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The bionic blues: Robot rejection lowers self-esteem☆

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ABSTRACT

Humans can fulfill their social needs with fictional and non-living entities that act as social surrogates. Though recent research demonstrates that social surrogates have beneficial effects on the individual similar to human relations, it is unclear whether surrogates can also cause similar harm to humans through social rejection. After playing a game of connect-4 with a human-sized robot, participants were informed by the robot that it would like to see them again (acceptance), would not like to see them again (rejection), or told nothing regarding a future interaction (control). Data revealed that social rejection from a robot significantly reduced self-esteem relative to receiving no-feedback and social acceptance (the latter two did not differ from each other). However, robot rejection had no impact on negative attitudes and opposition to the use of robots in everyday life. These findings demonstrate that social surrogates have the potential to cause psychological harm.

1. Introduction

Social bonds are fundamental to human living (Baumeister & Leary, 1995). A wealth of psychological research demonstrates the ill effect of disrupting or removing these social bonds in the forms of ostracism, exclusion, and rejection (Baumeister & Leary, 1995; Baumeister, Brewer, Tice, & Twenge, 2007; Leary, Tambor, Terdal, & Downs, 1995; Williams, 2007). For example, ostracism and rejection cause emotional numbness (DeWall & Baumeister, 2006), activate pain centers in the brain similar to experiences of physical pain (Eisenberger, Lieberman, & Williams, 2003), promote aggressive behavior (Leary, Kowalski, Smith, & Phillips, 2003; Twenge, Baumeister, Tice, & Stucke, 2001), and reduce self-esteem (Williams, 2007; Zadro, Williams, & Richardson, 2004).

The desire for social bonds is so strong that people often create relationships with fictional characters and non-living entities (Horton & Richard Wohl, 1956; Rubin, Perse, & Powell, 1985). People readily perceive and interact with computers as social actors, for example (Nass, Steuer, & Tauber, 1994). Such relationships appear to fulfill belongingness needs by acting as social surrogates, according to the *social surrogacy hypothesis* (Derrick, Gabriel, & Hugenberg, 2009; also see; Knowles, 2013). This hypothesis is based on the idea that needs can be indirectly satisfied through alternate means. For example, we can satisfy hunger without eating through the use of diet pills. Social surrogates are thought to satisfy belonging needs without establishing a real human connection. Social surrogates may be found in books, TV shows, movies, music, and video games because they approximate a social narrative that people can immerse themselves in. People then identify with characters in these media and establish a sense of connection. Primarily, social surrogacy is theorized to be motivated by human rejection as an attempt to reestablish a sense of social connection and belonging. Research indeed shows that social surrogates buffer against drops in self-esteem and increases in negative affect commonly elicited by social rejection from other people (Derrick et al., 2009; Pfundmair, Eyssel, Graupmann, Frey, & Aydin, 2015). If social surrogacy is capable of fulfilling basic human needs like belonging, however, then does surrogacy also have the same potential to cause psychological harm as human rejection? Prior research hints that harm is possible. For example, people expecting to lose a favorite TV show character anticipate that they would feel distressed, mirroring emotional reactions to social dissolutions (Cohen, 2004). Ostracism from a computer diminishes a sense of belonging and harms self-esteem (Zadro et al., 2004). However, no work has directly examined whether rejection from a social surrogate can have the same negative consequences as human rejection. This question is becoming increasingly important in our current world. A robot ‘revolution’ looms, artificial intelligence is on

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the rise, and humans increasingly use technology to satisfy social needs.

1.1. Robots are coming

Worldwide, billions of dollars are spent annually on developing robots that will care for the elderly, assist doctors in surgery, work in factories, help people shop, and fight alongside human soldiers. Prominent roboticists argue that robots will become fully integrated into society within the next few decades in what is dubbed as the ‘robot revolution’ (Ripley, 2014). Given this significant societal change, it is important to examine the impact of such technology on human cognition, affect, and behavior. Robots are often programmed with artificial intelligence to act like humans. Unfortunately, such artificial intelligence has already been shown to have harmful consequences. For example, after just a few hours online, Microsoft's ‘Tay’ bot began to espouse genocide of Jews, Blacks, and Mexicans based on social learning from other people on twitter (Owens, 2016). Similarly, Google's photo app program began to classify Black people as gorillas based on human input into the machine-learning algorithm (Crawford, 2016).

The present research, therefore, examines the impact of both social surrogate acceptance and rejection on self-esteem from a real, life-sized robot in an interpersonal context. Additionally, the present research explored whether social surrogate acceptance and rejection had a carryover effect onto more general evaluations of robots. Previous research suggests that social rejection can increase aggression toward others (e.g., DeWall, Twenge, Gitter, & Baumeister, 2009; Leary et al., 2003; Twenge et al., 2001).

In the context of human intergroup relations, research suggests that individual experiences with an outgroup member have the potential to carryover and impact global evaluations of the entire outgroup (e.g., McIntyre, Paolini, & Hewstone, 2016; Pettigrew, 1998; Pettigrew, Tropp, Wagner, & Christ, 2011). Therefore, in the current study, we explored whether social surrogate rejection and acceptance would impact more general attitudes towards robots, as measured with negative attitudes toward robots as well as support for public policies relating to the use of robots in everyday life.

2. Method

2.1. Participants

A total of 147 people from a large New Zealand university were recruited for the study in exchange for course credit or a $10 gift voucher. Our sample was collected from the University of Canterbury's psychology participant pool. In line with recommendations by Landers and Behrend (2015), our sample matches the bulk of past research on self-esteem and rejection allowing for easier comparison. Further, the effect of rejection on self-esteem from these samples is generalizable (Blackhart, Knowles, Nelson, & Baumeister, 2009). Previous studies examining the effects of social rejection used sample sizes ranging between 10 and 25 per condition (e.g., DeWall & Baumeister, 2006; Leary et al., 1995; Twenge et al., 2001; Zadro et al., 2004), Prior research demonstrates rejection has a moderate to large effect on self-esteem (Gerber & Wheeler, 2009). A power analysis based on these effect sizes in the G*power statistical package (*statistical test*: Many Groups ANOVA: One Way; *effect size* $f = 0.35$; α *level* $= 0.05$; *power* $= 0.80$; *number of groups* $= 3$) suggests a sample of 84 is needed to obtain 80% power. However, prior research also demonstrates that small differences between control conditions or rejection conditions can have a significant impact on effect sizes (Blackhart et al., 2009). Further, published research tends to inflate effect size estimates. Because of this, we followed a more rigorous heuristic from Simmons, Nelson, and Simonsohn (2013) and aimed to recruit 50 participants per condition for a sample of 150. At the end of the data collection year, we had 147 participants, of which, 6 failed the manipulation check (described below) and 2 others experienced technical difficulties during the study forcing us to cancel their sessions. Of the remaining 139 participants, 93 identified as female, 44 as male, and 2 as other. Participants were between the ages 17–46 years ($M = 20.14$; $SD = 4.30$).

2.2. Materials

Participants interacted with the Baxter robot designed by Rethink Robotics (http://www.rethinkrobotics.com/baxter/). Baxter is a 6-foot humanoid robot with a collection of integrated sensors and displays for safe interaction with humans. The robot is fitted with cameras to allow it to evaluate its surroundings and make judgments for where to move objects. Baxter was designed to handle a wide range of tasks in the manufacturing sector and is already working amongst humans in factories to complete various monotonous tasks. The robot's face itself is a screen where we installed neutral facial expressions with a periodic eye-blink. For the current experiment, the robot was programmed to play Connect 4 (Hasbro Inc.) with a participant (see Fig. 1). In addition, the robot was given speech using the IVONA voice generating program such that the participant could talk with the robot, controlled by a second experimenter, discreetly present in a neighboring control room.

2.2.1. Manipulation and procedure

Participants filled out a consent form and demographic information sheet (age, gender, nationality, education, and major) outside the main interaction room. Upon entering the room, participants were introduced to ‘Baxter’, a new member of the psychology department. Participants exchanged pleasantries with the robot, including their name, where they were from, and what they study. The robot then asked participants if they would like to play a game of connect 4 because it got bored on its own and enjoyed playing games when possible. All participants agreed to this request and were then left alone with the robot to play connect 4 while being covertly monitored by video camera (see Fig. 1). Although the video was not recorded, it was monitored to ensure participants properly interacted with the robot. The video camera was placed on the room ceiling and out of sight of the participants, while the video was streamed into the neighboring control room. Participants were only informed of the video monitoring as they were debriefed at the end of the study and were given the option to have their responses deleted if they felt uncomfortable with any aspect of the study. However, none asked to have their data deleted.

Toward the end of the game, the experimenter knocked on the door at which time the robot said: “Looks like our play-date is almost over.” The experimenter briefly informed participants that they had left a form for them on the table outside that they can complete before finding them at the end of the hallway. The game was soon completed, at which time, participants were randomly assigned to hear one of three responses from the robot: in the acceptance condition, the robot said: “That was fun, I would like to play with you again sometime” followed by “have a good day” and “goodbye”. In the control condition, participants heard “have a nice day” and “goodbye”. However, in the rejection condition, participants were told “That was boring! I don't want to play with you again” immediately followed by “goodbye”. The timing of the two statements was intentionally setup close together in this condition to sound like a dismissal. After participants left the robot room, they completed a package of questionnaires that was waiting on the table outside of the robot's room. The first measure was our

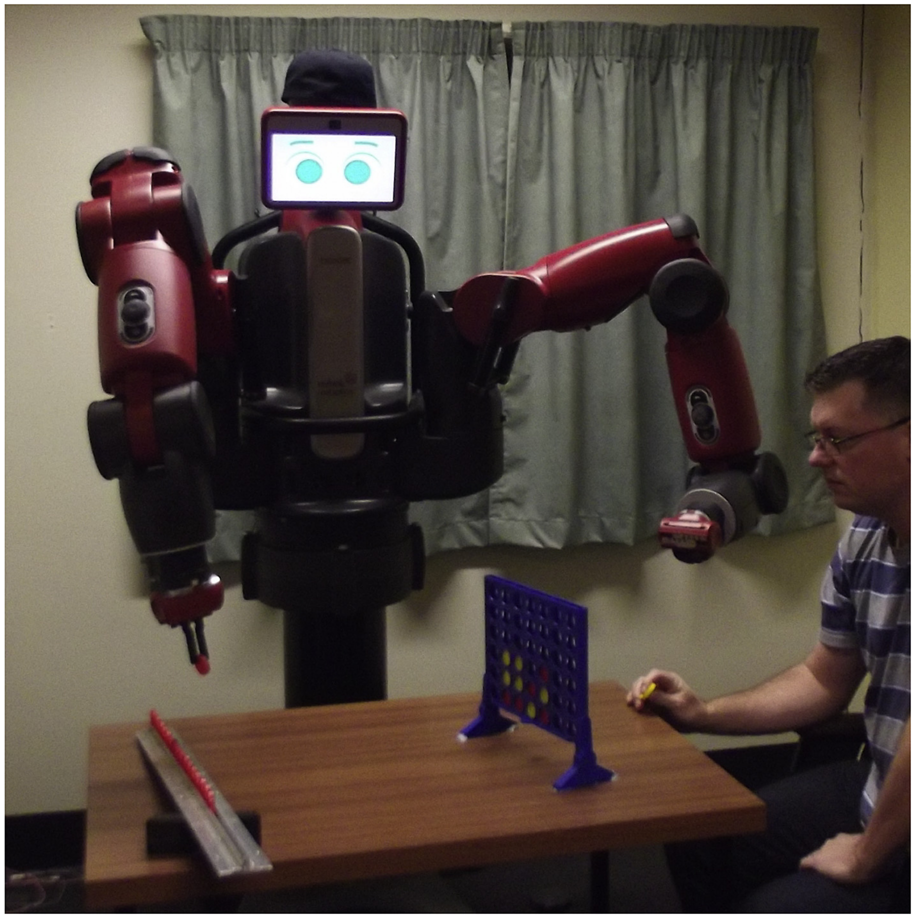

Fig. 1. Example of participant playing a game with the Baxter robot.

primary measure of interest, the Rosenberg (1986) self-esteem scale. After, participants completed measures of the degree of support for the use of robots in everyday life, policy support for an international robotics initiative and a measure of negative attitudes towards robots. After filling out these questionnaires, participants met an experimenter who asked if they would be willing to volunteer to participate in future experiments. Participants were then debriefed and thanked for their time.

2.2.2. Dependent measures

2.2.2.1. Self-esteem. The Rosenberg (1986) self-esteem scale is a popular 10-item measure of self-esteem ($\alpha = 0.90$, $M = 2.025$; $SD = 0.466$). Items were scored on a 1–4 likert scale (1 = strongly agree; 4 = strongly disagree) and included items such as "I feel that I have a number of good qualities" and "At times, I think I am no good." A number of studies have used this measure to capture fluctuations in current self-esteem (e.g., DeHart & Pelham, 2007; Niiya, Crocker, & Bartmess, 2004; see Blackhart et al., 2009; for a review of rejection and self-esteem measures).

2.2.2.2. Negative attitudes toward robots. Participants completed the 14-item measure of their attitudes towards robots (Nomura, Suzuki, Kanda, & Kato, 2006; Syrdal, Dautenhahn, Koay, & Walters, 2009). Participants indicated the extent to which they felt negatively toward robots (1 = Strongly Disagree; 5 = Strongly Agree) on the 14-item measure ($\alpha = 0.80$; $M = 2.727$; $SD = 0.525$). Sample items included: "I would feel uneasy if I were given a job where I had to use robots" and "I am concerned that robots would be a bad influence on children".

2.2.2.3. Support for robotics initiative. Using a 2-item measure adapted from previous work (Yogeeswaran et al., 2016; Zlotowski, Yogeeswaran, & Bartneck, 2017), participants were presented with a description of a new international robotics initiative to develop robots to work alongside people. Participants were told that several countries including their own were considering joining the initiative and contributing financially to the program to build next generation robots before being asked to indicate how much they (a) personally support the initiative and (b) support the allocation of tax payer dollars for such the initiative and robotics research using a 10-point Likert scale where 1 = Extremely Oppose and 10 = Extremely Favor (2 items; $\alpha = 0.75$; $M = 6.580$; $SD = 1.811$).

2.2.2.4. General support for the use of robots. Participants were also asked to indicate their more general support for the use of robots in everyday life. Using a 10-point Likert scale (1 = Extremely Oppose; 10 = Extremely Favor), participants indicated the extent to which the supported the increased use of robots in education, healthcare, law enforcement, and everyday life. Items included: "how do you feel about the increased use of robots in [healthcare/everyday life/law enforcement/education]" (4 items; $\alpha = 0.74$; $M = 6.360$; $SD = 1.695$).

3. Results

To ensure that participants heard the robot accept or reject them, all participants were verbally asked prior to debriefing what the robot had told them at the end of the game. Participants correctly identified what the robot said in all but 6 cases, leaving a sample of 139 participants (Acceptance = 48, Control = 48, Rejection = 43). A one-way ANOVA revealed a significant effect of our manipulation on participant self-esteem, $F(2, 136) = 6.526$, $p = 0.002$, $\eta^2_p = 0.088$. Planned contrasts revealed that participants who were rejected by the robot ($M = 17.372$; $SD = 4.736$) showed a significant decrease in self-esteem compared to those in the control condition ($M = 20.271$; $SD = 5.960$), $t(136) = -2.413$, $p = 0.017$, *Cohen's* $d = 0.539$, and those in the acceptance condition ($M = 21.646$; $SD = 6.259$), $t(136) = 3.557$, $p = 0.001$, *Cohen's* $d = 0.770$. However, no significant differences in reported self-esteem were found for those in the acceptance and control conditions, $t(136) = -1.178$, $p = 0.241$, *Cohen's* $d = 0.225$. Notably, post-hoc power analysis, calculated in G*Power revealed that *observed power* = 0.817 for the rejection − control contrast (*statistical test*: Means: Two Groups; *effect size* $d = 0.539$; α *level* = 0.05), and *observed power* = 0.977 for the rejection −acceptance contrast (*statistical test*: Means: Two Groups; *effect size* $d = 0.770$; α *level* = 0.05).

One-way ANOVAs revealed no significant effects of our manipulation on our measures of *negative attitudes towards robots*, $F(2, 136) = 0.867$, $p = 0.422$, $\eta^2_p = 0.013$; *support for a robotics initiative*, $F(2, 136) = 0.324$, $p = 0.725$, $\eta^2_p = 0.005$; or *general support for robots*, $F(2, 136) = 0.245$, $p = 0.780$, $\eta^2_p = 0.004$.

4. Discussion

As humans increasingly utilize technology and look to satisfy their social needs through social surrogates, it is important to understand if such technology can also negatively impact us in a similar way as human relations. With robots and artificial intelligence designed to mirror humans, there is a risk that such technology will inadvertently engage in similar actions as humans. In the current research, we examine whether social surrogate rejection or acceptance from a robot influences self-esteem, similar to research demonstrating the ill effects of interpersonal rejection from another human. After experiencing social surrogate rejection following a game with a robot, participants showed a significant decrease in self-esteem relative to receiving no feedback, and relative to being socially accepted. Being socially accepted did not increase self-esteem suggesting that there may not be an added bonus to gaining social approval from a robot.

Although the study tasks were seemingly innocuous, rejected participants were clearly upset even though they were aware the rejection was from a robot. This was evident in several cases where the participant was visibly upset after being rejected. One even told the robot to "get f***ed" as they walked out of the room. In other cases, participants showed a strong interest in scheduling another play-date with the robot that accepted them and asked the experimenter when they could come back. These anecdotes corroborate our findings which suggest that people are extremely sensitive to interpersonal rejection, even when the source is non-living. Prior research shows that interpersonal rejection has a moderate to large impact on self-esteem (Gerber & Wheeler, 2009; for conventions on judging the magnitude of effect sizes, see; Cohen, 1988; and; Murphy, Myors, & Wolach, 2014). Our current findings are comparable (Cohen's d scores = 0.539 and 0.770). Such work builds on research demonstrating that social ostracism from a computer can be harmful to the individual (Zadro et al., 2004) by demonstrating that social surrogate rejection in the context of a first-hand interactions with a human-sized robot can reduce self-esteem. This occurs even when the interaction context is intentionally designed to mirror first-time interactions similar to a first date.

Though the effect size was moderate, in the context of a looming robot revolution, designers of robots and artificial intelligences could be heedful of this potential dark side to human-robot interaction. As robots begin to take on more important social roles, such as providing company for the elderly or working in the service industry, care should perhaps be given to how robots act to avoid inducing feelings of rejection. Further, social surrogacy is driven by human rejection and loneliness (Derrick et al., 2009). Presumably, social robots will be built to provide comfort for those most in need, i.e., the lonely and disconnected. If robots inadvertently reject those who are most in need of social connection (even through social surrogacy), then a dip in self-esteem might be particularly problematic. Future research could examine these effects in vulnerable populations.

4.1. Limitations

We note certain limitations that could be addressed in follow-up study. First, though our measure of self-esteem has been used in prior research on rejection and self-esteem, state measures are typically more sensitive to context-dependent fluctuations of self-esteem (Blackhart et al., 2009). Future research could attempt to replicate our findings here using a state measure of self-esteem. Second, this experimental study could be further bolstered by future replication that seeks to establish external validity. That is, though our experimental laboratory study was well-suited to establish internal validity, it is yet unclear as to whether or not this effect would generalize to other contexts, samples, and stimuli (e.g., other robots). Third, we found that despite the fact that social surrogate rejection diminished self-esteem, it did not have a direct effect on attitudes towards robots in general. While participants may have experienced changes to their personal self-esteem and potentially displayed emotional reactions to the robot itself, these feelings do not appear to carry over into global evaluations of robots (as measured via negative attitudes toward robots measure and policy support for robotics research). This may be because people do not see robots as entitative or bonded together as a coherent unit (Campbell, 1958; Lickel et al., 2000) the way they often do with human outgroups. On the other hand, it may be that people construed the robot rejection as out of the norm for what robots are generally like (i.e., a subtype; for a review see Richards & Hewstone, 2001). Future research would benefit from closer examination into the nature of robots as social entities to better understand what aspects of human social groups may translate into human-robot perceptions.

Alternatively, perhaps the effect or rejection is only temporary and did not extend to dependent variables that came after self-esteem? Consistent with this, a recent meta-analysis demonstrates that the effect of rejection on intrapersonal variables like self-esteem is strongest on the first measure and weakest on the last measure (Hartgerink, Van Beest, Wicherts, & Williams, 2015). Future research could examine these questions directly. Finally, rejection also impacts feelings of belonging, control, negative affect, and social behavior (Williams, 2007). Future research could examine whether social surrogate rejection also extends to these outcomes. The present work provides a starting point for such future exploration.

Endnotes

1. Note that all dependent measures had skewness and kurtosis scores < 0.5, demonstrating univariate normality. All measures of attitudes towards robots were significantly correlated; *Negative attitudes towards robots* negatively correlated with *support for a robotics initiative*, $r(137) = -0.438$, $p < 0.001$; and *general support for robots*, $r(137) = -0.507$, $p < 0.001$. *Support for a robotics initiative*

positively correlated with *general support for robots*, $r(137) = -0.671$, $p < 0.001$. Though each is a separate measure from prior research, these correlations suggested to us that the measures could be combined as a general measure of attitudes towards robots. Indeed, factor analysis including these three scores reveal a single factor solution, *eigenvalue* = 2.084, *percent of variance explained* = 69.459, and reliability analysis revealed acceptable reliability, $\alpha = 0.78$. Thus we created a composite attitude towards robots score and conducted the analyses. One-way ANOVAs revealed no significant effects of our manipulation on this composite measure, $F(2, 136) = 0.469$, $p = 0.627$, $\eta^2_p = 0.007$.

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