Testing Implicit Attitudes Toward Prospective Military Reconnaissance Robots

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Introduction

The Army has fielded semi-autonomous robots that are capable of receiving tactical tasks and maneuvering across the battlefield. These robotic teammates should enhance both soldier capabilities and individual soldier survivability (Endsley, 2015; Szegedi et al., 2017). Designers must create robotic teammates that immediately garner trust with military service members and demonstrate their utility in mission execution. Previous research in social robotics has shown that both implicit and explicit attitudes impact decisions made towards robotic usage and acceptance (Young et al., 2009; Lee & Yen, 2022); however, the impacts and implications of these attitudes have not been tested within the military domain.

Background

Previous research suggests that the acceptance and utilization of novel technology depend largely on subjective perceptions and associations regarding robots – what they are, how they function, and their capabilities (Young et al., 2009). Attitudes towards robots can be categorized as explicit and implicit. Explicit attitudes operate on a conscious level and are generally measured through explicit self-reports, while implicit attitudes rely on unconscious and automatic processes (De Houwer et al., 2009). In this case, attitudes define the state of mind of an individual toward a robot conducting military reconnaissance. Previous research indicates attitudes towards robots arise from both conscious and unconscious processes, therefore both attitudes provide insight into how people perceive robots (MacDorman et al., 2009).

Research has identified a strong link between people's previous knowledge about robots and associated robotic acceptance (Arras & Cerqui, 2003), and thus most studies on human-robot interactions have examined explicit attitudes using self-report measures. However, another approach may be to assess implicit attitudes. The implicit theory of cognition suggests that individuals maintain two separate implicit and explicit cognitions toward objects of interest (Elsbach & Stigliani, 2019). Implicit cognitions are less susceptible to answers that might be formed by other experiential factors or deliberate self-perceptions (Gawronski & De Houwer, 2014; Lee & Yen, 2022). The Implicit Association Test (IAT) demonstrates associations towards images through participants' latency in associating words with a set of images, associating positive words toward images they favor significantly faster (MacDorman et al., 2009). The IAT has shown to be particularly adept in robotics research where it can evaluate even a relatively new object that participants are unfamiliar with (MacDorman et al., 2009; de Graaf et al., 2016).

A study by Lee and Yen (2022) introduced the Robot Implicit Association Test (R-IAT), a modified version of the Implicit Association Test, designed to measure implicit attitudes toward service robots. The R-IAT aimed to enhance understanding of individuals' unconscious preferences regarding human versus robot service providers. The R-IAT measured users' preferences for robots and informed strategies for the effective integration and customization of service robots. The R-IAT D-scores were significantly correlated with self-reported explicit attitude measures and behavior intentions, demonstrating the validity of the test. Building on Lee and Yen's (2022) methodology, the present study adapted the R-IAT to compare users' implicit preferences for two currently deployed military robotic scouts.

In our study, we explored the connection between the cognitive (explicit attitudes towards robots) and affective (implicit associations) components of people's attitudes towards robots. We proposed testing the hypothesis that the R-IAT correlates to explicit attitudes towards a reconnaissance robot with the following specific aims: (1) to determine explicit attitudes towards robots, we used the Nomura et al.'s (2006) Negative Attitude Towards Robots (NARS) Scale and Benton et al.'s (2022) Robot Power Scale (RPS), (2) to determine implicit attitudes towards robots, we used a Robot Implicit Association Test using two pictures of currently fielded Army robots, and (3) to determine a relationship between implicit and explicit attitudes, we conducted a correlational analysis using NARS, RPS, and the R-IAT D-score. This initial analysis investigated the connection between the R-IAT in the military domain and trait-level individual differences as measured by NARS and the RPS. Results can assist designers in optimizing the physical attributes of robotic scouts for improved usability and acceptance.

Approach

Replicating Lee and Yen's (2022) approach, a G-Power analysis with a small effect size (d = 0.25) and a power of 0.80, determined a minimum sample size of 101 participants. 113 undergraduate participants (58 women, 55 men), with a mean age of 18.70 years (*SD* = 1.01) completed the experiment. We also gathered self-reported attitudes using NARS and the RPS. The NARS used 14 questions to measure pre-existing attitudes towards robots across three subscales: (S1)

Situations of Interaction with Robots, (S2) Social Influence of Robots, (S3) Emotions in Interaction with Robots. The RPS measured explicit attitudes focused on robots in power. The RPS rates people's general perception towards the power of robots with 14 questions assigned to one of three subscales: (S1) directed and assistive tasks, (S2) problem solving and complex tasks, and (S3) social aspects. Participants completed the NARS, RPS, and then the R-IAT using IATgen software hosted by Qualtrics (Carpenter et al., 2019).

The R-IAT, adapted from Lee and Yen (2022), consisted of 7 blocks to measure the degree to which target pairs (robot picture) and categories (positive versus negative) were mentally associated. Figure 1 illustrates the experimental process, from the valence words, robotic images, and participant responses in the R-IAT. Participants were instructed to categorize each word or image as quickly and accurately as possible. Blocks were counterbalanced to avoid order effects.

Experimental Process to Test Implicit Associations towards Spot and UGV

Positive Words	Negative Words
Inquisitive	Unreliable
Detailed	Clumsy
Adaptive	Awkward
Reliable	Inefficient
Trustworthy	Useless
Robust	Creepy
Deliberate	Menacing
Useful	Slow

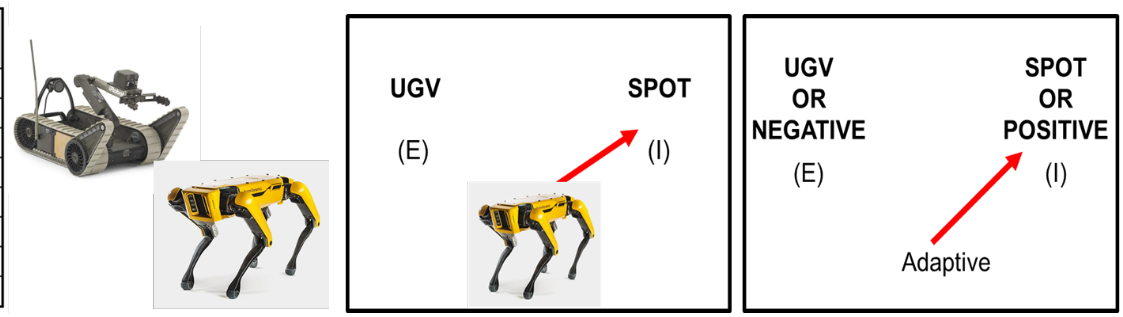

Figure 1. From left to right, (1) the words within the positive and negative categories, (2) pictures of the UGV and Spot the robot dog, (3) participants assign the picture to the correct pair – in this case, hitting "I" on the keyboard when shown a picture of Spot, and (4) participants assign the positive word "Adaptive" to the congruent pairing of "Spot or Positive."

The R-IAT was completed in approximately ten minutes. Upon completion, a standardized difference score (D score) was calculated to reflect participants' response speeds across different conditions. We hypothesized that Spot's anthropomorphic features would evoke positive implicit attitudes, leading participants to associate positive words with Spot more quickly, as indicated by response latencies. The IAT data were processed using the improved scoring algorithm outlined by Greenwald et al. (2003), and internal consistency was assessed using Cronbach's alpha, yielding $\alpha = .89$.

Outcome

The NARS and RPS scales were coded so that the higher the score indicated a more positive attitude towards robots or robots' power, respectively. Participants' NARS scores ($M = 2.61$, $SD = 0.49$) indicated a slight negative explicit attitude towards robots in general. The RPS scores ($M = 3.25$, $SD = .52$) indicated a slightly positive attitude toward robots' power. A Pearson correlation showed that neither measure of explicit attitude was significantly correlated with the R-IAT D-score.

When the IAT stimuli were congruent ($M = 877.17$ ms, $SD = 176.07$ ms), meaning that participants paired Spot with positive words or the UGV with negative words, response times were significantly faster than when the stimuli were incongruent ($M = 938.68$ ms, $SD = 199.78$ ms). For example, when participants paired the UGV with negative words, response times were significantly faster than when the UGV was paired with positive words. A one sample t-test revealed that participants had a positive implicit bias towards Spot, $t(114) = 3.68$, $p < 0.001$, 95% CI [0.07, 0.25].

Conclusion

Although IATs have not been typically used in military contexts, the R-IAT demonstrated validity in assessing implicit attitudes toward military robots. When comparing two currently fielded robots, participants associated Spot the robot dog with more positive attributes than the UGV, potentially because of Spot's anthropomorphic features (Hinds et al., 2004). By bypassing explicit attitudes, the R-IAT could offer an objective assessment of robotic attributes if positive implicit attitudes reliably show a practical difference in trust, reliance, or automation dependence.

Future research should explore the correlation between implicit attitudes and automation dependence; this exploration of attitudes predicting behavior has important practical applications. If implicit attitudes can predict dependence on automation, then the best designed robot will produce the greatest amount of dependence on a reliable robotic teammate.

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