Understanding Social Dynamics in Robot-Human Handovers Through the Lens of Expectancy Violations Theory*

Extended Abstract

Houston Claure
Cornell University
Ithaca, New York, USA
hbc35@cornell.edu

Malte Jung
Cornell University
Ithaca, New York, USA
mfj28@cornell.edu

ABSTRACT

As robots are increasingly working in collaboration with humans, it is important to understand a robot's influence on the physical task as well as its impact on the social dynamics of the team. Previous research has argued that a robot's behavior also carries social meaning, therefore we focus on the handover to understand the impact on a receiver when handover expectations are respected and when they are violated. We use expectancy violation theory to understand people's response to such violations of expectation and investigate how this impacts task completion and the experience of the task. We propose that a violation of expectation may not always lead to detrimental effects on the experience of the task but may impact the overall task completion. We aim to investigate this in the context of a handover due to its significant importance in human-robot collaboration. We present a theoretical framework, study design, and a discussion that aims to examine the implications of this work.

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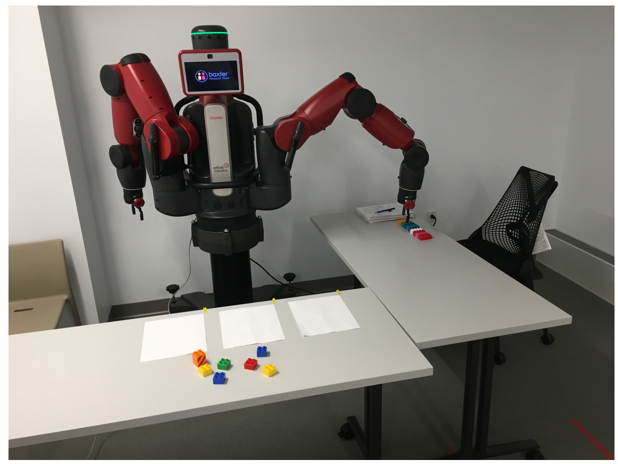

Figure 1: A visualization of the study workspace.

1 INTRODUCTION

Expectancy violations theory [1] explains an individual's expectations about nonverbal behaviors and the effects of violating such expectations. The theory posits that violations of these expectancies result in change in arousal which then leads to the following: valenced evaluations of the communicator, an interpretation of the implicit messages of the violating act, and an effort to understand the overall act. Furthermore, expectancy violations theory posits that not all violations of expectations will have negative communication outcomes. We posit several reasons why this theory could be a lens through which we could understand the nonverbal communication that is rife in a popular area of robotics, the handover. First, research on handover behaviors has shown that people have predetermined expectations of handover motion [8]. Second, current handover literature aims to find the most optimal or efficient handover, we argue that unexpected movements or trajectories from the robot are not always detrimental for the receiver. Third, we argue that changes in arousal due to violations of expectations can have different effects on the task experience as well as task completion during a collaborative task.

The elementary action of the handover is an important yet complex part of interactions between a human and robot in a joint activity. This shared activity requires coordination and communication—implicit or explicit—to change the possession of an object. Works by Knepper [8] and Dragan [5] have investigated the implicit or communicative aspect of a handover and there is an extensive amount of research looking into the orientation [10], velocity [7], and fluency [2], or the functional aspect of the handover. Taken together these studies demonstrate that people have expectations of the functional aspect and the communicative aspect of a handover. These works also make the assumption that the ideal handover must follow human expectations. For example, Cakmak et al. [3] states that possible inefficiency or unpredictable movements must be eliminated in handovers. Furthermore Dragan et al. [5] differentiates between predictability and legibility and the importance of clear actions for effective human-robot collaboration.

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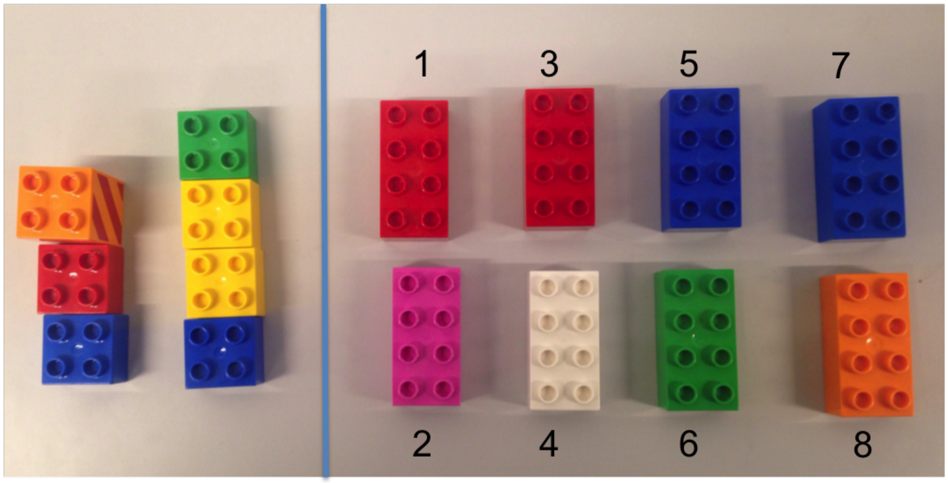

Figure 2: Blocks on the left of the line were initially provided to participants. Blocks on the right where handed in ascending order.

Figure 3: We hypothesize that a violation of expectancy will affect the overall performance.

While aiming for developing predictable and efficient handover motions is a very respectable goal, we argue that unexpected movements or violations of expectations may not always be detrimental. We propose a study that examines the impact of expectancy violation during a handover. Specifically, we use the context of a collaborative task and investigate the effects of the violation on the overall performance and experience of the task. As shown in Figure 3, we hypothesize that a violation of expectancy will cause an arousal and have a negative effect on the performance of the team. We also hypothesize that participants may not interpret the violation of expectation negatively.

2 METHODS

This study will focus on the effects that respecting or violating expected handover distance has on the participant and their assembly completion times.

Conditions: We looked at the various social distances defined by Hall [6] and results from Koay [9] to choose two handover distance conditions: respect (handover occurs 0.47 m from the person's torso) and violation (handover 0.17 m from the person's torso). The study will leverage a within-subject and alternating-order design. We will ask participants to complete a building task where they will use various blocks on the table in combination with blocks given by Baxter to complete three unique assemblies.

2.1 Design

Participants will be asked to complete a building task where they will use various blocks on the table in combination with blocks given by Baxter to complete three unique assemblies. Each assembly requires two or three blocks from Baxter and two or three blocks from those initially provided to the participant. Figure 1 shows a visual of the workspace where participants will stand behind the table facing Baxter. Baxter is controlled via Wizard of Oz by an operator not visible to the participants and will grab and handover blocks that are inaccessible to the participants. Figure 2 shows the blocks that will be laid out when the participants enter the room as well as the blocks that Baxter will pass to the participants. Figure 4 shows the various assemblies participants will have to build. A total of eight handovers will occur per assembly task study.

2.2 Baxter Robot

Baxter was developed by Rethink Robotics and has been used in various industrial settings. Baxter has a humanoid design, with a screen for a face and two arm manipulators each with 7 degrees of freedom. The Baxter's face will be turned off to avoid any effects that the robot's gaze could contribute during a handover.

2.3 Participants

We will recruit 30 healthy participants from the local Ithaca community who are over 18 years old.

2.4 Measures

We will investigate participant's reactions to having their expectations violated and its impact on overall performance through subjective and objective measures. The Robotic Social Attributes Scale (RoSAS) [4] will be given for participants to complete prior the experiment as well as after. Questions that gauge the participant's level of arousal will also be given after the experiment. This questionnaire is used to obtain people's perception of warmth and competence of the robot as well as obtain a measure of their discomfort.

Warmth: Six items pertain to participant's impression of the robot's warmth. These factors include: feeling, happy, organic, compassionate, social, and emotional.

Competence: Six items pertain to the participant's perceived intelligence of the robot. These factors include: knowledgeable, interactive, responsive, capable, competent, and reliable.

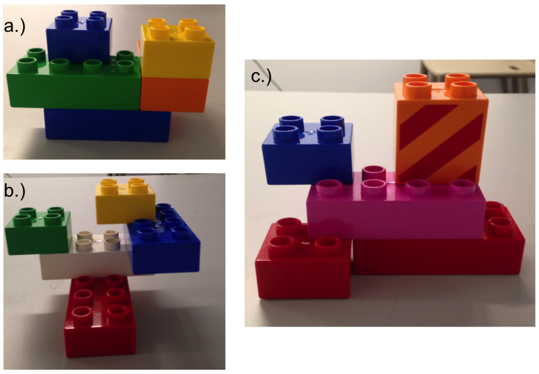

Figure 4: Measuring discomfort in participants across the three zones.

Discomfort: Six items pertain to the participant's feelings of discomfort. These factors include: aggressive, awful, scary, awkward, dangerous and strange.

Arousal: Two items pertain to the participant's feelings of arousal. These factors include: credibility and expectancy.

Performance: The overall time to complete all three structures will be measured as well as the time it takes to complete each individual structure.

3 DISCUSSION

The output of this study will illuminate several key points. First, we look to demonstrate that violations of expectations may not always be detrimental to the human-robot team. Second, our study will give a better insight into whether expectancy violation theory is applicable to human robot teams. To our knowledge, this theory has not been investigated in the field of human robot interaction(HRI) and thus could be impactful to the field. Third, this study will have many design implications and could be used as a framework for further developing behaviors in various contexts.

People have different expectations of behaviors in various contexts and environments. Programming a different behavior for every situation could be a cumbersome and unrealistic task due to the large number of variables present in every environment. By demonstrating that some actions, although they may violating expectations, could still be perceived in a positive manner would give a larger range of flexibility to programming different behaviors. For example, a robot that accidentally gets too close and touches you while trying to navigate through a crowd might not always be perceived as threatening or unsafe. This gives more flexibility to the computer scientist working to develop an object avoidance algorithm in a particular environment.

Furthermore, long term studies must be investigated to understand how expectancies change over time. This would be important to develop behaviors for robots who must also adapt and change their behavior over time as well. Doing such long term studies would be impactful due to the predicted future work environment which will see robots and humans working together for long periods of time.

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