Line chart of the interaction effect of robot Autonomy and Competence on Cognitive Trust. When the robot was competent, participants showed higher cognitive trust when the robot was autonomous.

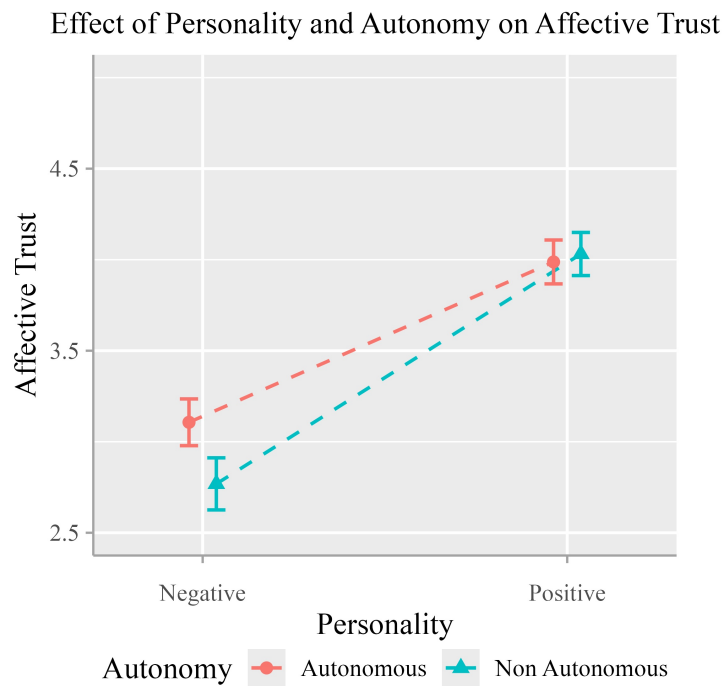


Figure 4: Line chart of the interaction effect of robot Autonomy and Personality on Affective Trust. When the robot was disagreeable, autonomy resulted in higher affective trust.

pants were significantly more willing to delegate when the robot was competent ($p < .001$, $d = .88$), whereas autonomy and personality did not show direct effects. Nonetheless, a significant interaction between competence and autonomy indicated that autonomy increased delegation only when the robot was competent, while it reduced delegation when competence was low. This suggests that autonomy amplifies positive performance but can be detrimental when the robot is unreliable. Moreover, a significant three-way interaction between competence, autonomy, and personality ($p = .004$) showed

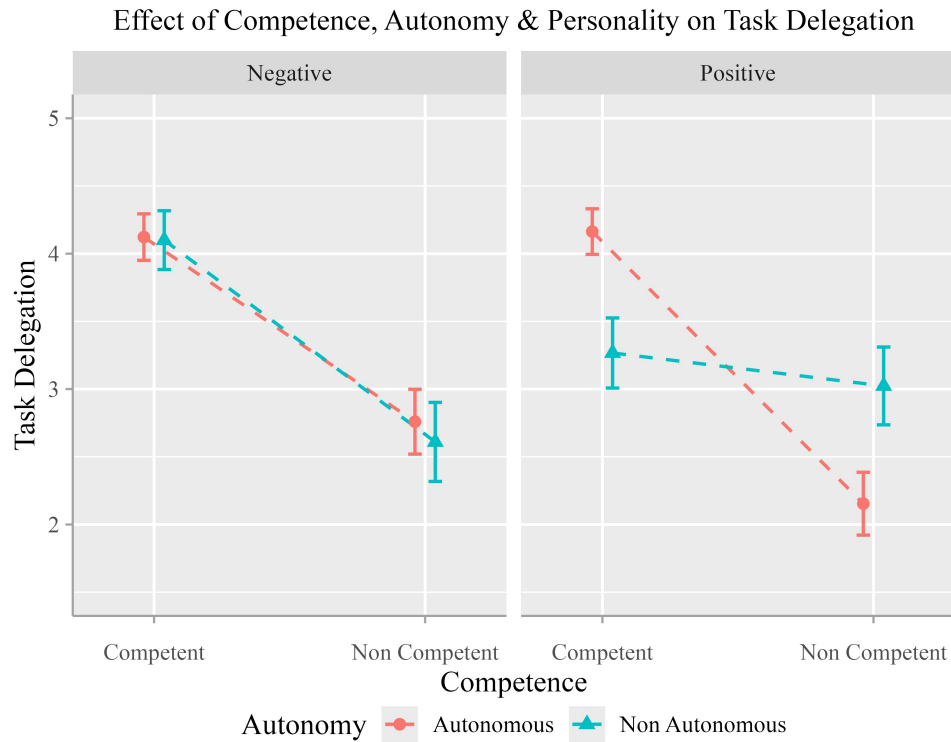


Figure 5: Line chart of the interaction effect of robot Competence, Autonomy and Personality on Task Delegation. Participants valued a competent and autonomous robot only when it was agreeable, while disagreeableness made them indifferent to its autonomy or competence.

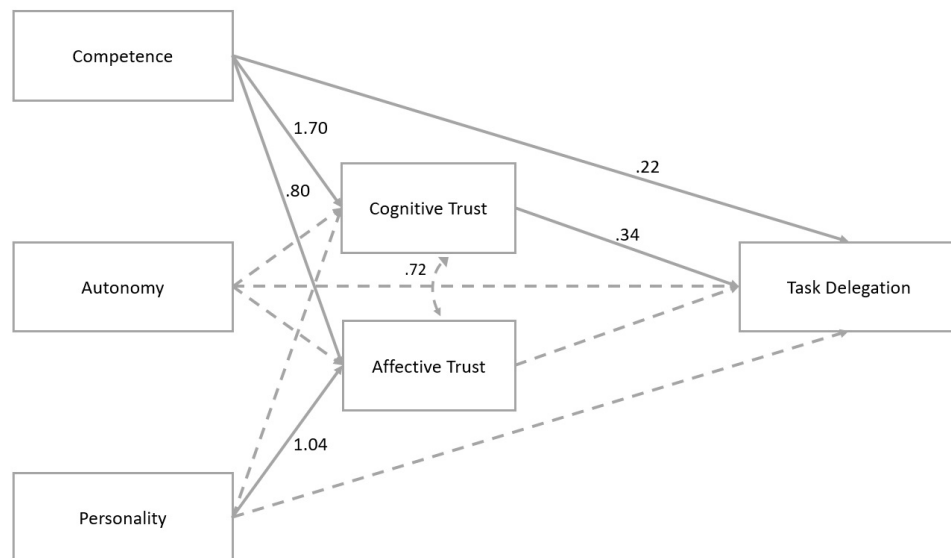


Figure 6: Path analysis results. Parameters estimates are unstandardised. Dotted lines represent insignificant paths. Continuous lines represent significant paths.

that these effects depended on the robot's social behavior: when the robot was agreeable, participants preferred a competent and autonomous agent, whereas with a disagreeable robot, delegation levels were generally lower and less sensitive to variations in competence and autonomy. ATR did not influence task delegation (Figure 5).

Finally, path analysis provided further insight into the mechanisms underlying these effects. The model explained a substantial portion of variance in cognitive trust ($R^2 = .43$), affective trust ($R^2 = .25$),

and task delegation ($R^2 = .18$). Results showed that competence significantly predicted both cognitive and affective trust, as well as task delegation. Importantly, only cognitive trust significantly predicted delegation and mediated the relationship between competence and behavior, indicating that decisions to rely on the robot are primarily driven by capability-based evaluations. Affective trust, although influenced by competence and personality, did not predict delegation and showed no mediating role. Autonomy and personality did not have direct effects on delegation, reinforcing their role as contextual rather than primary determinants (Figure 6).

4. Conclusions

The present study investigated how robot competence, autonomy, and the personality trait of agreeableness influence cognitive trust, affective trust, and task delegation in interaction with the NAO robot, contributing to a more nuanced understanding of trust formation in HRI.

H1 was largely supported and highlights the centrality of competence. Results consistently showed that robot competence is the primary driver of trust across both cognitive and affective dimensions, as well as of behavioral outcomes. When the robot successfully completed the task, participants reported substantially higher cognitive trust, confirming that performance reliability is the key basis for trust judgments. Competence also positively influenced affective trust, suggesting that perceived ability not only informs rational evaluations but also contributes to positive emotional responses. In contrast, agreeableness selectively influenced affective trust, reinforcing its role as a social-emotional cue rather than a determinant of perceived capability. Importantly, neither agreeableness nor autonomy had a direct effect on cognitive trust or task delegation, indicating that behavioral decisions are primarily grounded in functional performance rather than social or stylistic attributes.

H2 was supported through moderation effects, clarifying the conditional role of autonomy.^{**} Autonomy alone did not directly influence trust or delegation, but its impact emerged in interaction with other robot attributes. In particular, autonomy strengthened the positive effect of competence on cognitive trust and task delegation: participants were more willing to trust and delegate when a competent robot acted autonomously, suggesting that autonomy signals efficiency and initiative only when supported by reliable performance. Conversely, when the robot was not competent, autonomy failed to increase trust and even reduced delegation, likely because autonomous errors amplify perceived risk. A similar interaction pattern emerged for affective trust, where autonomy moderated the effect of agreeableness: autonomy increased affective trust only for disagreeable robots, suggesting a compensatory mechanism. In this case, autonomous behavior may mitigate negative social impressions by signaling engagement or effort, whereas for agreeable robots, affective trust was already high and remained stable regardless of autonomy. Overall, these findings indicate that autonomy is not inherently trust-enhancing but operates as a contextual amplifier of other attributes.

H3 was supported, identifying cognitive trust as the key mechanism linking robot attributes to behavior. Path analysis showed that cognitive trust significantly mediated the relationship between competence and task delegation, confirming that users rely on capability-based judgments when deciding whether to rely on a robot. In contrast, affective trust did not predict delegation and showed no mediating role, despite being influenced by both competence and agreeableness. This dissociation suggests that emotional trust contributes to the overall evaluation of the robot but does not translate into action in task-oriented contexts. Delegation decisions appear to depend primarily on expectations of performance rather than on relational or emotional factors.

Taken together, these results delineate a clear structure of trust in HRI: robot competence is a crucial factor in predicting cognitive, affective, and task delegation. In contrast, while robot personality traits were found to significantly influence affective trust, they did not affect cognitive trust or task delegation, indicating that emotional perceptions towards robots may be less consequential for practical task-related decisions. Furthermore, the moderating role of autonomy highlights its importance in enhancing the impact of competence on cognitive trust and personality on affective trust. This implies the need for careful design and calibration of autonomy levels in robots to enhance human trust. The results also

show that cognitive trust affects task delegation, suggesting that humans are more likely to assign tasks to robots they perceive as competent, while affective trust did not significantly influence this behavior. These insights have important implications for the design of robotic systems, particularly in environments where trust is essential for effective human-robot collaboration. Findings suggest a functional dissociation between affective and cognitive trust: while affective trust contributes to the overall evaluation of the robot, it does not appear to play a role in behavioral reliance in task-oriented scenarios, which is instead driven by capability-based evaluations.

The study relies on an online interaction paradigm and a single-item measure of task delegation, which may limit ecological validity and behavioral granularity. Future work should extend these findings to embodied HRI settings and richer behavioral metrics.

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Declaration on Generative AI

During the preparation of this work, the author(s) used GPT-5 in order to: Grammar and spelling check. After using this service, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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