APPLYING THE APPRAISAL THEORY OF EMOTION
TO HUMAN-AGENT INTERACTION

by

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Modeling and Simulation
in the College of Sciences
at the University of Central Florida
Orlando, Florida

Summer Term
2007

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ABSTRACT

Autonomous robots are increasingly being used in everyday life; cleaning our floors, entertaining us and supplementing soldiers in the battlefield. As emotion is a key ingredient in how we interact with others, it is important that our emotional interaction with these new entities be understood. This dissertation proposes using the appraisal theory of emotion (Roseman, Scherer, Schorr, & Johnstone, 2001) to investigate how we understand and evaluate situations involving this new breed of robot.

This research involves two studies; in the first study an experimental method was used in which participants interacted with a live dog, a robotic dog or a non-anthropomorphic robot to attempt to accomplish a set of tasks. The appraisals of motive consistent / motive inconsistent (the task was performed correctly/incorrectly) and high / low perceived control (the teammate was well trained/not well trained) were manipulated to show the practicality of using appraisal theory as a basis for human robot interaction studies. Robot form was investigated for its influence on emotions experienced. Finally, the influence of high and low control on the experience of positive emotions caused by another was investigated.

Results show that a human – robot live interaction test bed is a valid way to influence participants’ appraisals. Manipulation checks of motive consistent / motive inconsistent, high / low perceived control and the proper appraisal of cause were significant. Form was shown to influence both the positive and negative emotions experienced, the more lifelike agents were rated higher in positive emotions and lower in negative emotions. The emotion gratitude was shown to be greater during conditions of low control when the entities performed correctly,
suggesting that more experiments should be conducted investigating agent caused motive-conducive events.

A second study was performed with participants evaluating their reaction to a hypothetical story. In this story they were interacting with either a human, robotic dog, or robot to complete a task. These three agent types and high/low perceived control were manipulated with all stories ending successfully. Results indicated that gratitude and appreciation are sensitive to the manipulation of agent type.

It is suggested that, based on the results of these studies, the emotion gratitude should be added to Roseman et al. (2001) appraisal theory to describe the emotion felt during low-control, motive-consistent, other-caused events. These studies have also shown that the appraisal theory of emotion is useful in the study of human-robot and human-animal interactions.
I dedicate this work to my parents.

Their faith and support has allowed me to reach
greater heights than I ever thought possible.

Thank you.
ACKNOWLEDGMENTS

The author wishes to thank the committee members, Dr. Valerie Sims, Dr. Mathew Chin, Dr. Peter Kincaid, Dr. Brian Goldiez and Dr. Donald Jones, whose direction and support made this work possible. The patient guidance they provided, as well as the time and effort they contributed, are truly appreciated.

The author also wishes to acknowledge the efforts of the principle research assistants, Scott DaPra and Stephanie Colombo whose assistance with data collection and coding made a significant contribution to this research.

Thanks also to Jennifer M. Ross for her help and support.
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CHAPTER ONE: INTRODUCTION

Emotion plays a central role in how we interact and perceive the world around us. Evolution has provided us with an emotional processing system which allows us to prepare the body for action. It coordinates many aspects of our physiological and perceptual abilities that enable us react to events in a quicker fashion than our conscious ability allows. Our cognitive, rational processes influence our emotional system and vice versa. Experience allows us to reign in our evolutionary nature when appropriate, while still allowing emotion to enable us to react to novel situations and events. The coordination of the autonomic nervous system by emotion can be measured by the changes in our facial, physiological, vocal and subjective experience. The investigation into the causes of our emotional reaction has led researchers to hypothesize that emotion is activated by our appraisal of the situation or event. This appraisal theory of emotion proposes that it is not the situation or event itself which causes our emotional reaction, but our conscious and unconscious evaluation of the event. By investigating which appraisals are most important for emotional reaction, we come to understand a vital part of our interaction with the world around us. In the near future, an interaction which we will have more often is that of humans and autonomous robots. Few experimental studies have been conducted on this new type of interpersonal relationship. The appraisal theory of emotion has always assumed that when an emotional reaction is elicited do to a situation caused by another, that the instigator is a human. However, this theory is a good candidate to provide insight into human reaction to motive relevant events caused by an autonomous robot.
Autonomous robots are increasingly being used in everyday life: cleaning our floors, entertaining us and supplementing soldiers in the battlefield. As emotion is a key ingredient in how we interact with others and situations, it is important that our emotional interaction with these new entities be understood. One way of accomplishing this goal is using the appraisal theory of emotion to understand how we evaluate situations caused by this new breed of robots. One important appraisal that we make is that of agency. We evaluate whether we caused the situation, the environment (or processes beyond our control) caused the situation, or someone else caused the situation. It has always been assumed in appraisal theory that the someone else is human. One of the key goals of this dissertation is to attempt to verify if appraisal theory’s “someone else” can also be applied to an autonomous robot as the cause of the situation. If this is indeed correct, then the appraisals that are used by us to understand the world around us can be used to understand human-robot interaction.

Using live interaction is a relatively new method of investigating the appraisals that we make, but is necessary to fully understand the nuances of interaction. The live test bed created in study one, using appraisal theory as a basis, will allow the investigation of a number of factors. For instance, one important aspect of interaction with robotic entities is robotic form. One goal of this dissertation is to investigate if different types of robots cause us to alter the way in which we react emotionally to the interaction. In addition, positive emotions caused by the actions of someone else have only been briefly investigated. To fully understand our emotional experience during human-robot interaction it is important to understand not just the negative reactions of individuals but to comprehend the positive emotional aspects as well.
The appraisal theory of emotion is a good candidate to experimentally explain the emotional reactions of humans to their interaction with robots. By combining appraisal theory with robot research, a more systematic investigation can be undertaken to explain the emotional reaction occurring when humans and robots interact. In study one participants interacted with agents in a live setting while completing a series of tasks, while in study two participants read a hypothetical vignette in which they imagined themselves as the protagonist completing a task with an agent.

**Goals**

1. Create a test bed to evaluate emotional reaction of humans during human-robot interaction.
2. Use appraisal theory as a framework to influence emotions toward an agent in a live experimental situation.
4. Investigate positive emotions during human-robot interaction.
5. Conduct an experiment using a hypothetical story to elicit stronger reactions and allow the addition of a human agent as the instigator.

**Overall Hypotheses**

1. Emotions predicted by appraisal theory will be invoked by the agent.
2. Agent form will influence the strength of emotional reaction.
3. There will be a significant difference in the positive emotions during high- and low-control conditions while in the motive-consistent (the task was performed successfully) condition.

The first section of the literature review focuses on the importance of emotion in the everyday functioning of human experience. The second section looks at appraisal theory and the evidence that this can explain the emotional reactions of individuals to situations and events. The
third part of the literature review looks at some of the previous work that has been performed on social interaction between humans and robots.

CHAPTER TWO: LITERATURE REVIEW

What is Emotion?

Affective responses, such as emotions, feelings and moods, allow the mobilization of the body’s resources to deal with situations, events and “others” that may bring us harm or benefit (Cacioppo, Gardner, & Berntson, 1999). It is assumed that evolution has played a role in the development of emotions, given their integrated nature in which how react to the world around us (Darwin, 1872). Not only do emotions prepare us for action, but they also provide a strong social function as well (e.g., giving others clues as to our present state) (de Rivera & Strongman, 1992). Emotion, as experienced by humans, is a fleeting affective response that is immediate and stronger than the other affective responses. Moods, for example, are not as acute and persist for longer time frames (Scherer, 2003). Though not directly observable, emotion can be inferred from several indicators, including behavior, physiological changes and subjective evaluation. Emotions can vary in intensity across all three of these indicators, though it is assumed that behavior and subjective evaluations are highly correlated (Ruch, Ekman, & Rosenberg, 2005).

It must be understood that though we describe our emotional experience with words, the feeling of “anger” is a neurobiologically based, multifaceted concept, where our conceptualization of “being angry” is simply our way of understanding and categorizing our
experience. As Barrett, Mesuqita, Ochsner, and Gross (2007) point out, “emotion words are not the names of things—rather they demarcate mental representations that are constituted as feelings of pleasure or displeasure and socially situated conceptualizations of emotion.” Humans are very good at labeling chunks of information into easy-to-understand categories. However, since this dissertation focuses on an experimental method of evaluating human-robot emotional interaction, we shall use these commonly accepted terms and categories as it eases the discussion and provides the most practical way (at the moment) of investigating human robot emotional interaction.

The next sections of this dissertation will describe research on emotion and giving a general background to aspects which are relevant to this discussion. First, I will describe the relationship between emotion and cognition. Second, I will describe categories of emotions that are universally recognized. Next, I will explain the negative event bias that our experience of emotion seems to follow and the symptoms of emotion. Finally, I will lead into the appraisal theory of emotion, which guides the experimental design.

**Emotion and Cognition**

Phelps’ (2006) overview of the relation between emotion and cognition is divided into five topics: emotional learning, emotion and memory, emotion’s influence on attention and perception, processing of emotional stimuli and changing emotional responses. Her discussion of emotional learning focuses on fear, namely that of fear conditioning to negative stimuli. A direct link has been discovered between the emotion of fear and the involvement of the
amygdala. The fear emotion evoked through negative reinforcement with painful stimuli is also involved in social conditioning and cultural learning.

Emotion influences the saliency of a stimulus, leading to increased encoding of the experience. Consolidation of the memory increases and recall of an emotional event is augmented as well. The initial saliency of the event is strongly tied to the perception of the stimulus. Anderson’s experiment (2005) showed that the well-documented “attentional blink,” (in which one stimulus is rapidly followed by a second stimulus, leading the second stimulus being unperceived) was overcome when the second stimulus was of great emotional value. This shows emotional significance can shape our perceptual experience.

In changing emotional responses, research is discussed that shows that emotional processing of stimuli occurs irrespective of attention and awareness. Studies in nonhuman animals have shown a separate brain pathway that processes the emotional impact of a situation before perceptual functions. These findings would suggest that emotional processing may happen before perception. However, it also has been shown that conscious attempts to reduce the impact of emotional stimulus are effective, which shows an influence of cognition over emotion. An example is the study by Ochsner, Bunge, Gross, and Gabrieli (2002) in which participants look at a picture of a women crying outside of a church. The common reaction is to interpret the situation as a woman saddened by a funeral. However, by suggesting that she is crying out of joy during a wedding, participants experienced less amygdala activation under an fMRI. While routinely represented as dual systems, with emotion on one hand and cognition on the other, at a fundamental neurological level, emotion and cognition are integrated together in a way that influence each other.
Negative Event bias

Research has shown that negative information is processed more immediately than positive information (Pratto & John, 1991). This focus on negative information is hypothesized to occur due to evolutionary pressure. Negative information has a much greater urgency to the individual, as it may require an immediate response, and will cause the individual to pause in order to evaluate this critical stimulus. While positive stimuli may be important in the long run, humans have more time to process positive events, and therefore do not need to deal with it immediately. In their experiment, Pratto and John (1991) found that color-naming latencies were consistently longer for blocks with text of undesirable traits because the negative traits attract more attention. Another example is a study by Schimmack and Derryberry (2005) in which they found that strong unpleasant stimuli caused longer reaction times in a study that had participants perform math problems while trying to ignore unpleasant pictures. Negative events also occur less frequently than their positive counterparts. All-in-all, daily life is a sequence of positive events. A bias toward the perception of negative events, therefore, would be expected given the importance of identifying negative events and heading them off.

Rozin and colleagues (Rozin et al., 2003; Rozin & Royzman, 2001) define the tendency to focus on negative events as “negativity bias,” which entails four aspects. First, negative potency occurs when positive and negative events are put on the same scale, the negative will be viewed as more extreme. Second, negative dominance takes place when negative and positive events are combined and the outcome is usually negative. The third is negative gradient dominance, which states that negative events grow more negative as temporal and spatial
proximity increases faster than positive events become more positive. Lastly, greater negative differentiation, occurs where negative emotions are more differentiated and varied.

Symptoms of Emotion

Individuals experience emotion as a set of five symptoms (Roseman, Smith, Scherer, Schorr, & Johnstone, 2001). These symptoms provide guidelines to the areas in which measurement of emotions may be performed. The first is Phenomenology - thoughts and feeling qualities, which may be measured by subjective questionnaire. The second is Physiology - neural, chemical, and other physical responses in the brain and body, which may be measured by physiological data collection, such as Electroencephalogram (EEG), Electrocardiogram (EKG) and galvanic skin response (GSR). The third is Expressions - facial, vocal, and postural signals of emotion state, which may be measured by methods including vocal analysis and facial action coding (Cohn, Ekman, Harrigan, Rosenthal, & Scherer, 2005). The fourth is Behaviors - action tendencies or readiness. The fifth is Emotivations – emotional motivations, conceptualized as characteristic goals that people want to attain when the emotion is experienced. Taken together, this set of responses forms an integrated emotional response system (Roseman, Smith, Scherer, Schorr, & Johnstone, 2001). This emotional response system follows the notion that emotions, far from being irrational and not useful, provide a method to activate and coordinate the body’s resources and allow an effective response to a situation.

The following sections will describe further the facial, vocal and physiological findings of emotion research, as well as a discussion about subjective methods of data collection.
Facial Aspects of Emotion

Research has shown that at least seven distinct emotions are easily recognized in static images of people’s facial expression across cultures and countries around the world. The most commonly identified emotions in such research are anger, disgust, fear, happiness, sadness, surprise, and contempt (Ekman, 1993). While these are identifiable in static investigations, temporal analysis of gaze, head movement, and posture have shown to convey specific emotional expressions for embarrassment and shame, sympathy and love (Keltner et al., 2003). Emotions have generally been defined and categorized based on those available for facial display. This categorization does not negate the possibility of other emotions involving complicated emotional states may not have an individually identifiable facial expression.

The majority of early work in the field of facial expression of emotion was done by Paul Ekman. The research on cross-cultural facial expression of emotion has shown that pictures of faces displaying emotions can be identified even in preliterate societies with no exposure to media (which may have influenced their naming of display) (Ekman, 1993). Ekman’s Facial Action Coding System (FACS) identifies movements of muscles in the face, which account for varying emotion expression and provide a way to measure and discuss the topic (Ekman, Friesen, Ancoli, & Parrott, 2001). Coding is done with action units, where singular muscles may have multiple action units and two or more muscles working together may have an action unit. Below are two pictures, Action Unit 0 – neutral (see Figure 1) and Action Unit 1 – the Inner Brow Raiser (see Figure 2).
Using the FACS system, it is possible, for instance, to identify a particular type of smile (in reaction to experimental stimulus) that related to dimensions reported by a subset of the experimental group. Researchers were also able to identify the intensity of happiness and the two happiest participants (Ekman, Friesen, Ancoli, & Parrott, 2001).

Physiological Aspects of Emotion

The autonomic nervous system (ANS) influences many bodily systems, including heart rate, digestion, respiration rate, salivation, perspiration and diameter of the pupils (Levenson, Ekman, Campos, Davidson, & de Waal, 2003). This may be without conscious thought, such as body temperature regulation, or the ANS may be influenced by conscious thought, such as breathing. The ANS is comprised of two branches; the parasympathetic nervous system, which is primarily involved in relaxation, and the sympathetic nervous system, which causes the body to become more active, as in the fight-or-flight response. Emotions play a large role in the
functioning of the ANS. A review by Levenson, Ekman, Campos, Davidson, and de Waal (2003) lists six aspects of the ANS where emotions are integral: emotional activation, subjective emotional experience, positive emotion, autonomic expression, emotional contagion and empathy, and emotion regulation. The three most relevant to the current studies will be described further below.

*Emotional activation* is the coordinated launch of ANS systems to respond to a wide range of situations, such as fighting, fleeing, or relaxing. Why generally this is a reactionary system in which the emotional activation takes place do to an external stimulus, it can also work in a reverse manner, where a person simulating a physiological response can cause the actual physiological symptoms. An experiment by Levenson, Ekman, and Friesen (1990) guided participants in creating faces typical of emotions and measured physiological signals showing that merely producing the face of the emotion caused a similar response to an emotion generated due to an external stimulus.

*Emotional contagion* allows the activation of emotion to be passed to others. This passing of emotions serves a number of functions, such as alerting, calming, and empathizing (Levenson, Ekman, Campos, Davidson, & de Waal, 2003). Researchers describe the purpose of emotional contagion as a way of allowing a group to function effectively as a team, mobilizing for attack, or in the case of laughter and signs of positive emotion, allowing the group to relax.

While *positive emotion* has not received nearly as much attention experimentally as the fight-or-flight type negative responses, it plays a very important role in the deactivation of the ANS. In a study, participants were shown two video clips with a baseline cardiovascular response taken beforehand (Fredrickson & Levenson, 1998). The first video clip invoked fear,
while the second video clip was either neutral, positive, or negative. The positive video clip, inducing either amusement or contentment, provided a much faster return to baseline cardiovascular response than the neutral clip.

There are few studies in which physiological responses are measured while investigating the appraisal theory of emotion, however Van Reekum and colleagues (2004) studied the physiological responses to experimentally manipulated appraisal dimensions in a video game. Goal conduciveness (achieving or failing at a goal) and intrinsic pleasantness (the innate goodness of the stimulus) were manipulated by measuring physiological response after positive (gaining a level) and negative (losing a life) events, as well as playing a pleasant or unpleasant tone during each event. Goal conduciveness was shown to produce reliable changes in ANS activity. Intrinsic pleasantness, however, did not show significant results. One explanation would be that intrinsic pleasantness is not a valid appraisal and would not invoke an emotional response by itself. However, since this study was one of the first to manipulate appraisals in an experimental setting, the stimulus of pleasant and unpleasant may have been insufficient to activate an ANS response. The use of sound could have been an ineffective way of manipulating the variable.

Vocal Aspects of Emotion

While related to the physiological expression of emotion because of the influence that the ANS may have over the vocal tract, tense situations may constrict the vocal tract causing a higher vocal pitch for instance, the voice also incorporates social aspects of emotional
communication. Scherer (2003) argues in his review of emotional vocal research that the Brunswikian lens model (see Figure 3) is the proper way to represent the aspects of emotional vocal communication. The model starts with the sender encoding the speech produced. The emotional state of the person will alter the speech patterns. This is caused by ANS coordinated physiological changes such as altered respiration, phonation, and articulation.

![Figure 3: A Brunswikian lens model of the vocal communication of emotion (Scherer, 2003).](image)

These emotionally altered speech patterns are then transmitted to the receiver, who interprets the emotional cues and applies an interpretation. Each step along the way provides aspects amiable to research: how the emotion is encoded, how it is transmitted, how it is received, and how it is interpreted.
Scherer (2003) further discusses the methods by which each of these steps has been studied. Of particular interest to this study are the methods of getting vocal patterns to study. He describes three methods: the analysis of natural vocal expression (e.g. analyzing recordings of pilots in dangerous flight situations), induced emotion (creating an experimental situation in which to prompt emotional expression), and simulated vocal expression (where actors produce emotional dialog based on emotion categories). The most commonly studied vocal measure is fundamental frequency, which measures the movement of vocal folds, which vibrate during phonation. The rate of vibration directly corresponds to the fundamental frequency ($F^0$), and is highly correlated with the perception of pitch (Russell, Bachorowski, & Fernandez-Dols, 2003).

Fundamental frequency has been identified in appraisal theory of emotion experiments to change with aspects of control (Scherer, 2003). During high-control situations, fundamental frequency and amplitude (what we perceive as loudness) increase, while in low-control situations fundamental frequency is low and with a restricted range, also with low amplitude.

The results of studies conducted on vocal correlates of emotion have been investigative in nature with no particular hypothesis on the directionality of the vocal measures. However, results have shown so far that the greatest correlation of vocal aspects to emotion is due to arousal level (Russell, Bachorowski, & Fernandez-Dols, 2003). According to Roseman et. al. (2001), people who experience high control situations are in a position to act. Therefore the arousal level of the person is higher due a preparation of response. In a low control situation there is little a person can due to influence the situation so a conservation of resources (low arousal) is the best course of action. Likewise in a motive-inconducive environment (goals are not being met) the person in question would experience high arousal in order to be prepared to rectify this negative state. In a
motive-conducive situation, a person would be achieving their goals and therefore the conservation of resources (low arousal) would be the best course of action in case situations arise in the future that would require action. The increase in pitch (related to fundamental frequency) and loudness (related to intensity) have both been shown to be indicators of higher arousal (Russell, Bachorowski, & Fernandez-Dols, 2003).

The appraisal theory of emotion has had experimental success using vocal measurements to judge the effect of manipulations. In Johnstone, van Reekum, Hird, Kirsner, and Scherer’s (2005) experiment, they used a video game to elicit affective speech by manipulating a set of appraisal values. They found that mean energy, fundamental frequency, utterance duration, and the proportion of the utterance that was voiced, varied with goal conduciveness. They also discovered that spectral energy distribution was affected by pleasantness, and pitch dynamics affected by an interaction of both.

In earlier studies by Johnstone and Scherer (1999), another computer game was used to influence emotional appraisals. During appraisal events, they had their participants say the phrase “At this moment I feel _____” and used this to measure vocal qualities. They found fundamental frequency range to be to be higher under low-coping manipulations with slower articulation of the phrase in the low-coping and obstructive manipulations.

Self Report

Often the best information gained, and easiest way to collect it, is asking people how they feel. Studies of the appraisal theory of emotion often ask the participants to state the emotion that they are experiencing, as well as rating predicted emotions on a scale. Other methods involve the
use of cartoon characters with the participant moving a slider to show the amount in which they feel the cartoons’ emotional expression (Johnstone, van Reekum, Hird, Kirsner, & Scherer, 2005). The ability to measure subjective emotional experience during an experiment is limited to a short report allowing for high repetition during the experiment. However a longer emotional report usually given at the beginning or end of an experiment is the Positive and Negative Affect Schedule (PANAS) state measure (Watson, Clark, & Tellegen, 1988), which uses a 20-item rating measurement to score a level of Positive Affect and Negative Affect.

Types of Emotion Theories

One of the most contentious issues in emotion research is how emotions should be represented and conceptualized. The two main types of theories involve a categorical approach or a dimensional approach. The categorical approach divides emotions into distinct terms (such as happiness or anger). There has been much research on the reliability of individuals to judge the emotional state of others using facial characteristics and vocal characteristics. Subjectively, our experience of emotion is characterized by categories, such as happy or sad. The second approach is the dimensional approach in which emotion is conceptualized as running on one to three continuous variables, such as the two common variables Valence (positive and negative) and Activation (high energy and low energy). While in categorical emotional theory someone might be referred to as experiencing happiness, in dimensional emotional theory the person would be represented as experiencing a positive emotion with high energy.
The Appraisal Theory of Emotion

Appraisal Theory is a cognitive theory of emotion. Appraisal theorists (Oatley & Johnson-Laird, 1987; Ortony, Collins, & Clore, 1988; Roseman, Scherer, Schorr, & Johnstone, 2001; Scherer, Schorr, & Johnstone, 2001; Smith & Lazarus, 1993) claim that emotions are elicited by evaluations (appraisals) of events and situations and not the events or situations themselves. The goal of appraisal theorists is to discover the variety of evaluations that are integral to the wide range of emotions experienced. Appraisals are carried out on events and situations that are deemed motive-relevant (i.e., that have some effect on the individual’s needs or goals). These appraisals produce emotional episodes which lead to adaptive action or internal adjustment.

Roseman and Smith (2001) give three reasons in support of the Appraisal theory over other theories of emotional expression. First, it accounts for the differentiated nature of emotional response. Dimensional theories of emotion, using variables such as arousal and valence, cannot explain the reliable cross-cultural distinction between discrete emotions, including those shown in studies such as Eckman, Sorenson, and Freisen’s (1969) work on cross-cultural facial emotion recognition -- if the experience of emotion is dimensional then they should describe the facial expression in terms of dimensional constructs. Second, appraisal theory explains the individual and temporal differences in emotional response. The same situation may evoke a different emotional reaction for different observers. Also, the same person may experience a different emotion over time as his/her view of the situation changes. This is a difficulty for theories of emotion that rely on the event itself to produce the emotion. Finally, the range of situations that evoke the same emotion (a person can experience anger in response to
different events) can be explained by appraisal theory. Each separate event would involve the same appraisals. Any time a set of appraisals is made, it will always produce the same emotion, regardless of the situation.

Methods used to Study the Appraisal Theory of Emotion

Appraisal theory has used three main types of studies to investigate the underlying causes of emotional reactions (Roseman, Smith, Scherer, Schorr, & Johnstone, 2001; Schorr, Scherer, Schorr, & Johnstone, 2001). The first is vignette research, which has participants read short emotion-eliciting stories. Readers discuss how they would have felt if they were in the situation of the protagonist. The content of the stories is systematically varied to produce different appraisals and, therefore, different emotions. The second type used in appraisal research is the retrospective study. Participants are encouraged to remember an emotional episode in their past, then describe and answer questions about their emotional experience. The third type is the experimental study. Events are manipulated in a controlled environment, and emotions and appraisals are measured at the moment of occurrence.

While in the past, vignette and retrospective studies have formed the backbone of appraisal theory, an increasing number of studies have been conducted using the experimental paradigm. These have been performed using confederates to manipulate the situation (Roseman & Evdokas, 2004) or simulation, where emotional episodes experienced during key moments of a video game (e.g., finishing a game level or losing a life) are measured, both for their physiological (van Reekum et al., 2004), and vocal aspects (Johnstone, van Reekum, Hird, Kirsner, & Scherer, 2005).

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Types of Appraisal Theories

There are three aspects on which appraisal theorists base their models (Roseman, Smith, Scherer, Schorr, & Johnstone, 2001). The first is structural- versus process oriented. The structural models look at and define the factors (appraisals) that cause certain emotions, (Roseman, Scherer, Schorr, & Johnstone, 2001). Process-oriented models seek to understand the neurological process that generates these appraisals and subsequent emotional reaction (see (Scherer, Schorr, & Johnstone, 2001)). The next aspect (Roseman, Smith, Scherer, Schorr, & Johnstone, 2001) is fixed- vs. flexible-appraisal order. Fixed-appraisal models assume appraisals operate in a single order, investigating whether prior appraisals are needed for the next appraisal in line to be judged. Flexible-appraisal models propose that each appraisal can be made regardless of what previous appraisals were made. Finally, they mention continuous vs. categorical aspects of emotion. Categorical discriminations assume there are a finite number of emotions that can be generated from a limited number of appraisals. Continuous discriminations assume that there are an infinite number of emotions that can be generated. Roseman’s (2001) model looked at appraisals in a structural manner (he seeks to identify distinct appraisals which determine the emotional outcome), which can occur in a flexible order (the appraisals do not have to take place one after another), while being elicited in a categorical manner (He predicts a finite number of distinct emotional outcomes). However, he postulated that appraisals may be on a continuum in which a dividing line is drawn in order to determine the proper categorical appraisal. For instance, while perceived control can encompass a wide variety of situations from low through high, he assumes that in the end we determine that we are either in a low or high control situation.
Roseman’s Appraisal Theory of Emotion

This dissertation uses Roseman’s theory of emotional appraisal (Roseman, Scherer, Schorr, & Johnstone, 2001). It is conceptually well developed, is based on empirical data, has changed over the past 20 years to incorporate the results of new studies and provides easily testable hypotheses. It provides the ideal method of creating a test bed to investigate the emotional interaction between human and robot.

The Development of Roseman’s Theory

Roseman’s appraisal theory of emotion has been developed over a sequence of experiments. Successive studies have seen a change in method and in the content of the appraisals included in the theory. His initial dissertation research observed that emotions can be accurately predicted from a dichotomous key of five criteria: Motivational State, Situational State, Probability, Legitimacy, and Agency (Roseman, 1983, 1984). Initial tests of his hypothesis involved a vignette methodology where participants were given multiple stories (in which appraisals were manipulated). Participants were instructed to evaluate the stories as if they were the lead character. These initial experiments led Roseman to conclude that appraisal theory could legitimately explain emotional reaction and further refined his theory. Roseman’s next group of studies switched to a retrospective method in which participants recalled emotional events in their lives. He further refined his theory to predict a total of 17 different emotions evaluating not only his own theory but also the hypothesized appraisal of others (Roseman, Antoniou, & Jose, 1996; Roseman, Wiest, & Swartz, 1994).
Roseman’s recent studies have shifted to an experimental methodology to test out his theory in an applied setting. The first study varied appraisals of motivational state (relating an event to appetitive vs. aversive motivation) and outcome probability (certain vs. uncertain) (Roseman & Evdokas, 2004). Participants in the appetitive (pleasure-maximizing) group were told that they would be in one of two groups, one of which would receive a pleasant taste and the other group would get a tasteless solution. Half of these were later told that they would definitely be receiving a pleasant taste (Obtain-Pleasant Certain appraisal condition) and the other half were led to believe they would probably be in the pleasant-taste group (Obtain-Pleasant Uncertain appraisal condition). Participants in the aversive (pain-minimizing) group were told they would be in either a no-taste group or an unpleasant-taste group. Half then learned that they would either definitely be in the no-taste group (Avoid-Unpleasant Certain appraisal condition) while the other half were told they would probably be in the no-taste group (Avoid-Unpleasant Uncertain appraisal condition). The results of this study indicated that high levels of joy were experienced in the appetitive motivational state rather than the aversive motivational state. Avoidance of the aversive motivational state led to relief, and when participants perceived that an appetitive motivational state would probably be attained, resulted in high hope ratings.

Appraisals in Roseman’s Current Theory of Emotion

Roseman’s current theory (Roseman, Scherer, Schorr, & Johnstone, 2001) includes the following appraisals: Unexpectedness, Situational State, Motivational State, Probability, Agency, and Control Potential. The following diagram (see Table 1) shows how the appraisals predicted
in Roseman’s theory interact with each other. Note that the shaded area is not differentiated as there is a dearth of experiments in this area for appraisal theory.

Table 1: Roseman’s Appraisal Theory of Emotion (derived from Roseman, Scherer, Schorr, & Johnstone, 2001, pgs. 70-71). The center shaded area highlights the positive emotions investigated in this dissertation, while the outside shaded areas indicate the appraisals manipulated.
The first appraisal is *Unexpectedness*; all unexpected events or situations will lead to an emotion of Surprise. The following appraisals are all Not-Unexpected appraisals.

*Situational State* involves the difference between events or situations that are motive-consistent or motive-inconsistent. The most influential element for the determination of Situational State is whether the event improved matters or made them worse (Roseman, Antoniou, & Jose, 1996). This determines whether the person will experience a “positive” (e.g., hope, joy, relief, etc.) or a “negative” emotion (e.g., fear, sadness, anger, etc.). The Situational State appraisal, which leads to positive or negative emotions, may not be evaluated in a similar manner for both motive-consistent and motive-inconsistent assessments. As described before, Pratto and John (1991) have shown that negative stimuli are more likely to attract attention than positive stimuli. This explains part of the difficulty in studying appraisals involving motive-consistent elements as the emotional response may be more difficult to measure and not as differentiated.

*Motivational state* is unique to Roseman’s appraisal theory and distinguishes between the desire to maximize reward (an appetitive motive) or minimize punishment (an aversive motive). This is an important category of appraisal as it allows the determination of positive or negative emotion to be based purely on Situational State and not on the type of goal.

*Probability* determines whether the outcome to the situation is certain or uncertain.

*Agency* is used to evaluate whether the event is caused by the environment or circumstance based (circumstance), caused by another (other), or self-caused (self). To date, all appraisal theorists have described their “other” as another human.
Finally, *Control Potential* is involved in the appraisal of the situation. A high-control evaluation is involved when a person believes there is something he or she could do to influence the motive relevant aspects of the situation. In a low-control evaluation the individual believes there is little he or she can change.

**Human-Robot and Human–Animal Interaction**

Gratch, Mao, Marsella, and Sun (2006) comment that social relationships with others generate many of the emotions that we experience. We have developed the ability to display and decode a wide variety of emotional states. Emotions provide a pervasive and central role in our ability to interact with the world around us. They argue that in order to facilitate human-robot communication we must consider the emotional content of the interaction to truly understand the relationship.

Currently, research in human-robot interaction focuses on three general areas. These include adding a computational emotion layer to robot cognition, giving robots the ability to understand user emotions, and giving robots the ability to express emotions physically. Little research has been done on the social and emotional interaction between humans and the robots. This is perhaps due to the lack of common robotic autonomous entities in everyday life. Exceptions to this are the owners of the Sony AIBO. The AIBO provides an interesting way to study this topic due to its combination of robotic and dog-like characteristics. Experiments have shown a wide range of benefits to dog companionship, which some of those in the robotics community have tried to leverage as a goal of social robotic interaction.
Beck and Meyers’ (1996) overview of companion animal ownership concludes that animals fulfill many different functions in people’s lives. These include increased social contact by improving social attractiveness, fulfilling companionship needs in the absence of human contact, allowing children to learn caring and responsibility and various health benefits (e.g., reduced blood pressure).

For instance when looking at nursing home environments, a study found that when comparing volunteers visits alone versus volunteers visits with a dog, the dogs presence led to significantly higher increases in mood (Lutwack-Bloom, Wijewickrama, & Smith, 2005). The use of companion animals in health care settings is not without its issues. Khan and Farrag (2000) mention the potential problems of animal bites, disease transference from animals, and cross contamination between patients. However, these potential issues are rare.

Given the benefits of animal ownership it seems that robots may be able to provide a similar level of companionship and benefits without such issues as neglect or health problems. In a study by Friedman, Kahn, and Hagman (2003), the authors studied the social interactions of people and their robotic dogs (AIBO) via online message boards. By reading users’ postings on these message boards, they grouped key words/phrases/ideas into 5 main categories: Technological Essences, Life-Like Essences, Mental States, Social Rapport and Moral Standing. Each main category was broken down further into sub categories. Most users made comments speaking to life-like essences by commenting on AIBO’s biological essences (“eyes,” “ears,” or “head”) or biological processes (“sleeping”). While close to half of users mentioned intentional behavior or other mental states, still 75% stated that AIBO was a piece of technology or toy. Due to this notion, perhaps, only 12% of members made comments as to the moral standing of
AIBO (e.g., believing that it should not be harmed etc.). The main result of the study was that even though all users know that AIBO is, in fact, not alive, the majority still named, interacted with, and made statements about their AIBO as if it were living entity.
CHAPTER THREE: STUDY ONE

Purpose of Study One

The purpose of study one is threefold. The first purpose is to verify the test bed as a reliable method to influence appraisals when interacting with an agent. The second purpose is to test the differences in emotional experience elicited by a variety of agents. The third purpose is to expand our understanding of positive emotions experienced during high and low control motive-consistent events.

The use of experimentation to test appraisal theory is a relatively new method with few studies having been performed. As such, entering into this endeavor is with a few unknowns. There is a question whether the methods chosen to influence appraisals will alter the participants’ emotional experience, and whether the difficulty in eliciting strong emotional response in an ethically limited controlled setting will keep participants from showing emotional differentiation.

The successful creation of a test bed to influence emotions will benefit the field in a number of ways. For instance, during the relatively few studies that investigate human – robot social interaction, participants generally engage in either a singular task, or are only asked about their experience once a long engagement is complete. This only offers a singular glimpse at the emotional interplay between human and robot. Knowing how a participant will respond to an activity comprised of one type of event does not let us investigate the human robotic relationship. Our social interaction with others is a mix of events which cause a variety of emotional experiences. Indeed it is this mix which governs many of our associations. Friendships
are comprised of many different experiences, involving the memory of a variety of emotions. Even our best friends, who we are happy with the majority of the time, sometimes make us angry.

This test bed then will allow us to see the full range (or at least a larger subset) of emotional experience when participants encounter a variety of agents in different situations. Each agent is predicted then to have a pattern of emotion elicitation which is unique to that entity, referred to as an *emotion footprint*. While one agent may not be faulted for failing in a high control condition, another agent may be held accountable and elicit a stronger negative emotional reaction by the participants.

Study one will attempt to invoke two distinctive positive emotional reactions to an “other” caused situation by varying the level of perceived control. In Roseman et al. (2001) original model (see Table 2) there is only the emotion “liking” to cover all aspects of a successful interaction with another as the cause. This study seeks to examine if control potential influences emotional reaction in this area (see Table 3).

Table 2: Subset of Roseman et al. (2001) model showing control potential and situational state interactions during a situation caused by another agent.

<table>
<thead>
<tr>
<th>SITUATIONAL STATE</th>
<th>MOTIVE-CONSISTENT</th>
<th>MOTIVE-INCONSISTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liking</td>
<td>Dislike</td>
<td>LOW CONTROL POTENTIAL</td>
</tr>
<tr>
<td></td>
<td>Anger</td>
<td>HIGH CONTROL POTENTIAL</td>
</tr>
<tr>
<td></td>
<td>Contempt</td>
<td></td>
</tr>
</tbody>
</table>
Table 3: Subset of Roseman et al. (2001) model showing control potential and situational state interactions during a situation caused by another agent with the addition of hypothesized placement of gratitude and appreciation emotions.

<table>
<thead>
<tr>
<th>SITUATIONAL STATE</th>
<th>MOTIVE-CONSISTENT</th>
<th>MOTIVE-INCONSISTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appreciation</td>
<td>Dislike</td>
<td>LOW CONTROL POTENTIAL</td>
</tr>
<tr>
<td>Gratitude</td>
<td>Anger</td>
<td>Contempt</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HIGH CONTROL POTENTIAL</td>
</tr>
</tbody>
</table>

One difficulty in understanding the basis of positive emotions using appraisal theory is that there has been little research in this area concerning “other” caused events. To date, most inquiries have focused on the “negative” emotions, seeking to understand what causes a negative emotional reaction to a situation, such as fear and anger. While this is a valuable goal and worthy of attention, it is becoming more apparent from recent discussions in the field, that human factors should also work to promote pleasure as well as prevent pain. Understanding what makes people experience positive emotions and identifying the varieties of positive emotions is a step in this direction. Specifically, this study seeks to address whether control potential influences the vocal and subjective measures of positive interactions with agents.

Study One - Hypotheses

In the first study the participant will have a teammate perform a series of 8 tasks. The goal is for the teammate to successfully complete each task. This study will manipulate 3 variables in order to test the following hypotheses. The first variable is agent type. Participants will either interact with a dog, a Sony AIBO, or a Lego NXT. These represent in order, a
biological agent with lifelike attributes, a robotic agent with lifelike attributes, and a robotic agent without lifelike attributes. The next variable is situational state. Each participant will be presented with both manipulations of situational state. The first manipulation of situation state is the agent performing the task successfully (motive-conducive) and the second is the agent failing at the task (motive-inconducive). The last variable manipulated in the experiment is perceived control. Each participant will receive both manipulations of perceived control. In the high control situations the participant will be told that the agent they are interacting with is very well trained in the task, while in the low control situations, the participant will be told that the agent is not very well trained for the task.

Verification of Test Bed

To verify that the experiment is manipulating the variables correctly, the following hypotheses serve as manipulation checks for perceived control, situational state, and that the participant sees that the agent is the cause of the situation. Since situational state directly affects whether humans perceive positive or negative emotions, this will be used as the manipulation check.

1. Participants’ subjective measures of control (teammate expected performance and control of the situation) should be significantly higher in the high control condition than in the low control condition.
2. Participants’ appraisal of agency should indicate that the teammate has a significantly higher rating as the cause of the situation than the participants themselves or the environment.
3. The positive emotions (Gratitude, Appreciation, and Affection) will be significantly higher in the Motive-Consistent condition than in the Motive-Inconsistent condition.

4. The negative emotions (Dislike and Anger) will be significantly higher in the Motive-Inconsistent condition than in the Motive-Consistent condition.

Test of Previous Appraisal Predictions

Roseman et. al. (2001) appraisal theory of emotion predicts that the manipulations in this study will produce the emotion dislike in the low control–motive inconducive condition and that anger will results from the high control–motive inconducive condition. These hypotheses will test that these emotions are indeed produced.

5. Dislike will be significantly higher in the low control condition than in the high control condition.

6. Anger will be significantly higher in the high control condition than in the low control condition.

Agent Hypotheses

One aspect of emotional reactions that humans have is a social response to other humans actions. This response should be more favorable for the biological and lifelike entities as they invoke a more human-human like interaction.
7. The dog condition will evoke significantly higher ratings of the positive emotions (gratitude, appreciation, and affection) than the robotic dog, or the robot condition. The robotic dog will have significantly higher ratings than the robot condition.

8. The dog condition will evoke significantly lower ratings of the negative emotions (dislike and anger) than the robotic dog, or the robot condition. The robotic dog will have significantly lower ratings than the robot condition.

Positive Emotion Investigation Hypotheses

In Roseman et. al. (2001) current appraisal theory of emotion, there is no distinction between positive emotions generated in high or low control situations caused by someone else (both conditions are predicted to produce the emotion liking). These hypotheses seek to test if the emotions of gratitude and appreciation are better descriptors of the emotions experienced in these cases.

9. Gratitude will be significantly higher in the low control condition than in the high control condition.

10. Appreciation will be significantly higher in the high control condition than in the low control condition.
Audio Measures

Based on previous research (Scherer, 2003), the following audio measures should be influenced by the manipulation of high and low control. The high control condition should invoke a state of preparation for action by the participant leading to these effects.

11. Fundamental frequency will be significantly higher in the high control condition than in the low control condition.
12. Floor to ceiling Fundamental Frequency will be significantly higher in the high control condition than in the low control condition.
13. Intensity will be significantly higher in the high control condition than in the low control condition.

Methodology

Participants and Variables

Participants

Participants were undergraduate volunteers recruited from the University of Central Florida through the online psychology participant gathering software, Experimentrak. Participants received two points of extra credit in their undergraduate psychology classes for their participation. The study was one hour in length and took place in the University of Central
Florida’s psychology building in the Applied Cognition and Technology lab over a six week period. A total of 86 (37 male, 49 female) participants were run in this experiment. The participant age range was 18-37 ($M = 19.85$, $SD = 2.60$). Prior to Study One, 15 participants were used to pilot test the two robot conditions and another 10 were used to pilot test the dog condition. The pilot testing was used to clear up hardware and methodological issues, as well as to get the dog accustomed to the experiment.

**Independent Variables**

The experimental design was a 2 (Situational State; within) x 2 (Control Potential; within) x 3 (Agent Type; between) design. Situational State was manipulated as either goal conducive (the agent performs the task required) or goal non-conducive (the agent does not perform the task required). Control Potential (high and low) was manipulated by informing the participants beforehand that the entity in question was either very well trained in the particular task or not well trained. The three between-subject conditions presented to the participants were: interaction with a three-wheeled robot (Lego NXT), a robotic dog (Sony AIBO), or a live dog (see Figure 4). A more detailed explanation of the three agent conditions is located in the apparatus section of study one.
Figure 4: The three non-human agents used in study one (from left to right: the Lego NXT, Sony AIBO, and dog “Sasha”).

The three entities were chosen to represent a range of physical types for autonomous agents form from a non-biological non-lifelike entity (Lego NXT) to a non-biological lifelike entity (Sony AIBO) to a biological lifelike entity (Dog). A real dog was chosen to represent the most lifelike entity as a hypothetical advanced robotic agent. The uncanny valley theory (Seyama, 2006) hypothesizes that when a robotic entity approaches realism there is a dip in positive perception right before true realism. So a robotic entity (or computer generated character) would be viewed more positively if it were slightly unrealistic than if it tried for too much realism. The choice of a real dog then bypasses the uncanny valley by providing a perfectly realistic portrayal of a live entity (which it is). The AIBO represents a middle ground, in which it is obviously not a live dog, however has many of the characteristics that identify a dog. It has a form that walks on four legs and has correctly proportional limbs and features. It’s design is below the uncanny valley then as it takes the generalized form of a real dog while still being obviously robotic. The last agent chosen, the Lego NXT, provides a robotic platform which is minimally lifelike. It does not walk on legs and has no obvious features which correlate to a living entity. It should be mentioned that the agents have many other aspects which are
different such as size (the dog is larger than the AIBO which is larger than the Lego NXT), mobility (the dog walks on four legs, the AIBO on four legs however its front legs are bent at an awkward angle when walking, and the NXT moves on wheels), the two robots are hairless, etc. When all aspects are taken together though the three entities in question were judged to be good representations of the three conditions (non-biological non-lifelike entity, non-biological lifelike entity, and biological lifelike entity).

**Dependent Measures – Subjective**

After seeing the agent for the first time, participants were asked to rate their teammate on seven characteristics (cooperative, intelligent, likeable, friendly, aggressive, easy, and difficult) at the beginning of the experiment. Few participants had ever seen an AIBO or a Lego NXT before, and it was important to understand their initial preconceived notions of the entity. After the interaction, the same seven attributions were rated to see if their opinion of the agent changed due to their interaction. The ratings were from one to seven with one being strongly disagree and seven being strongly agree.

After each task, participants were asked to read a sign that said “At this moment I feel _____ toward my teammate”, filling in the blank with how they felt at that time. This statement was to be read before the separate emotion ratings were made to see if there were words participants used to describe their emotional state that were consistently outside of the individual emotion ratings. This phrase was also used for the vocal analysis (see later in this method section for a further explanation).
After each interaction, participants were asked to rate five emotions by answering the question “To what extent do each of the following describe what you are feeling right now at this moment?” from 0 (not at all) to 10 (extremely). This was similar to what Roseman (1984) used in his studies. The rated emotions included the ones predicted in Roseman’s theory for motive inconsistent (dislike and anger), however instead of Liking for the predicted result of the motive-consistent condition (a term he has changed in different versions of his studies, though not due to experimental results), three terms were chosen to investigate possible positive emotional reaction (Affection, Appreciation, and Gratitude). Affection was chosen as an antonym to dislike and anger. The synonyms Appreciation and Gratitude were chosen due to the definition of grateful as “warmly or deeply appreciative of kindness or benefits received; thankful.” It was hypothesized that even though they were synonyms they might represent different emotional constructs in peoples’ minds. After discussion, it was hypothesized that Appreciation was due to something beneficial done for a person when it was not too much trouble and Gratitude defined as an a feeling when the person has done something unexpectedly beneficial that went beyond normal duty.

**Manipulation Check Measures**

Prior to each task, the participant was asked “The task you and your teammate will attempt next is …” whereupon the participant responded with the next command. Because each participant was told only the number of the next task, (located on the wall in front of them, see APPENDIX D), this question was used to make sure that they read the correct command and that they understood which task was next. For instance, they were told “Your next task is number
11.” To the above question they would answer, “Look left, look right.” This was done so that they would not be influenced by how the experimenter spoke the command. For instance, the participant would not take on the pitch and cadence of the experimenter.

In order to check the perceived control manipulation, the participants were asked before the task, “How well do you think your teammate will perform on this task?” The participants would respond with a number between one and seven, with one being “very poorly” and seven being “very well.” They were also asked how much control they thought they would have over the outcome of the task. They would respond with a number between one and seven, with one being “none” and seven being “complete.” The second question was a direct check of the manipulation, while the first question was asked to see if anticipated performance (which the high or low training might be perceived as) was how the participants viewed the question.

In order to check that each participant was actually assigning the correct responsibility for the outcome (it was important for them to make the appraisal of “other”) three questions were asked on a seven-point scale from “not at all” to “completely.” “My actions were responsible for the outcome of the task, my teammate’s actions were responsible for the outcome of this task, and the environment was responsible for the outcome of the task.”

At the end of the experiment, three questions were asked in an investigative manner. “How important was it for you to do well on these tasks?” rated from one, “not at all,” to seven, “completely.” “Overall, during the study, to what extent do you feel you had influence over the outcome of the task?” rated from one, “not at all,” to seven, “completely” (to see if they believed the second experimenter was actually controlling the robots). “Please briefly describe the
interaction with your teammate,” which was an open-ended question used to gain insight into their perception of the interaction.

**Dependent Measures – Vocal**

After each task, the participants were asked to read aloud the phrase “At this moment I feel _____ toward my teammate.” This was used as to provide consistency to the phrase used for vocal analysis. This was also used in Johnstone and Scherer’s (1999) experiment. The following vocal aspects were measured (F$^0$ is closely related to what we perceive as Pitch, and Intensity to what we perceive as Loudness): Median F$^0$, F$^0$ Ceiling (measured at the 95$^{th}$ percentile), Floor F$^0$ (measured at the 5$^{th}$ percentile), F$^0$ range (Ceiling minus Floor), F$^0$ variance (measured as F$^0$ standard deviation), Median Intensity, Intensity Ceiling (measured at the 95$^{th}$ percentile), Floor Intensity (measured at the 5$^{th}$ percentile), Intensity range (Ceiling minus Floor), and Intensity variance (measured as standard deviation of Intensity).

**Investigative Measures**

As part of a larger overall research effort, two trait ratings were taken at the end of the study. These were the Anthropomorphic Tendencies Scale, which measures people’s tendency to apply human qualities to nonhuman objects and entities, and the Parental Attribution Test (Bugental, Mantyla, Lewis, Cicchetti, & Carlson, 1989), which is used as a tool to assess a participant’s locus of control during a care-giving situation.
Apparatus

Demographic Questionnaire

Prior to the start of the experiment, participants filled out a short demographic questionnaire (See APPENDIX A). Apart from common demographic information, the questionnaire also asked if the participants had any experience with a variety of robotic devices and if they liked dogs.

PANAS Emotional State Survey

As part of a larger research effort participants filled out the PANAS (Positive and Negative Affect Schedule) (Watson, Clark, & Tellegen, 1988) current emotional state survey (on paper) was used to assess the participant’s mood during the current day using a list of 20 terms such as Interested and Excited (see APPENDIX C). Once scored, the survey gives a measure of Positive Affect and Negative Affect.

Participant Survey Station

During the experiment, participants answered interaction survey questions on a 15” LCD monitor run on a Windows PC using UCCASS ("Unit Command Climate Assessment and Survey System") online survey software. The post interaction questionnaires and surveys (ATS and PAT) that were run after the experiment also used the UCCASS software.
Pictures of Command and Hand Signals

During the experiment, the vocal commands and hand signals for each task that the participant could use for reference were posted in clear sight on a wall approximately 13 feet away from the participant behind the Agent experimental area. Each command was on an 8” x 11” piece of white paper. The hand signals were hand drawn, and the commands were printed type. Two participants had to put on glasses before beginning the experiment in order to read the signs.

Experimenter Sheet

During the experiment, the experimenter recorded the responses to questions of perceived control and emotion of the participant after each task on an experimenter sheet. (See APPENDIX B). Tasks were randomized in batch form using Microsoft Excel and written on the sheet prior to the arrival of the participant. Randomization was based on three points. The first randomization was done for task type (sit, lie down, etc.). The second randomization was for control condition. High Control meant the teammate was well trained in the task and Low Control meant the teammate was not well trained. The last randomization was done for success/fail condition of each task. The second experimenter in the control/recording room used a copy of the experimenter sheet to record a redundant copy of the tasks and responses. After the participant finished the experiment, the two experimenters compared the sheets for consistency of responses.
Agent Experimental Area

The agent experimental area was a 9’ x 9’ area defined by 14” walls (see Figure 5) to keep the live dog confined during the experiment and to separate the participant from the agents during the interaction. A 2’ x 3’ rectangle was taped to the floor, centered in front of the agent area to keep the participant centered during the interaction (See Figure 16).

![Figure 5: Study room with tasks on far wall. The second experimenter is located behind the one-way mirror.](image)

Vocal Recording Apparatus

Participants were recorded vocally through a wireless microphone with a connection to the audio port on the back of the Control Room experimenter’s computer. Voice was recorded in
the audio track of the software used to record video (see below). Vocal analysis (see *Figure 6*) was performed with PRAAT vocal analysis software (Boersma & Weenik, 2007).

![Vocal waveform in PRAAT audio analysis software.](image)

*Figure 6:* Vocal waveform in PRAAT audio analysis software.

**Video Recording Apparatus**

Participants were video recorded with 4 security cameras placed in the lab. The cameras were placed (1) directly above the participant looking down, (2) facing the participant approximately 10’ away from the back of the agent experimental area, (3) from the right of the participant approximately 20’ feet away, and (4) directly above the agent area looking down. These video cameras were connected to a video splitter which combined the four images into one screen in a grid view. This signal was then passed to the Control Booth computer via a video capture card. Video was recorded at 720x480 at 30 frames a second. Due to the lag time in displaying the video when watched live on the computer, a small TV was set up and the video signal split before it reached the computer. This permitted the live monitoring of the four cameras which allowed the 2nd experimenter to view the experiment as the one-way mirror occluded much of the room.
Second Experimenter Control Room

The second experimenter in the recording/control room (see Figure 7) used a 30” LCD monitor to view the four camera feeds and the control software. A small TV was also used to display a live feed. The room had a one way mirror which allowed the 2nd experimenter to see into the room. The second experimenter remote controlled the robotic agents with which the participants interacted. Control of the robot was facilitated using the video signal to monitor robot progress as it was easier to see with the top down view. Audio from the wireless microphone could be heard over the TV.

Figure 7: Recording room located behind a one way mirror.
As part of a larger project physiological measures of GSR and EKG were also collected at the experimenter survey station.

**Dog Condition**

For the dog condition, a 15 pound, six-year-old female Shetland sheepdog was used (see Figure 8). This dog trained for 20 minutes a day for two months with different people giving the commands in order to get the dog used to a variety of people. Positive reinforcement, including dog biscuits and vocal congratulations, was used as a reward for successfully completing commands in the training sessions.

![Image of a dog](image)

*Figure 8: “Sasha” - the dog condition*

The dog was friendly and got along well with the participants. During the experiment, the dog’s gender and breed were not revealed until the end of the experiment in order to keep the participants unbiased, though many asked. Also the dog was always referred to as “teammate”
and not as “Sasha” during the experiment. Referring to the dog as teammate did not seem to affect the initial training, as it seems the command and hand signals overcame any preconditioned training in which her name was used.

**Robot Condition**

*Figure 9: Lego NXT.*

The robot chosen for the non-anthropomorphic robot condition was the Lego NXT (see Figure 9). This robotic platform was chosen for its low cost, its wide availability, and the wide range of free software written to control it. The Lego NXT comes with well-designed autonomous software package NXT-G v1.0 that allows the user to control many aspects of this very configurable robot in a graphical drag-and-drop environment. Indeed, the hardware that comes in the box (see Figure 10) allows the individual to assemble a wide range of robotic entities from a three-wheel robot to one that walks on two legs (see Figure 11). There is a plethora of software available to control the robot autonomously, via a chain of commands downloaded to the robot’s memory, such as seek the red ball, pick it up with the claw attachment. However, for this experiment it was decided that in order to perform reliably for all
participants a software package that could control the Lego NXT as a remote control device would be ideal. The NXT comes with Bluetooth built into the robotic platform, which allowed control from the control room.

![Lego NXT control “brick” and various motors and sensors.](image10.png)

*Figure 10:* Lego NXT control “brick” and various motors and sensors.

![Lego NXT in bipedal configuration.](image11.png)

*Figure 11:* Lego NXT in bipedal configuration.

The software package OnBrick (see Figure 12 for the interface) was chosen as it was available for free and allowed not only remote control of the individual motors and sensors but also allowed a slightly higher level of command, such as turn right 90 degrees, which moved one
motor backward and the second motor forward, allowing the robot to turn. There is also a calibration built in to allow for motor inconsistency. Custom commands were built in the OnBrick software to allow the following commands: moving forward and backward, turning 90 and 180 degrees, and two separate musical tones.

![NXT OnBrick programmer interface](image)

*Figure 12: NXT OnBrick software interface with default programming.*

**Robotic Dog Condition**

For the robotic dog condition, the Sony AIBO was chosen (see *Figure 13*). The Lego NXT has the possibility of configuration in a bipedal configuration, which is anthropomorphic,
but it was decided that the AIBO would be ideal as it has a dog-like form, which matched nicely with the Dog condition. The AIBO has been used in many psychological experiments as a “social robot.” It is one of the few consumer robots that (1) has an anthropomorphic form and (2) is highly programmable using high-level (graphical drag and drop programming environment) or low-level (Java or C++) programming.

Figure 13: Sony AIBO.

It also has a high level of capability including the use of twenty motors. While the AIBO was built to be autonomous, it was determined that the AIBO was not reliable enough to perform actions for each participant without a training session for each. Even then, commands would not be reliably performed. It was decided to use a remote control software package to control the AIBO. Commands were sent over the campus wireless Internet from the control station and were received through a wireless access card built into the AIBO. The software used was the java based Tekkotsu (http://www.cs.cmu.edu/~tekkotsu/). The main control panel (see Figure 14) allowed access to custom movements, such as sit, as well as pre-programmed actions, including lie down and “bark”. In addition, the movement control panel (see Figure 15) provided access to
movement functionality, such as turning and moving forward and backward. It was discovered that the best movement was achieved by pressing the cursor at the second ring of circles in order to provide smooth movement.

![Tekkotsu-Java based AIBO remote control](image)

*Figure 14: Tekkotsu-Java based AIBO remote control.*
Procedure

Participants were run individually in sessions that lasted approximately 60 minutes. To ensure that each participant had identical instructions, the experimenter read from a prepared script. Participants were recruited from the online undergraduate recruiting system Experimentrak. They received two credits in their current undergraduate psychology course for participating in the one-hour study. They arrived at assigned times at the Applied Cognition and Technology lab in the University of Central Florida’s Psychology building over a six-week period. Participants were greeted when they entered the lab. After filling out the informed consent, audio recording and physiological measuring devices were attached, involving a wireless headset microphone and wire leads relating to EKG and GSR measurement.

Participants were informed that they would perform tasks with a nonhuman agent. Their goal was to successfully complete as many of the tasks as they could. After filling out the demographics questionnaire and emotional state questionnaire, participants were briefly
introduced to the agent. They were then instructed on their role in the experiment, which was to
direct their agent teammate to perform a variety of tasks. For example, turning around, rolling
over, and eliciting sound. Each agent condition had a set of tasks that were as similar as possible,
while taking into consideration their limitations (e.g. the AIBO is unable to roll over).

Participants were told the first of the eight tasks (the order of which were randomized for each
participant) to complete along with the hand signal for the task (see Table 4 for the list of tasks
for each agent).

Table 4: List of tasks for each agent. (For hand signals accompanying the commands see
APPENDIX D)

<table>
<thead>
<tr>
<th></th>
<th>Successful Tasks</th>
<th>Unsuccessful Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lego NXT</td>
<td>Turn 360 Degrees</td>
<td>Turn 180 degrees</td>
</tr>
<tr>
<td></td>
<td>Make Noise</td>
<td>Zig Zag</td>
</tr>
<tr>
<td></td>
<td>Move Backward</td>
<td>Look Left, Look Right</td>
</tr>
<tr>
<td></td>
<td>Move Forward</td>
<td>Move in a Large Circle</td>
</tr>
<tr>
<td>AIBO</td>
<td>Turn 360 Degrees</td>
<td>Turn 180 degrees</td>
</tr>
<tr>
<td></td>
<td>Lay Down</td>
<td>Zig Zag</td>
</tr>
<tr>
<td></td>
<td>Sit</td>
<td>Look Left, Look Right</td>
</tr>
<tr>
<td></td>
<td>Move Forward</td>
<td>Move in a Large Circle</td>
</tr>
<tr>
<td>Dog</td>
<td>Turn 360 Degrees</td>
<td>Turn 180 degrees</td>
</tr>
<tr>
<td></td>
<td>Lay Down</td>
<td>Zig Zag</td>
</tr>
<tr>
<td></td>
<td>Sit</td>
<td>Look Left, Look Right</td>
</tr>
<tr>
<td></td>
<td>Look Left, Look Right</td>
<td>Move Backward</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Make Noise</td>
</tr>
</tbody>
</table>

Participants then answered a question about how difficult they believed the task would be
to accomplish. Then they attempted to have the agent perform the task. Participants used the
phrase “teammate ___” (filling in the command) to direct their teammate along with a
corresponding hand signal (see Figure 16).
The agent then attempted to perform the task. After each attempt, participants were asked if they believed their teammate had completed the task. If they said “yes” then the task was complete, if they said “no” then they attempted the task a second time.

Figure 16: Dog Agent performing the “sit” task.

They were then requested to say “At this moment, I feel ___ toward my teammate,” filling in the blank with word from a list of possible emotional terms. After each task, they rated a series of emotions on 11-point scales, and answered questions about the cause of the outcome of the task. After all tasks had been completed, they filled out the Parental Attribution Test, Anthropomorphism Tendency Scale, and a post experiment survey. After finishing the surveys, the participants were thanked for their time and participation, given a debriefing statement, and given the opportunity to ask any questions about the experiment or research.
The second experimenter in the control/ recording booth monitored the video/ audio recording, the physiological recording, and controlled the robots remotely.

Results

Due to the difficulty of having the dog perform all four of the successful actions (the dog averaged 3 out of 4), it was decided to only use the first case of each manipulated condition. Therefore the analysis of the interaction uses only the first attempt of high-control-successful, low-control-successful, high-control-unsuccessful and low-control-unsuccessful. The second attempt on each of these conditions was not used for analysis in study one. An alpha level of .05 was used for all statistical tests.

Manipulation Checks

In order to test whether the manipulation of perceived control was successful, the two dependent variables of participants control over outcome and teammates anticipated performance where compared in the high and low control conditions. A successful manipulation would have both ratings significantly higher in the high control situation. The manipulation of the responsibility of outcome was also tested. In order for a successful manipulation of agency to be achieved, the participant should view the agent (Dog, AIBO, or Lego NXT) as significantly more responsible for the outcome then themselves or the environment.
Participants’ Control Over Outcome

A 2 within (successful/not successful) x 2 within (high control / low control) x 3 between (Dog/AIBO/Lego) repeated measures mixed ANOVA was performed to verify the manipulation of high/low control with the question of participants’ ratings of participants’ control over outcome.

There was a main effect for success $F(1,77) = 8.82, p=.004. n^2=.10$. Pairwise comparisons showed that the successful condition ($M=3.88, SE=.14$) was rated significantly lower in participants’ control over outcome than the unsuccessful condition ($M=4.24, SE=.12$).

There was a main effect for control $F(1,77)=19.35, p<.0005. n^2=.20$ (see Figure 17). Pairwise comparisons showed that the High control condition ($M=4.34, SE=.13$) was rated significantly higher in participants control over outcome than the Low control condition ($M=3.78, SE=.13$).

Figure 17: Participants rating of perceived control over outcome for the high control and low control condition
Teammate’s Anticipated Performance.

A 2 within (successful/not successful) x 2 within (high control / low control) x 3 between (Dog/AIBO/Lego) repeated measures mixed ANOVA was performed to verify the manipulation of high/low control with the question of participants’ ratings of teammate’s anticipated performance.

There was a main effect for control $F(1,77) = 244.62, p < .0005. n^2 = .76$ (see Figure 18). Pairwise comparisons showed that the high control condition ($M=5.84, SE=.10$) was rated significantly higher for ratings of teammate’s anticipated performance than the low control condition ($M=3.51, SE=.12$).

![Figure 18: Participants rating of anticipated teammate’s performance for the high control and low control condition](image)

There was an interaction between control and agent type $F(2,77)=3.13, p = .049. n^2 = .08$. 

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A one way ANOVA was conducted on High Control Condition rating of teammate’s anticipated performance (using the average of the High Control Successful and High Control Unsuccessful) in order to investigate the control x condition interaction. There was no significant main effect for agent type $p > .05$.

A one way ANOVA was conducted on Low Control Condition rating of teammate’s anticipated performance (using the average of the High Control Successful and High Control Unsuccessful) in order to investigate the control x condition interaction. There was no significant main effect for agent type $p > .05$.

Responsibility for Outcome

A 3 responsibility (mine, teammates, environment) x 2 control (high/low) repeated measure x 2 success (successful/unsuccessful) completely within, repeated measure ANOVA was conducted to determine participants’ evaluation of responsibility for outcome.

There was a main effect for Success $F(1, 78) = 14.11, p < .0005. \eta^2 = 0.15$. Responsibility ratings were rated significantly higher in the successful condition ($M = 4.21, SE = 0.10$) than in the unsuccessful condition ($M = 3.94, SE = 0.09$).

There was a main effect for Responsibility $F(2, 78) = 114.16, p < .0005. \eta^2 = 0.59$ (see Figure 19). Post Hoc Least Significant Difference pairwise comparisons on Responsibility ratings indicated that the My Teammate’s Actions rating ($M = 5.33, SE = .10$) had significantly higher ratings than the My Own Actions rating ($M = 4.12, SE = .12$) and Environment ratings ($M = 2.77, SE = .16$). The My Own Actions rating was rated significantly higher than the Environment ratings.
There was a significant responsibility x success interaction $F(2,156) = 10.07, p < .0005$. \( \eta^2 = 0.11 \) (see Figure 20).

**Figure 19:** Ratings of responsibility for outcome

**Figure 20:** Responsibility as a function of task outcome.
Three paired sample t-tests were conducted using the average of the two successful conditions (high control/low control) vs. the average of the two unsuccessful conditions (high control/low control) on the three measures of responsibility (my action responsible/teammate’s action responsible/environment responsible).

For the My Actions Responsible question, the successful condition ($M = 4.54, SD = 1.24$) was significantly higher than the unsuccessful condition ($M = 3.70, SD = 1.43$) $t(78) = 4.67, p < .0005$. The other two t-tests were not significant.

*Emotion Ratings*

Each of the emotions rated by the participant (affection, appreciation, anger, dislike, and gratitude)) after each interaction with the agent (dog, AIBO, or Lego NXT) was investigated to see the influence of the independent variables agent type (dog, AIBO, or Lego NXT), control (high control/low control), and success (motive conducive – meaning successful/motive inconducive – meaning an unsuccessful task).

A 3 (agent type; between) x 2 (success; within) x 2 (control; within) repeated measure, mixed ANOVA was conducted on all participants’ ratings of emotional terms. Eighty-one participants were used for subjective measure analysis (26 robot, 27 robotic dog, 28 dog). This reduction in total participants was due to software difficulties with the online survey.
Affection

There was a main effect for Success $F(1, 77) = 42.93, p < .0005. \eta^2 = 0.36$. Affection was rated significantly higher in the successful condition ($M = 5.28, SE = 0.30$) than in the Unsuccessful condition ($M = 4.03, SE = 0.27$).

There was a main effect for condition $F(2,77) = 38.17, p < .0005. \eta^2 = 0.50$. Post Hoc Least Significant Difference pairwise comparisons on Condition indicated that the Dog condition ($M = 7.84, SE = .46$) had significantly higher ratings of affection than the AIBO ($M = 3.81, SE = .46$) and Lego ($M = 2.32, SE = .47$) conditions. The AIBO condition was rated significantly higher than the Lego condition.

<table>
<thead>
<tr>
<th>Agent Type</th>
<th>Hi Control</th>
<th>Lo Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOG</td>
<td>7.648</td>
<td>8.037</td>
</tr>
<tr>
<td>AIBO</td>
<td>3.741</td>
<td>3.87</td>
</tr>
<tr>
<td>LEGO</td>
<td>2.462</td>
<td>2.173</td>
</tr>
</tbody>
</table>

Figure 21: Agent type by control interaction for affection.

There was a significant control x agent type interaction $F(2,77) = 3.30, p = .042. \eta^2 = 0.08$ (see Figure 21).
A one way ANOVA was conducted on Hi Control Condition rating of affection (using the average of the High Control Successful and High Control Unsuccessful) in order to investigate the control x agent type interaction. There was a significant main effect for agent type $F(2,80) = 33.50, p < .0005$. Post Hoc LSD tests indicated that the Dog condition was significantly higher ($M = 7.70, SD = 1.90$) than the AIBO condition ($M = 3.74, SD = 2.81$) and the Lego condition ($M = 2.46, SD = 2.61$).

A one-way ANOVA was conducted on Low Control Condition rating of affection (using the average of the Low Control Successful and Low Control Unsuccessful) in order to investigate the control x agent type interaction. There was a significant main effect for agent type $F(2,79) = 42.10, p < .0005$. Post Hoc LSD tests indicated that the Dog condition ($M = 8.04, SD = 1.71$) was significantly higher than the AIBO condition ($M = 3.87, SD = 2.93$) and the Lego condition ($M = 2.17, SD = 2.40$). The AIBO condition was also significantly higher than the Lego condition.

**Anger**

There was a main effect for Success $F(1, 77) = 32.90, p < .0005$. Anger was rated significantly higher in the unsuccessful condition ($M = 1.16, SE = 0.20$) than in the successful condition ($M = .18, SE = 0.07$).

There was a main effect for agent type $F(2,77) = 3.65, p < .031$. Post Hoc Least Significant Difference pairwise comparisons on agent type indicated that the Lego condition ($M = 1.01, SE = .21$) had significantly higher ratings of anger than the Dog ($M = .23, SE = .21$) condition.
There was a significant success x agent type interaction $F(2,77) = 3.68, p = .030. \eta^2=0.09$ (see Figure 22).

![Agent Type x Success Interaction](image)

**Figure 22:** Agent type by success interaction for anger.

A one-way ANOVA was conducted on the successful condition rating of anger (using the average of the Successful Low Control and Successful High Control) in order to investigate the success x agent type interaction. The results were not significant $p>.05$. A one-way ANOVA was conducted on Unsuccessful condition rating of anger (using the average of the Unsuccessful Low Control and Unsuccessful High Control) in order to investigate the success x agent type interaction. There was a significant main effect for agent type $F(2,80) = 4.15, p = .019$. Post Hoc LSD tests indicated that the Dog condition ($M = .41, SD = 1.07$) was significantly lower than the Lego condition ($M = 1.77, SD = 2.25$).
Appreciation

There was a main effect for Success $F(1, 76) = 110.48, p < .0005$. Appreciation was rated significantly higher in the successful condition ($M = 5.28, SE = 0.30$) than in the unsuccessful condition ($M = 4.03, SE = 0.27$).

There was a main effect for agent type $F(2,76) = 13.46, p < .0005$. Post Hoc Least Significant Difference pairwise comparisons on agent type indicated that the Dog condition ($M = 6.01, SE = .42$) had significantly higher ratings of appreciation than the AIBO ($M = 3.73, SE = .42$) and Lego ($M = 3.02, SE = .44$) conditions.

Dislike

There was a main effect for Success $F(1, 76) = 44.66, p < .0005$. Dislike was rated significantly higher in the unsuccessful condition ($M = 1.63, SE = 0.23$) than in the successful condition ($M = .23, SE = 0.07$).

There was a main effect for agent type $F(2,76) = 7.26, p = .001$. Post Hoc Least Significant Difference pairwise comparisons on agent type indicated that the Dog condition ($M = .21, SE = .24$) had significantly lower ratings of dislike than the AIBO ($M = 1.11, SE = .24$) and Lego ($M = 1.46, SE = .24$) conditions.

There was a significant success x agent type interaction $F(2,76) = 6.06, p = .004$. $\eta^2 = 0.14$ (see Figure 23)
A one-way ANOVA was conducted on Successful condition rating of dislike (using the average of the Successful Low Control and Successful High Control) in order to investigate the success x agent type interaction. There was not a significant main effect for agent type $F(2, 79) = 2.62, p = .080$.

A one-way ANOVA was conducted on Unsuccessful condition rating of dislike (using the average of the Unsuccessful Low Control and Unsuccessful High Control) in order to investigate the success x agent type interaction. There was a significant main effect for agent type $F(2, 79) = 7.60, p = .001$. Post Hoc LSD tests indicated that the Dog condition ($M = .41, SD = .87$) was significantly lower than the AIBO condition ($M = 1.91, SD = 2.33$) and the Lego condition ($M = 2.56, SD = 2.59$).
Gratitude

There was a main effect for Success $F(1, 73) = 90.59, p < .0005. \eta^2 = 0.55$. Gratitude was rated significantly higher in the successful condition ($M = 5.43, SE = 0.33$) than in the unsuccessful condition ($M = 2.39, SE = 0.30$).

There was a main effect for Control $F(1, 73) = 11.36, p = .001. \eta^2 = 0.14$. Gratitude was rated significantly higher in the Low Control condition ($M = 4.10, SE = 0.27$) than in the High Control condition ($M = 3.73, SE = 0.28$).

There was a main effect for agent type $F(2,73) = 12.77, p < .0005. \eta^2 = 0.26$. Post Hoc Least Significant Difference pairwise comparisons on agent type indicated that the Dog condition ($M = 5.83, SE = .46$) had significantly higher ratings of gratitude than the AIBO ($M = 3.03, SE = .46$) and Lego ($M = 2.88, SE = .48$) conditions.

Attributions

Participants rated the agent (Dog, AIBO, or Lego NXT) on 7 attributes (cooperative, intelligence, likable, friendly, aggressive, easy, and difficult) before and after the tasks they completed with their teammate. Each of these was investigated to see if there was a difference in before and after ratings (pre/post) to determine if they were affected by the interaction with the agent. In addition analysis included whether agent type influenced their ratings.

A 2 within (pre/post) x 3 between (Dog/AIBO/Lego) repeated measures mixed ANOVA was performed to compare pre- and post-participant ratings of each attribution.
Cooperative

There was a main effect for Pre/Post $F(1, 77) = 8.4, p = .005. \eta^2 = 0.10$. The Pre-interaction measure of Cooperativeness ($M = 4.72, SE = .13$) was significantly higher than the Post-interaction measure ($M = 4.26, SE = .13$).

There was a main effect for agent type $F(2, 77) = 6.91, p = .002. \eta^2 = 0.15$. Post Hoc Least Significant Difference pairwise comparisons of agent type indicated that the Dog condition ($M = 5.02, SE = .17$) had significantly higher ratings of cooperativeness than the Lego condition ($M = 4.28, SE = .18$) and AIBO condition ($M = 4.17, SE = .18$).

There was a significant pre/post x agent type interaction $F(2,77) = 5.38, p = .006. \eta^2 = 0.12$ (see Figure 24)

Three paired sample t-tests were conducted with Pre Rating vs. Post Rating on each of the three Agent Conditions (Dog/AIBO/Lego). For the Dog condition the pre rating ($M = 5.61$, Figure 24: Cooperative ratings as a function of time of rating and agent type.}

<table>
<thead>
<tr>
<th>Agent Type</th>
<th>Pre Rating</th>
<th>Post Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOG</td>
<td>5.61</td>
<td>4.43</td>
</tr>
<tr>
<td>AIBO</td>
<td>4.22</td>
<td>4.11</td>
</tr>
<tr>
<td>LEGO</td>
<td>4.32</td>
<td>4.24</td>
</tr>
</tbody>
</table>
was significantly higher than the post rating ($M = 4.43, SD = 1.10$) $t(27) = 4.41, p < .0005$. The other two agent t-tests were not significant.

**Intelligence**

There was a main effect for agent type $F(2, 77) = 14.08, p < .0005$. $\eta^2 = 0.27$. Post Hoc Least Significant Difference pairwise comparisons of agent type indicated that the Dog condition ($M = 5.48, SE = .23$) had significantly higher ratings of Intelligence than the Lego condition ($M = 4.14, SE = .24$) and AIBO condition ($M = 3.89, SE = .23$).

**Likable**

There was a main effect for agent type $F(2, 76) = 33.48, p < .0005$. $\eta^2 = 0.47$. Post Hoc Least Significant Difference pairwise comparisons of agent type indicated that the Dog condition ($M = 6.50, SE = .22$) had significantly higher ratings of Likable than the Lego condition ($M = 3.94, SE = .24$) and AIBO condition ($M = 4.80, SE = .22$). The AIBO was significantly higher than the Lego.

**Friendly**

There was a main effect for agent type $F(2, 76) = 30.75, p < .0005$. $\eta^2 = 0.45$. Post Hoc Least Significant Difference pairwise comparisons of agent type indicated that the Dog condition ($M = 6.34, SE = .26$) had significantly higher ratings of Friendly than the Lego condition ($M =
3.35, $SE = .29$) and AIBO condition ($M = 4.43, SE = .27$). The AIBO was significantly higher than the Lego.

**Aggressive**

There was a main effect for Pre/Post $F(1, 77) = 38.30, p < .0005$. $\eta^2 = 0.33$. The Pre-interaction rating of Aggressive ($M = 2.13, SE = .12$) was significantly higher than the Post-interaction measure ($M = 1.38, SE = .07$).

There was a main effect for agent type $F(2, 77) = 5.02, p = .009$. $\eta^2 = 0.12$. Post Hoc Least Significant Difference pairwise comparisons of agent type indicated that the Lego condition ($M = 2.08, SE = .15$) had significantly higher ratings of Aggressive than the Dog condition ($M = 1.45, SE = .14$).

**Easy**

There was a main effect for Pre/Post $F(1, 75) = 13.36, p < .0005$. $\eta^2 = 0.15$. The Pre-interaction rating of Easy ($M = 4.39, SE = .14$) was significantly higher than the Post-interaction measure ($M = 3.81, SE = .13$).

There was a main effect for agent type $F(2, 75) = 8.11, p = .001$. $\eta^2 = 0.18$. Post Hoc Least Significant Difference pairwise comparisons of agent type indicated that the Dog condition ($M = 4.70, SE = .18$) had significantly higher ratings of Easy than the AIBO condition ($M = 3.82, SE = .18$) or the Lego condition ($M = 3.77, SE = .19$).
**Difficult**

There was a main effect for Pre/Post $F(1, 76) = 10.44, p = .002. \eta^2 = 0.12$. The Post-interaction rating of Difficult ($M = 3.77, SE = .15$) was significantly higher than the Pre-interaction measure ($M = 3.18, SE = .13$)

There was a main effect for agent type $F(2, 76) = 6.80, p = .002. \eta^2 = 0.15$. Post Hoc Least Significant Difference pairwise comparisons of agent type indicated that the Dog condition ($M = 2.95, SE = .18$) had significantly lower ratings of Difficult than the AIBO condition ($M = 3.62, SE = .18$) or the Lego condition ($M = 3.86, SE = .19$).

**Audio Measurements**

Measurements of the participants’ vocal patterns were investigated to determine if they were influenced by the perceived control variable. A prediction was made for median fundamental frequency to be higher in the high control conditions and the successful conditions. A prediction was made as well for the median intensity to be higher in the high control situations and the successful conditions. The other audio measures are investigative in nature.

Analysis of the audio measures used a 2 within control (high control/low control) 2 within success (successful/unsuccessful) x 3 between agent type (Dog/AIBO/Lego) repeated measures mixed ANOVA with gender as a covariate (male/female) and was performed on the phrase “at this moment I feel” after each interaction. For the audio measures only 84 (49 female, 35 male) participants were used for analysis due to difficulty with the recording equipment.
Median Fundamental Frequency

There was a main effect for Success $F(1, 64) = 4.47, p = .038, \eta^2 = 0.07$. Pairwise was not significant. There was a significant success x agent type interaction $F(2,64) = 3.31, p = .043, \eta^2 = 0.09$.

A one-way ANOVA was conducted on females for Successful condition Median Fundamental Frequency (using the average of the Successful Low Control and Successful High Control) in order to investigate the success x agent type interaction. There was a significant main effect for agent type $F(2,39) = 3.62, p = .037$. Post Hoc LSD tests indicated that the Lego condition ($M = 195.33, SD = 16.42$) was significantly lower than the AIBO condition ($M = 213.36, SD = 24.70$) and the Dog condition ($M = 215.66, SD = 23.58$).

A one-way ANOVA was conducted on females for Unsuccessful condition Median Fundamental Frequency (using the average of the Unsuccessful Low Control and Unsuccessful High Control) in order to investigate the success x agent type interaction. There was a significant main effect for agent type $F(2,38) = 4.57, p = .017$. Post Hoc LSD tests indicated that the Lego condition ($M = 189.80, SD = 18.86$) was significantly lower than the AIBO condition ($M = 215.08, SD = 21.85$).

Ceiling Fundamental Frequency - 95 quartile

There were no significant results ($p > .05$).
Fundamental Frequency - 5 quartile

There was a significant success x agent type interaction $F(2,64) = 3.62$, $p = .03$. $\eta^2 = 0.10$.

Post Hoc tests detected no significant results ($p>0.05$).

Fundamental Frequency Range Floor to Ceiling

There was a main effect for agent type $F(2, 76) = 6.80$, $p = .032$. $\eta^2 = 0.10$. Post Hoc Least Significant Difference pairwise comparisons of agent type indicated that the Lego condition ($M = 30.17$, $SE = 4.37$) had significantly lower Fundamental Frequency Range than the AIBO condition ($M = 47.17$, $SE = 4.58$).

SD of Intensity

There were no significant results ($p>0.05$).

Median Intensity – quartile 50%

There were no significant results ($p>0.05$).

Ceiling Intensity – quartile 95%

There was a significant control x agent type interaction $F(2,54) = 3.80$, $p = .029$. $\eta^2 = 0.12$.

Post Hoc tests detected no significant results ($p>0.05$).
Floor Intensity – quartile 05%

There was a significant Success x agent type interaction $F(2,54) = 3.71, p = .031. \eta^2 = 0.12$. A one-way ANOVA was conducted on males for Successful condition Floor Intensity (using the average of the Successful Low Control and Successful High Control) in order to investigate the success x agent type interaction. There was a significant main effect for agent type $F(2,30) = 3.42, p = .047$. Post Hoc LSD tests indicated that the AIBO condition ($M = 20.49, SD = 6.15$) was significantly lower than the Lego condition ($M = 25.26, SD = 3.74$) and the Dog condition ($M = 25.19, SD = 3.79$).

Range Intensity – Floor to Ceiling

There were no significant results ($p > .05$).

Audio Duration

There was a main effect for Success $F(1, 73) = 4.06, p = .048. \eta^2 = 0.05$.

Post Hoc Least Significant Difference pairwise comparisons of duration indicated that the Successful condition ($M = 1.47, SE = .04$) was significantly shorter than the unsuccessful condition ($M = 1.62, SE = .05$).
Discussion

Believability of Autonomous Action

Of some concern when creating this experiment was the believability of the autonomous nature of the agents. This turned out not to be an issue for almost all of the participants. Only one participant was removed from the data do to commenting that they did not believe they were controlling the AIBO during the after experiment questions. The success of this manipulation is hypothesized to be the result of immediate feedback on their commands. When the participant said “teammate sit” the agent immediately sat. This cause and effect led to a highly believable interaction.

Verification of Test Bed

It was hypothesized that participants’ subjective measures of control (teammate expected performance and control of the situation) should be significantly higher in the high control condition than in the low control condition. The results support this finding that teammate’s expected performance and participants’ perceived control over the outcome is significantly higher for the high-control condition compared to the low-control condition. These results serve as a manipulation check for the high and low control condition.

It was hypothesized that participants’ appraisal of agency should indicate that the teammate has a significantly higher rating as the cause of the situation than the participants themselves or the environment. The results confirmed this manipulation check. Participants rated
their teammate higher than their own actions or the environmental circumstances for being responsible for the outcome of the task.

It was hypothesized that participants’ positive emotions (Gratitude, Appreciation, and Affection) would be significantly higher in the Motive-Consistent condition (i.e., successful) than in the Motive-Inconsistent condition (i.e., unsuccessful). The data supported this finding across all three positive emotions.

It was hypothesized that participants’ negative emotions (Dislike and Anger) would be significantly higher in the Motive-Inconsistent condition (i.e., unsuccessful) than in the Motive-Consistent condition (i.e., successful). Again the data supported this manipulation check across both negative emotions.

The success of the manipulation checks indicated that this test bed does in fact reliably induce the targeted appraisals and may be used to study the aspects of emotional interaction with an agent.

Tests of Previous Appraisal Predictions

It was hypothesized that participants’ emotion ratings of dislike and anger would be significantly different in the low control conditions than in the high control conditions. This was not supported by the data ($p>.05$ in both cases). It seems that though dislike and anger have in past research been found to be linked to control condition this was not evident in the current study. A limitation of this study was that the non success of the tasks may not have elicited strong enough negative emotions in the human operator. If for example, a participant had
received an electric shock for each incorrect task, differentiation in negative ratings may have been increased.

*Agent Condition by Evoked Emotion*

It was hypothesized that the dog condition would be rated higher than the robotic dog or robot conditions for positive emotions (i.e., affection, appreciation, and gratitude). It was further hypothesized that the robotic dog condition would be rated higher for positive emotions compared to the robot condition. Results confirmed this pattern of results across the three positive emotions (see *Figure 25*).

*Figure 25*: Positive emotions across agent conditions. Note that bars represent standard error.

The dog was rated higher in positive emotions than either of the robot conditions in all cases. However, while the mean of the robotic dog was higher than the robot across all positive emotions, this effect was only significant for affection. This indicates that affection is sensitive to
not only whether that agent is biological or nonbiological, but also to whether a nonbiological agent possesses lifelike characteristics. That is, one’s feeling of affection to an agent are higher for organic living entities than for non-living entities. Further, this research suggests that imbuing nonbiological entities with lifelike characteristics can actual increase users’ experience of the emotion affection for the agent. This has profound consequences for human-machine interactions as technology becomes more ubiquitous in the future. A hypothetical example would be imbuing a household robot with anthropomorphic features. This could increase the family’s affection for the robot easing user acceptance and improving product retention. However, affection was the only positive emotion that discriminated between types of robots. Gratitude and appreciation did not indicate a difference between the robot and the robotic dog. These measures may reflect emotions that are more aptly used in dealing with biological than nonbiological agents, and not discriminating among robots with different levels of lifelike characteristics. On the other hand, the results did reflect a trend in the hypothesized pattern and perhaps the sample-size was too limited to detect a small effect or the AIBO may not have been sufficiently lifelike compared to the LEGO-NXT to elicit a significant effect. If the goal of the robotic dog is to stimulate the emotional aspects of dog companionship, it succeeds in increasing the experience of the emotion affection; however, is lacking in some action or characteristics that influence the experience of the other two positive emotions.

It was further hypothesized that the robot would be rated higher than the robotic dog or dog for operator self-reported negative emotions (i.e., dislike and anger). It also was hypothesized that the robotic dog would be rated higher for operator negative emotions than the dog condition. While graphical representation of the data confirmed this general pattern of
results across the two negative emotions, there was only partial statistical support (see Figure 26).

![Negative Emotions x Agent Type](image)

*Figure 26:* Negative emotions across agent conditions. Note that bars represent standard error.

The robot was rated higher across both negative emotions as compared with the dog. The robotic dog also was rated significantly higher than the dog in the negative emotion of dislike, though it was not significantly higher in operator self-reported anger. It was particularly interesting that at no time did the robot and the robotic dog significantly differ in regards to operator self-reported negative emotion. These results indicate that users reacted with less negative emotion to a biological agent (i.e., the real life dog) compared to a nonbiological agent (i.e., the typical robot or robotic dog). This effect may be due to the already limited positive emotion users felt toward the nonbiological agents. That is, the nonbiological agents were perhaps less likable than the biological agent. The fact that the two nonbiological agents were rated equivalently for negative emotions is a very interesting finding, this suggests that
regardless of the lifelike characteristics imbued into a non-living agent, these characteristics will not protect that agent from incurring operator negative emotions. This may be better explained by applying these findings to our hypothetical household robot example. According to these results a biological household helper (e.g., a human housekeeper) would probably engender lower ratings of negative emotions in the homeowners than an equally effective robotic housekeeper. Whether or not that robotic housekeeper was imbued with lifelike characteristics would not influence (either positively or negatively) perceived negative emotions in the homeowners (i.e., homeowners would harbor equal negative emotion to Rosie the robotic maid as a generic housekeeping appliance). It then becomes a question of what features of biological entities protect these agents from inducing negative emotion in users? It may be related to the higher levels of positive emotions (e.g., affection) these biological agents induce in human operators that helps inoculate them from causing higher levels of negative emotions.

Alternatively, users may simply be more forgiving of biological agents since biological agents are believed to be imperfect, that is to say no one ‘living’ is immune to occasional mistakes. Thus a human operator could be expected to make a casual mistake on one problem and then be correct on the next, the same could be said for other living entities. However, robots are generally considered to work perfectly or not at all. For instance, if the program is correctly entered in a robot it should perform the same way every time (Beck, Dzindolet, & Pierce, 2002). Machines tend to be either functional or dysfunctional, thus in the present study in which the agent was unsuccessful on half the trials users may have been less forgiving of nonbiological entities, which gave rise to higher self-ratings of negative emotions.
Agent Attributions

A look at how participants rated the agents’ attributions provides some insight into how they viewed the different types. The first analysis of attributions looked at how users felt about the agents before the interaction (pre) and after the interaction (post). On first being introduced to the agents, participants thought that the entities were significantly more cooperative, aggressive, easy, and significantly less difficult than they thought at the end of the interaction (see Figure 27). This would suggest that these attributes are the most susceptible to be changed by the interaction itself, while ratings of intelligence, likable, and friendly are more enduring regardless of the interaction.

Figure 27: Pre and post ratings of attributes (*significant difference between pre and post evaluations)
An interesting comparison between biological vs. non biological and lifelike vs. non-lifelike can be examined by comparing the attribute ratings. In some, all three agent types are significantly different, showing that the degree of “lifelike features” may be influencing ratings. The Dog is more lifelike then the Robotic Dog which is more lifelike then the Robot. In other attribute ratings, the Dog (the only biological agent) was rated significantly higher then both robots, showing that the biological nature of the agents was judged by participants (see Figure 28).

Figure 28: Average attribute ratings for each agent type

Likable and friendly are attributes where the dog is greater than the robotic dog, and the robotic dog is greater than the robot. These attributes may have a basis in not only the biological nature of the entity but also the whether it is lifelike or not. Not only is the dog more likable and friendly (perhaps due to the biological nature of the dog) then the two robots, but that there is some characteristic (perhaps lifelike design) about the robotic dog that is also more likable and friendly then the robot.
Cooperative, Intelligence, Easy, and Difficult may be based on the biological nature of the entity as the dog was higher than both the robotic dog and the robot in these attributes.

**Positive Emotion by Control Conditions**

It was hypothesized that gratitude would be significantly higher in the low control condition than in the high control condition. This was supported by the results of the study (see Figure 29).

![Gratitude and Appreciation x Control](image)

**Figure 29:** Ratings of gratitude and appreciation for high and low control conditions

This result for gratitude indicates that while adverse consequences may be necessary to distinguish the negative emotions of dislike and anger it is possible to evoke the positive emotion of gratitude without the impact of serious consequences for performance. That is, the sheer joy of successfully completing the task can evoke the emotion of gratitude. It is suggested that the
emotion gratitude be investigated further as a candidate for the emotion experienced during low control situations in which the outcome is successful and caused by another agent (see Table 5).

Table 5: Subset of Roseman et al. (2001) model showing control potential and situational state interactions during a situation caused by another agent with the addition of gratitude as it is hypothesized to exist based on results from study one.

<table>
<thead>
<tr>
<th>SITUATIONAL STATE</th>
<th>MOTIVE-CONSISTENT</th>
<th>MOTIVE-INCONSISTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gratitude</td>
<td>Dislike</td>
</tr>
<tr>
<td></td>
<td>Anger</td>
<td>Contempt</td>
</tr>
</tbody>
</table>

It was hypothesized that appreciation would be rated significantly higher in the high control condition than in the low control condition. This was not supported by the data ($p>.05$). It seems that though gratitude was affected by the level of perceived control, appreciation was not significantly affected by this manipulation. This result may be due again to the fact that there were no extreme repercussions. In this case no beneficial repercussions, to participants for their human-agent team performance. It could also be the case that appreciation is the wrong emotional term for this construct. Roseman et. al. (2001) theory is a categorical theory of emotion, which states that each categorical emotion must have its own unique characteristics. Gratitude, therefore, is unique in that it varies with control potential. Appreciation appears to be a more general term that covers both low and high control situations, making it a less likely candidate for a distinct, categorical emotion.

Hitherto, no appraisal studies have varied control in a successful condition. The fact that the positive emotion of gratitude was significantly different between high and low perceived
control levels demonstrates that humans can differentiate these positive emotions, and they should be included in the future study of appraisal theory. However, again, the fact that appreciation and the negative emotions were not observed to vary over perceived levels of control, indicates that another factor may be vital to inducing these emotions in human operators (i.e., such as investment in performance). A greater reinforcement of success or a greater punishment for failure may have shown a significant distinction in the emotional reaction of the participants.

Audio Measures by Control Conditions

It was hypothesized that median fundamental frequency, floor to ceiling Fundamental Frequency, and intensity would be significantly higher in the high control condition than in the low control condition. All of these measures were not significant ($p > .05$ in all cases). The lack of effect for audio measures by the control conditions could be related to a limitation of the current research. After each trial, users reported their current emotion to the experimenter These reports were used to evaluate audio responses to the previous human-agent interaction. However, since the audio responses were made to the experimenter, the responses may have been colored by the fact that they were being communicated post-hoc (i.e., after up to 2 attempts) to a human experimenter. In future research it may be beneficial to include the operator saying a standard word (e.g., “Attempt Completed”) to the agent itself after the completion of each attempt successful or not. This would also allow for the measuring of vocal emotion content while the experience was happening. The few seconds in-between the experience of the participant’s
emotion and the measure of voice, may have reduced the potency of the emotions effect on the voice.
CHAPTER FOUR: STUDY TWO

Purpose of Study Two

The second study was conducted to compare the results of a vignette method, which has been used for the majority of appraisal theory of emotion studies, to the live experimental method used in the first study. An attempt was made to keep the situations as comparable as possible to elicit similar emotions. In addition, the vignette method allowed the addition of a “human” agent in which to compare the robotic entities to. In the first study, the use of a human agent was not possible due to the nature of the task (if a participant asked a human to turn around and the human did not perform the task, it would not be credible). The ability to have a human as a variable in addition to the robotic entities would allow a direct comparison of the agent type used in previous appraisal theories (that of another human causing the situation), to that of the autonomous robot. Another factor that has been changed is the intent to evoke stronger emotions from the participant by explaining that a hypothetical $400 reward would be the given if the teammate performed the task correctly. This was done to allow a greater distinction between the positive emotions that were measured in the first study by giving the participants greater motivation to achieve the hypothetical task successfully. Last, the variables of interest in this study are the three agent types (human, robot, robotic dog) and perceived control (High and Low), while the variable of situational state (the entity was successful or not) was not manipulated with the vignettes always ending in a positive motive conducive results, the teammate always succeeded in the task.
Study Two - Hypotheses

Manipulation Check

To verify that the experiment was manipulating the variables correctly, the following hypotheses served as manipulation checks for perceived control and that the participant saw the agent as the cause of the situation.

1. Participants’ subjective measures of control (teammate expected performance and control of the situation) should be significantly higher in the high control condition than in the low control condition.

2. Participants’ appraisal of agency should indicate that the teammate has a significantly higher rating as the cause of the situation than the participants themselves or the environment.

Agent Hypotheses

One aspect of emotional reactions that humans have is a social response to other humans actions. This response should be more favorable for the biological and lifelike entities as they invoke a more human-human like interaction.

3. The human condition will evoke significantly higher ratings of the positive emotions (gratitude, appreciation, happy, proud, and affection) than the robotic dog, or the robot condition. The robotic dog will have significantly higher ratings than the robot condition.
Positive Emotion Investigation Hypotheses

In Roseman et. al. (2001) current appraisal theory of emotion, there is no distinction between positive emotions generated in high or low control situations caused by someone else (both conditions are predicted to produce the emotion liking). These hypotheses seek to test if the emotions of gratitude and appreciation are better descriptors of the emotions experienced in these cases.

4. Gratitude will be significantly higher in the low control condition than in the high control condition.

5. Appreciation will be significantly higher in the high control condition than in the low control condition.

Methodology

Participants and Variables

Participants

Participants were undergraduate volunteers recruited from the University of Central Florida through the online psychology participant gathering software, Sona Systems (the department changed to a new online system after study one was performed). Participants received one point of extra credit in their undergraduate psychology classes for their
participation. The study was fifteen minutes in length and took place online over a three week period. A total of 129 (31 male, 98 female) participants were run in this experiment. The participant age range was 18-42 ($M = 21$, $SD = 4$). Prior to experiment two, 4 participants from a convenience sample were used to pilot test the survey for understanding and mistakes.

**Independent Variables**

The experimental design was a 2 (Control Potential; between) x 3 (Agent Type; between) design. Control Potential (high and low) was manipulated by informing the participants during the survey that the entity in question was either very well trained in the task or not well trained. The three agent type conditions presented to the participants were: robot, robotic dog, and human. The participants were not given a description of the agent, only that they were teammates with a “robot”, “robotic dog”, or “human”. In previous vignette research the actors have been human, so the inclusion of a human agent in study two is used to provide a direct comparison between previous studies and the robotic conditions.

**Dependent Measures – Subjective**

After reading through the situation, participants were asked to rate five emotions by answering the question “To what extent do each of the following describe what you would be feeling right now at this moment?” from 0 (not at all) to 10 (extremely). Emotion terms used in the second study included the terms from the first study (Appreciation, Affection, Gratitude, Dislike and Anger) as well as terms that participants used consistently in the question, “at this
moment I feel ______ towards my teammate.” These new terms were: Happy, Proud, Disappointed, and Frustration. Each term was rated from one to seven (not at all - extremely). As part of a larger research project participants also filled out the PANAS (Positive and Negative Affect Schedule) (Watson, Clark, & Tellegen, 1988)

**Manipulation Check Measures**

In order to check the perceived control manipulation, the participants were asked before the outcome of the task, “How well do you think your teammate will perform on this task?” The participants would respond with a number between one and seven, with one being “very poorly” and seven being “very well.” They were also asked how much control they thought they would have over the outcome of the task. They would respond with a number between one and seven, with one being “none” and seven being “complete.” The second question was a direct check of the manipulation, while the first question was asked to see if anticipated performance (which the high or low training might be perceived as) was how the participants viewed the question.

In order to check that each participant was actually assigning the correct responsibility for the outcome (it was important for them to make the appraisal of “other”) three questions were asked on a seven-point scale from “not at all” to “completely.” “My actions were responsible for the outcome of the task, my teammate’s actions were responsible for the outcome of this task, and the environment was responsible for the outcome of the task.” At the end of the experiment the question, “Please take a moment to write down any thoughts you have about the situation described,” was used to gain insight into their perception of the story.
Procedure

Participants followed a web link to the survey located on surveymonkey.com from the Sona Systems online participant management system. A variable was passed from the Sona Systems site that enabled the experimenter to later give credit to the participants. Participants then read an Informed consent form online, and pressed the “next” button to accept. Participants next filled out the PANAS survey. The participant then read a narrative (see APPENDIX I) in which they were to work with a teammate. They were asked questions about their interpretation of situation and about what their emotional reaction would be if they were in that situation. Participants then read a debriefing form online (see APPENDIX I)

Study 2 Results

Manipulation Checks

In order to test whether the manipulation of perceived control was successful, the two dependent variables of participants control over outcome and teammates anticipated performance where compared in the high and low control conditions. A successful manipulation would have both ratings significantly higher in the high control situation. The manipulation of the responsibility of outcome was also tested. In order for a successful manipulation of agency to be achieved, the participant should view the agent (human, dog, or robotic dog) as significantly more responsible for the outcome than themselves or the environment.
Teammate’s Anticipated Performance

A 3 between (agent type: human/robotic dog/robot) x 2 between (control: high/low) Univariate ANOVA was conducted on participants’ ratings of teammate’s anticipated performance.

There was a main effect for agent condition $F(2, 123) = 3.78, p = .026, \eta^2 = 0.06$ (see Figure 30). Post Hoc Least Significant Difference pairwise comparisons on agent condition indicated that the robot agent ($M = 5.29, SE = 0.22$) had significantly higher ratings of expected performance than the human agent ($M = 4.50, SE = 0.20$). The robotic-dog agent was not significantly different from the other two conditions.

Figure 30: Teammate performance expectation as a function of teammate agent type. (*) significant difference
There was a main effect for Control $F(1, 77) = 21.02, p < .0005, \eta^2 = 0.15$ (see Figure 31). Expectations were rated significantly higher in the high-control condition ($M = 5.44, SE = 0.17$) than in the low-control condition ($M = 4.35, SE = 0.17$).

![Figure 31: Teammate’s anticipated performance for high and low control conditions](image)

The interaction between agent and control condition was not significant ($p > .05$).

**Participants’ Control Over Outcome**

A 3 between (agent type) x 2 between (control) Univariate ANOVA was conducted on participants’ ratings of *participants control over outcome*. All effects were nonsignificant ($p > .05$).
Responsibility for Outcome

Three paired sample t-tests were performed to ensure that the teammate was rated the highest as responsible for the outcome (see Figure 32). My teammates actions ($M=5.93$, $SD=1.26$, $SE=0.111$) were rated significantly higher (more responsible) than My actions ($M=3.69$, $SD=1.75$, $SE=0.154$) $t(128)=10.46$, $p<.0005$. My teammates actions ($M=5.93$, $SD=1.26$, $SE=0.111$) were rated significantly higher (more responsible) than circumstances ($M=2.59$, $SD=1.75$, $SE=0.143$) $t(128)=16.36$, $p<.0005$. My actions ($M=3.69$, $SD=1.75$, $SE=0.154$) were rated significantly higher (more responsible) than circumstances ($M=2.59$, $SD=1.75$, $SE=0.143$) $t(128)=5.03$, $p<.0005$.

![Figure 32: Ratings of responsibility for outcome for each agency](image)

*Figure 32: Ratings of responsibility for outcome for each agency*
Responsibility for Outcome

To further investigate participants ratings of responsibility for outcome, an analysis of the results for outcome was performed with agency as a second variable, to look at how the agent condition influenced their rating.

My Actions

A 3 between (agent) x 2 between (control) Univariate ANOVA was conducted on participants’ ratings of responsibility for one’s actions.

There was a main effect for agent condition $F(2, 123) = 3.87, p = .023, \eta^2 = 0.06$ (see Figure 33). Post Hoc Least Significant Difference pairwise comparisons on agent condition indicated that participants in the robotic-dog agent condition ($M = 4.21, SE = 0.26$) had significantly higher ratings of responsibility for the actions in the scenario than participants in the human agent condition ($M = 3.22, SE = 0.25$). The robot agent was not significantly different from the other two conditions ($p > .05$ in both cases).
The main effect for control and interaction between agent and control condition were not significant ($p>.05$).

**Teammate’s Actions**

A 3 between (condition) x 2 between (control) Univariate ANOVA was conducted on participants’ ratings of how responsible their teammate was for the actions. All effects were not significant ($p>.05$).
Environment

A 3 between (condition) x 2 between (control) Univariate ANOVA was conducted on participants’ ratings of how responsible the environment was for the actions in the scenarios. All effects were nonsignificant ($p > .05$).

Emotion Ratings

Each of the emotions rated by the participant (dislike, gratitude, affection, appreciation, anger, happy, proud, disappointed, and frustration) after each interaction with the agent (human, robot, or robotic dog) was investigated to see the influence of the independent variables agent type (human, robot, or robotic dog) and control (high control/low control).

A 3 between (agent type) x 2 between (control) Univariate ANOVA was conducted on participants’ ratings of each emotion.

Dislike

All effects were nonsignificant ($p > .05$).

Gratitude

There was a main effect for agent type $F(2, 123) = 3.65, p = .029, \eta^2 = 0.06$ (see Figure 34). Post Hoc Least Significant Difference pairwise comparisons on agent type indicated that participants in the human agent condition ($M = 6.30, SE = 0.23$) had significantly higher ratings
of emotional gratitude than participants in the robot agent condition ($M = 5.40, SE = 0.25$). The robotic-dog agent was not significantly different from the other two conditions.

**Figure 34**: Gratitude as a function of agent type (*significant difference)

The main effect for control and interaction between agent type and control conditions were not significant ($p > .05$).

**Affection**

All effects were nonsignificant ($p > .05$).

**Appreciation**

There was a main effect for agent type $F(2, 123) = 3.24, p = .043, \eta^2 = 0.05$. Post Hoc Least Significant Difference pairwise comparisons on agent type indicated that participants in the
human agent condition ($M = 6.51, SE = 0.20$) had significantly higher ratings of emotional appreciation than participants in the robot agent condition ($M = 5.77, SE = 0.22$). The robotic-dog agent was not significantly different from the other two conditions.

The main effect for control and interaction between agent type and control condition were not significant ($p > .05$).

**Anger**

All effects were nonsignificant ($p > .05$).

**Happy**

There was an interaction effect for agent type by control condition $F(2, 123) = 3.63, p = .029, \eta^2 = 0.06$ (see Figure 35).

![Control x Agent Type Interaction](image)

*Figure 35: Happiness as a function of control condition.*
The main effect for agent type and the main effect for control condition were not significant ($p > .05$).

Three independent sample t-tests were performed to investigate the agent type by control interaction. The emotion happy was rated significantly higher in the robotic dog condition under high control ($M=6.73$, $SD=.55$) than in the low control condition ($M=5.86$, $SD=1.77$) $t(41)=2.2$, $p=.034$.

There was no significant difference in the other two agent type conditions. $p > .05$

**Proud**

All effects were not significant ($p > .05$).

**Disappointed**

All effects were not significant ($p > .05$).

**Frustration**

All effects were not significant ($p > .05$).
Discussion of Study Two

Manipulation Tests

While expectations of performance varied in the predicted manner with high and low control manipulations, participants’ perceived control was not significantly affected. It is hypothesized that the well trained and not well trained manipulation did not have as strong an effect as when the participant was in front of the agent in study one. Due to this issue, any results of study two in relation to high and low control are suspect.

The participants did make the desired attribution of agency based on responsibility of outcome. The teammate was thought to more responsible for the outcome than the participant’s actions or the circumstance.

Negative Emotions

The agent type or expectation of performance did not seem to have an effect on the emotions of dislike, anger, disappointed, or frustration. This is expected as the results of the all the conditions were successful.

Positive Emotions

Gratitude and Appreciation were rated higher in the biological human condition than in the robot condition, but the Robotic Dog condition was not significantly different than the other
two conditions (see Figure 36). The lack of effects on the other positive emotions may mean that gratitude and appreciation best represent the emotions experienced when a robotic agent performs a successful task in which a participant benefits. However, it may also be that the vignette chosen did not adequately influence the participants’ emotional response.

![Positive Emotion Ratings x Agent Type](image)

*Figure 36: Positive emotion ratings for each agent type (* significant difference between human and robot)*

**Agent Type**

A general pattern emerged from the data indicating that agent type can make a difference in the emotional reactions of participants to events and situations. As in study one, the biological agent (the human in study two) received generally higher ratings of positive emotions over the robotic dog and robot. The robotic dog was rated generally higher than the robot. This pattern was visible in the results of study two even though the vignette forced the participants to imagine their teammate. As in study one, gratitude and appreciation appear to be the most sensitive
emotional ratings for differentiating an agent’s influence. This is consistent with the suggestion that appraisal theorists should investigate these two emotions further.
CHAPTER FIVE: CONCLUSION

Limitations

Study One

In study one there were two factors which limited the ability to test hypotheses. The first was the inability of the dog condition to correctly respond during all conditions. Namely the dog had difficulty in performing all four of the successful conditions tasks. While well trained, the dog performed an average of only three out of the four successful-condition tasks correctly. The variation in the way the commands were presented by the participants appeared to be the cause. Some of the participants were loud and forceful, while others gave the commands in a subdued manner. By only looking at the analysis of the first time the agent performed each condition (successful-high control, unsuccessful-high control, successful-low control, unsuccessful-low control) this problem was addressed. However, the ability to look at all eight of the tasks (each condition being repeated twice) would provide a larger amount of data to analyze over a longer interaction.

The second issue which may have influenced the tasks is the low reward for the participants for performing correctly. While they were told that their goal was to achieve as many tasks successfully as possible, a stronger incentive may have led to more intense positive emotional reactions when they successfully completed the task (gaining a reward), and more intense negative reactions when they did not complete the task (not gaining a reward). The
results of the negative emotions rated indicated that they were not very upset when the agent did not perform the task required. A monetary incentive may have increased this response.

\textit{The Dog Condition}

The dog condition exemplified many of the issues experienced when dealing with a live animal in an experimentally controlled condition, namely that the dog is not remote controlled. There was an issue with the roll over command in which the dog was unable to roll over due to the barrier. The dog would be close to the barrier instead of in the middle of the agent area, which would have given her space in which to roll over. Another problem was the lack of 100 percent consistency in performing the actions. While most of the participants were able to perform three out of the four successful commands (sit, lie down, and turn 360 degrees), there was an issue with a few participants. Although the dog was extremely well trained to perform the successful conditions, some participants would say the commands in a nonchalant voice instead of a commanding voice. The use of voice and hand signals solved most of these issues because the dog would respond to the hand signals even if the voice command was not urgent enough. For one of the commands (turn 360 degrees) it was required to inform the participants to make the hand movement in a counterclockwise circle, as the dog did not respond well to a clockwise circle. They were also instructed to make “a large circle” with their hand as this was most effective. Before the “down” command, they were told to start very high and proceed to very low, as during pilot testing this was the most effective. A movement of only a few inches was not enough to cause the dog to lie down if they were not commanding enough with the voice.
**Robot Condition**

The Lego NXT had difficulty with the command to turn 180 degrees. About 50 percent of the time it would only turn roughly 160 degrees, giving some people an unsure answer as to whether it had completed its task. Another difficulty discovered during pilot testing was that participants did not all have a clear idea of what 90 and 180 degrees entailed. During the experiment, commenting that 90 degrees will mean that your teammate will be facing sideways and that turning 180 degrees your teammate will be facing the opposite direction cleared up this issue.

**Robotic Dog Condition**

The AIBO, when sitting, must, at some point, stand up to perform the next tasks. It was discovered during pilot testing that if the AIBO stood up after the sit command was finished that some participants were confused why it had stood up on its own without input from the participant. The experimenter solved this problem by picking up the AIBO and turning it sideways after the sit command, while the participant filled in the online form. During this time, the control booth operator would stand the AIBO up and place it back on the ground. This had the effect of showing the participants that it had some sort of automatic mechanism that would cause it to stand when picked up off the floor. This seemed to clear up the issue.
**Invocation of Strong Negative Emotion**

One of the issues with an experimental setting in which to test appraisal theory is the difficulty in evoking strong emotional response from participants. While the positive emotional response was satisfactory manipulated in the motive-consistent and motive inconsistent conditions, there was not a very strong negative emotional response to the motive-inconsistent condition. The addition of a monetary incentive, such that the person would not gain money if the participant failed in a motive-inconsistent condition, would lead to a stronger negative emotional response. This would also allow the investigation of the aversive vs. appetitive motive appraisal in which the person is either trying to prevent the loss of money, or in another condition attempting to gain money.

**Study Two**

In the second study there were a few issues that may have influenced the participants in a manner that was unexpected. It is believed that vignette used could be improved to provide a more predictable response. The first issue was the agent description, it was decided to use only the type name of the agent (human, robotic dog, robot) in order to have participants react based on their preconceived notions of each type. This led to confusion, however, where in the discussion question at the end of the survey a few participants thought that the robotic dog was not like an AIBO but was actually a dog that had robotic attachments. Upon further consideration, the robot condition could have been misinterpreted to include a wide variety of
robotic types. It is suggested in future research to provide a better description of the entity the participant is interacting with, perhaps even a photograph of the entity. It may also be beneficial to have the participant describe the agent they were interacting with at the end of the experiment in order to check this manipulation.

The second issue was that of the task performed. The goal was to have the participants believe the task was like a game which they were trying to win. Comments by the participants however made it clear that they thought that the packages that the agents were inspecting were live bombs, and that the task was unrealistic and cruel as a spectator sport. It was difficult to come up with a task in which a human, robot and robotic dog would all be expected to able to complete that would be relevant to the participant. This is an issue that must be addressed if research using vignettes are to applicable to human agent interaction.

Future research

Investigation of more Appraisals

While these studies sought to investigate the impact of motive consistent and motive inconsistent events, agent type, and that of high and low control, other appraisals should be investigated to determine their relevance to human robot interaction. For instance, if the hypothesized appraisals of appetitive and aversive motives influence human-robot interaction in the same manner as they do human-human interaction. One limitation of using a live experiment is the difficulty of incorporating more then a few independent variables, however each study
could look at two of three variables of interest at a time. A follow up study using the same method as study one could easily be altered with a monetary incentive to increase the motivation (and emotional reaction) of the participants. Appetitive vs. aversive motivation could also be added easily by giving the participant at the beginning the monetary incentive while taking away for unsuccessful tasks (aversive motive), or starting the participant with no money and giving them a reward for when they complete a successful task (appetitive motive).

The vignette method, if a better story were used, would be able to incorporate all of the variables at once. The participants only have to fill out a survey which is much easier for high participant counts then the live experimental method. Care should be taken to pilot the vignette extensively, however, to make sure that variables of interest are manipulated correctly.

Investigation of Positive Emotional Episodes when Caused by an “Other”

Few experimental appraisal studies have been carried out that investigate the positive emotions involved when caused by another person. The results of this study show that high and low control during a situation impact participants emotional response and should be investigated more thoroughly. Positive emotional interaction with products is a very popular topic at the moment and appraisal theory may be able to provide a manner of experimental investigation into these factors.
Relevant applications

Implications for Roseman’s Appraisal Theory of Emotion

Hitherto, no appraisal studies have varied control in a successful condition when another entity was the cause. The fact that the positive emotion of gratitude was significantly different between high and low perceived control levels demonstrates that humans can differentiate these positive emotions, and they should be included in the future study of appraisal theory (see Table 6). In addition the emotion appreciation was sensitive to the type of agent a participant had as a teammate. This emotion should be investigated further in order to discover more precisely how it is influenced.

Table 6: Subset of Roseman et al. (2001) model showing control potential and situational state interactions during a situation caused by another agent with the addition of gratitude as it is hypothesized to exist based on results from the two studies.

<table>
<thead>
<tr>
<th>SITUATIONAL STATE</th>
<th>MOTIVE-CONSISTENT</th>
<th>MOTIVE-INCONSISTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gratitude</td>
<td></td>
<td>Dislike</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anger</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contempt</td>
</tr>
</tbody>
</table>

These studies have also shown that Roseman et al. (2001) appraisal theory of emotion is useful in the study of human-robot and human-animal interactions. The appraisals described in the theory do indeed manipulate the emotional reaction of the participants. It is suggested that
further research be conducted to determine if the other appraisals mentioned in the theory also influence human-robot and human-animal interaction.

_Social Human – Robotic Interaction_

Interaction with robots that are created to be social in nature is becoming increasingly popular. The success of the Sony AIBO shows a function for these entities in society. Even robots such as IRobot’s Roomba, have a social component to them. Users often speak of the Roomba using the personal pronoun “he” to describe tasks that the robot is caring out. Care was taken in the design of this robot to make the status sounds indicative of the entities state at the moment, evoking feelings of success when it finishes it task. The study of robot form and the emotional qualities a social robot elicits will play a strong role in the future of autonomous robots becoming common place in the home.

_Military Implications_

The use by the military of robotic forces, to replace or supplement current human forces, intends to increase combat efficiency and effectiveness while at the same time minimizing casualties. Currently the role of robotic forces is filled by remote controlled machines where the emotional impact of working along side them may be minimal. However, the use of autonomous vehicles which require no or reduced human supervision will introduce some interesting questions. How will soldiers react to an autonomous robot as a fellow squad member? How will the civilian population react to having military patrols carried out by robotic forces? If current
global trends continue, war zones will take place in countries where exposure to robotic entities may be at a minimum. The design of robotic forces to reduce the negative emotional reaction of the populous is a must.
APPENDIX A
STUDY ONE: INFORMED CONSENT
Study One

Informed Consent Form

The University of Central Florida and UCF Psychology Department support the protection of human subjects participating in research. We are presenting the following information so that you can decide whether you wish to participate in this study.

In this study, you will be asked to direct a non-human teammate to perform certain behaviors. Previous to the session you will be asked to fill out a questionnaire. During the session, we may record various physiological measures including heart rate and galvanic skin response (a measure of skin conductance). You will also be audio and video taped. The recordings and all physiological data will be stored in a locked cabinet after completion of the study and will be destroyed once data analysis and transcription has been completed. Only lab researchers will have access to the recordings. After the completion of the tasks, you will be asked to fill out a questionnaire. As researchers we are interested in how people in general answer questions. We are not interested in any particular person’s specific responses. Furthermore, all of the data collected in this study will be kept completely confidential and throughout the study, you will be identified by a subject number only. No names will be used. The subject number will not be linked to your name in any way.

The study should require less than two hours of your time. If you have signed up for this study through ExperimenTrak, standard extra-credit will be awarded to your account. No other compensation will be awarded besides this extra credit. Your participation is strictly voluntary and you may withdraw at any time without consequence. You must be 18 years or older to participate. If you choose not to or cannot participate, an alternative assignment will be available to you for the same extra credit.

There are no anticipated risks to you as a subject in this study. The benefit to you is added knowledge about participation in psychological research. Some of this research may be published in the form of journal articles, posters or presentations. The results will be analysis in aggregate form; individual answers and physiological data will not be published.

If you wish to see the results of this study, you may request a write-up of them from the investigators below. Additionally, you may contact the investigators with questions about this research.

Primary Investigators:

Valerie Sims, PhD
Department of Psychology
University of Central Florida
(407) 823-0343
Vsi1ms@gmail.com

Matthew Chin, PhD
Department of Psychology
University of Central Florida
(407) 823-2565
dr.matthew.chin@gmail.com

This research study has been reviewed and approved by the UCF Institutional Review Board. Questions or concerns about research participants’ rights may be directed to the UCF IRB office, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246. The telephone number is (407) 823-2901

If you believe you have been injured during participation in this research project, you may file a claim with the UCF Environmental Health & Safety, Risk and Insurance Office, P.O. Box 163500, Orlando, FL, 32816-3500 (407) 823-6300. The University of Central Florida is an agency of the State of Florida for purposes of sovereign immunity and the university’s and state’s liability for personal injury or property damage is extremely limited under Florida law.
Accordingly, the university’s and state’s ability to compensate you for any personal injury or property damage suffered during this research project is very limited.

I have read the procedure described above. I voluntarily agree to participate in the procedure and I have received a copy of this description, and I am 18 years of age or older.

I agree to be audio and video taped_____ YES _____ NO

Signature of Participant: ___________________________ Date: ________________
Dog-AIBO Experimenter Script

PRE-EXPERIMENT

Before participant arrives, assign a participant number. Take out “randomized task list” Turn on all equipment:
CPU1: Open BSLpro (BioPac), WinTV2000(Video recording), robot entity software
CPU 2: Log into website (acatlab.com\UCCASS) and open “Human-Agent Interaction and enter participant #
Turn on TV
Activate Lego/AIBO

Experimenter
Control Booth
Italics is said aloud by Experimenter

Experiment Start

Experimenter: Hello and thank you for coming in today. If you have a seat right there we can get started. The experiment is going to take about an hour. Before we get started you will need to read over and sign the informed consent form.

Hand participant Informed Consent. Once signed, put into signed consent folder.

Experimenter: Next there is a brief survey which asks about what kind of mood you are in today.

Write participant number at the top and hand participant the PANAS survey. Once signed, put into PANAS folder.

Turn headset on, make sure microphone is facing participant.

Experimenter: In order to record your communication with your teammate we need to place this headset on. Please adjust the microphone so it is about 1 inch from your mouth and slightly to the side. Please read these statements that will allow us to check the volume and microphone placement.

Point to Microphone instruction sheet on cover of binder.

Participant reads the phrases on the microphone sheet. “A-Z”, “Pedro’s puppy is playful” “Peggy’s paper is purple”, “Patty’s pizza is perfect”

Control Booth operator will verify audio for loudness and P’s. and give the thumbs up though the window.
Experimenter: During this experiment we will be monitoring your galvanic skin response and heart-rate. In order to do this we need to attach a few stickers to your wrists, fingers and ankles.

Attach the EKG and GSR electrodes as per diagrams.

Experimenter: Next we have a brief survey to learn a little more about you. Your answers are anonymous and not associated with your name. Please continue until you see a red “STOP” on the screen.

Start the online survey on the survey computer and enter the participant number. The participant then fills out the Demographics portion of the online survey.

Experimenter: In this study, you will be cooperating with a teammate to accomplish a set of tasks. This will be the teammate you will be working with today.

(Introduce teammate by retrieving the dog, robotic dog, or robot from Control Room, and place teammate behind barrier. Inform participant there can be no physical contact.

Experimenter: Please return to the computer. The next few questions ask you what kinds of attributes you believe your teammate possesses. Continue until you see a red STOP.

Participant fills out the Pre-Attribution section of the online survey.

Make sure the participant is standing in the middle of the box in front of the teammate barrier.

Press the BioPac control switch in front of the overhead camera.

Experimenter: Now let me explain what you will be doing today. We are working with the Army to test vocal and visual signals when communicating with non-human teammates. Previous research has been conducted to train your teammate to respond to certain hand and voice signals. Your teammate has been trained very well to respond to half of the commands you will be giving today, and the other half it has only been briefly trained on. We will be video and audio recording your interaction to see how successful the training was. We are also interested in how you feel about interacting with a non-human teammate so we will be asking you some questions about your interactions.

During your interaction you will be trying to accomplish a series of 8 tasks with your teammate. It is your goal to accomplish as many of these eight tasks successfully as possible. For each of the tasks you will have 2 attempts to accomplish the task.
For each task, I will first tell you task number and how well your teammate is trained in that task. I will ask you how well you think your teammate will perform on the task, as well as how much control you think you have over the outcome of the task. Then the task will begin.

Please start by saying “Teammate” and then give the command at the same time as the hand gesture. On the wall you can see the corresponding hand signal with each command. (Point to wall).

After you give the command, your teammate will attempt to accomplish the task. After the attempt, I will ask you “Do you believe your teammate has completed the task” Please answer Yes or No. If your answer is No, you will be given a second attempt at accomplishing the task. I will then repeat the question.

After this you will be asked to pick a word that describes how you are feeling towards your teammate right at this moment. Here is a list of sample emotions. Feel free to use your own word or any word from the list. When you have a word in mind, please read the following sentence aloud. (Point to sentence.)

Do you have any questions up to this point? Okay let’s get started.

Repeated for each of the 8 conditions:

Experimenter: The next task that you and your teammate will attempt is number ___. (fill in with number on experimenter sheet). Your Teammate is )very well trained / not very well trained) in this task.

Experimenter: The task you and your teammate will attempt next is...
Wait for participant to respond with the command

Experimenter: How well do you think your teammate will perform in this task?
Wait for participant to give answer, and write down number on experimenter sheet

Experimenter: How much control do you think you will have over the outcome of this task?
Wait for participant to give answer, and write down number on experimenter sheet

Experimenter: OK, you may proceed
Participant then says Teammate ________. (command)
Agent performs action.

Experimenter: Do you think your teammate has completed the task?
If no repeat previous
If yes continue
Experimenter: Please first choose a word and then read the following sentence...
Write down answer on experimenter sheet.
Experimenter: Please fill out the following questions based on the interaction you just had with your teammate.

Participant moves to survey station and fills out survey

On the last condition (condition 8) add that there are a few extra questions at the bottom.

Experimenter: Based on your interaction today please rate your teammate on the following attributes.
Participant fill out post attribute questionnaire.

Experimenter: Thank you for participating today there are just few more things to do

Remove headset and electrodes.

Experimenter: Please fill out the following surveys
Participant fills out the ATS and PAT on the survey computer

Hand debriefing form and ask if there are any questions about the experiment. Give a brief overview of what is being studied

Hand participant the experiment evaluation form, tell them it may be turned in on the third floor of the psychology building.
<table>
<thead>
<tr>
<th>Participant #</th>
<th>Code</th>
<th>Command</th>
<th>1st Attempt</th>
<th>2nd Attempt</th>
<th>Condition</th>
<th>#/Hi-Lo</th>
<th>Y/N</th>
<th>Y/N</th>
<th>Emotion Word</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 to 7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How well do you think your teammate will perform in this task? From 1 to 7, 1 being very poorly, 7 being very well

How much control do you think you will have over the outcome of this task? From 1 to 7, 1 being very poorly, 7 being very well

How well do you think your teammate will perform in this task? From 1 to 7, 1 being very poorly, 7 being very well

How much control do you think you will have over the outcome of this task? From 1 to 7, 1 being very poorly, 7 being very well

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How much control do you think you will have over the outcome of this task? From 1 to 7, 1 being very poorly, 7 being very well

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How much control do you think you will have over the outcome of this task? From 1 to 7, 1 being very poorly, 7 being very well

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How much control do you think you will have over the outcome of this task? From 1 to 7, 1 being very poorly, 7 being very well

How well do you think your teammate will perform in this task? From 1 to 7, 1 being very poorly, 7 being very well

How much control do you think you will have over the outcome of this task? From 1 to 7, 1 being very poorly, 7 being very well

How well do you think your teammate will perform in this task? From 1 to 7, 1 being very poorly, 7 being very well

How much control do you think you will have over the outcome of this task? From 1 to 7, 1 being very poorly, 7 being very well

How well do you think your teammate will perform in this task? From 1 to 7, 1 being very poorly, 7 being very well

How much control do you think you will have over the outcome of this task? From 1 to 7, 1 being very poorly, 7 being very well

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How much control do you think you will have over the outcome of this task? From 1 to 7, 1 being very poorly, 7 being very well

How well do you think your teammate will perform in this task? From 1 to 7, 1 being very poorly, 7 being very well

How much control do you think you will have over the outcome of this task? From 1 to 7, 1 being very poorly, 7 being very well

How well do you think your teammate will perform in this task? From 1 to 7, 1 being very poorly, 7 being very well

How much control do you think you will have over the outcome of this task? From 1 to 7, 1 being very poorly, 7 being very well

1. The task you and your teammate will attempt next is
2. Ask two questions: please face your teammate and wait for a minute
3. Ok, Please proceed
4. Do you believe your teammate has completed the task?
5. Please choose a word that most closely describes how you feel toward your teammate and read the phrase aloud.
6. Please continue the game by answering the questions about the interaction you just had.

**Figure 37: Experimenter sheet.**
Directions

This scale consists of a number of words that describe different feelings and emotions. Read each item and then circle the appropriate answer next to that word. Indicate to what extent you have felt this way during the past week.

Use the following scale to record your answers.

(1) = Very slightly or not at all  (2) = A little  (3) = Moderately  (4) = Quite a bit  (5) = Extremely

<table>
<thead>
<tr>
<th></th>
<th>Very slightly or not at all</th>
<th>A little</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Interested</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>Distressed</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>Excited</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>Upset</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5.</td>
<td>Strong</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>Guilty</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7.</td>
<td>Scared</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8.</td>
<td>Hostile</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>Enthusiastic</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10.</td>
<td>Proud</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11.</td>
<td>Irritable</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12.</td>
<td>Alert</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13.</td>
<td>Ashamed</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14.</td>
<td>Inspired</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15.</td>
<td>Nervous</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16.</td>
<td>Determined</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17.</td>
<td>Attentive</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18.</td>
<td>Jittery</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>19.</td>
<td>Active</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>20.</td>
<td>Afraid</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

*Figure 38: Attribute questionnaire.*
Figure 39: Computerized demographic questionnaire experiment 1.
**Figure 40:** Computerized pre-attributions questionnaire.
**TASK 1/8 Post-Interaction**

To what extent do each of the following describe what you are feeling right now at this moment:

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
<tr>
<td>19. Affection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Anger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Appreciation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Dislike</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Gratitude</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

24. **My actions were responsible for the outcome of this task.**
   Not at all | Completely |
   | | | | | | | | | | |
25. **My teammates actions were responsible for the outcome of this task.**
   Not at all | Completely |
   | | | | | | | | | | |
26. **The environment was responsible for the outcome of this task.**
   Not at all | Completely |
   | | | | | | | | | | |

Please **STOP** and inform the experimenter that you are finished with this part.

---

**Figure 41:** Computerized post-interactions questionnaire.
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. COOPERATIVE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. INTELLIGENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. LIKEABLE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. FRIENDLY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. AGGRESSIVE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. EASY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. DIFFICULT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90. Importance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>91. Influence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>92. Interaction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 42:** Computerized post-attributions questionnaire.
Figure 43: Hand signal for sit command.
Figure 44: Hand signal for lay down command.
Figure 45: Hand signal for turn 360° command.
Figure 46: Hand signal for roll over command.
Figure 47: Hand signal for move in a large circle command.
Figure 48: Hand signal for move forward command.

“Teammate: Move Forward”
Figure 49: Hand signal for move backward command.
Figure 50: Hand signal for make noise command.

“Teammate: Make Noise”
“Teammate: Turn 180°”

Figure 51: Hand signal for turn 180° command.
Figure 52: Hand signal for zig-zag command.
“Teammate: Look Left, Look Right”

Figure 53: Hand signal for look left look right command.
Figure 54: Hand signal for stand up command.
APPENDIX E
STUDY ONE: WALL INSTRUCTIONS
Before Task:

1. The task you and your teammate will attempt next is ________.

2. How well do you think your teammate will perform in this task?

   very poorly 1 2 3 4 5 6 7 very well

3. How much control do you think you will have over the outcome of this task?

   none 1 2 3 4 5 6 7 complete
At this moment, I feel _______ towards my teammate.

Dislike  Gratitude  Affection
Appreciation  Anger
APPENDIX F
STUDY ONE: POST EXPERIMENT FORMS
Debriefing Statement

Thank you for participating in this study. The main objective of this research is to investigate the influence of trait ratings of perceived control on participants interaction with non human teammate. Previous studies have shown that perceived control in a care giving situation may influence interaction with animals and robotic entities. Perceived control may manifest itself in word and grammar choices as well as physiological measures. In addition, ratings of the non-human teammate on attributions such as intelligence, cooperativeness, etc. may vary. This study created situations in which the teammate is cooperative (able to complete task) and uncooperative (unable to complete task) and measured participants responses.

Please do not discuss the specifics of this experiment with your peers as some of them may not have participated yet.

If you have any questions about your participation in this study, feel free to contact the Principle Investigators listed below.

Valerie Sims, PhD
Department of Psychology
University of Central Florida
(407) 823-0343
vsi1ms@gmail.com

Matthew Chin, PhD
Department of Psychology
University of Central Florida
(407) 823-2565
dr.matthew.chin@gmail.com
Psychology Research Experience Evaluation Form for Participants

Please complete this form to evaluate your experience as a participant in the [RESEARCHER] Study conducted by [RESEARCHER] (Researcher).

Your Current Psychology Course(s): ______________________________________________________________________

This is important to our educational efforts and the feedback you provide will aid in the evaluation and possible modification of the research participation experience. Your answers are anonymous.

When you have completed this form, return it to the Psychology Department Main Office, Phillips Hall, Room 302. For each question, please circle the statement that best indicates your response.

Do you clearly understand the purpose of this study?

The researcher did not explain the purpose, I did not receive a written or oral explanation of the study. The researcher explained the purpose or gave me a written explanation of the study, but did not give me a way to ask further questions. The researcher explained the purpose, gave me a chance to ask questions, and answered the questions I had.

Was participating in this study a learning experience for you?

I completed the study, but did not receive any additional information. I furthered my learning about the research process (informed consent, debriefing, etc.) OR this specific study (not both). I gained information about the research process and this specific study. I gained information about the research process, this specific study, and research that supports this study.

Were you treated with courtesy and respect?

The researcher did not treat me with courtesy and respect. The researcher treated me with some courtesy and respect. The researcher treated me with an acceptable level of courtesy and respect. The researcher treated me with a great deal of courtesy and respect.

Additional comments (continue on back if necessary):

Figure 55: Student research evaluation form.
Notice of Exempt Review Status

From: UCF Institutional Review Board
FWA00000351, Exp. 5/7/10, IRB00001138

To: Aaron A. Pepe

Date: June 04, 2007

IRB Number: SBE-07-05030

Study Title: Applying the Appraisal Theory of Emotion to Human-Agent Interaction

Dear Researcher:

Your research protocol was reviewed by the IRB Chair, Vice-chair or designated reviewer on 6/4/2007. Per federal regulations, 45 CFR 46.101, your study has been determined to be minimal risk for human subjects and exempt from further IRB review or renewal unless you later wish to add or use identifiers or change the protocol procedures in a way that might increase risk to participants. Before making any changes to your study, submit the Addendum/Modification Request Form for IRB approval. If the risk changes to greater than minimal risk, you will have to submit a new application for the study for expedited or full board review.

The category for which exempt status has been determined for this protocol is as follows:

- Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey or interview procedures, or the observation of public behavior, so long as confidentiality is maintained.

A waiver of documentation of consent has been approved. Participants do not have to sign a consent form, but the IRB requires that you give participants a copy of the IRB-approved consent form or letter. All data must be retained for a minimum of three years past the completion of this research. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel. Advise the IRB if you receive a subpoena for the release of this information or if a breach of confidentiality occurs. Also, report any unanticipated problems or serious adverse events (within 5 working days).

Sincerely,

Signature applied by Janice Turchin on 06/04/2007 10:30:04 AM EDT

Figure 56: IRB letter of exemption.
May 17, 2007

Valerie Sims, Ph.D. and
Matthew Chin, Ph.D.
University of Central Florida
Department of Psychology
Psychology Building
Orlando, FL 32826-1390

Dear Drs. Sims and Chin:

With reference to your protocol #3459 entitled, “Analysis of Perceived Control and Vocal Intonation during Dog Training” I am enclosing for your records the approved, expedited document of the UCFIRB Form you had submitted to our office. This study was approved on 5/15/2007. The expiration date for this study will be 5/14/2008. Should there be a need to extend this study, a Continuing Review form must be submitted to the IRB Office for review by the Chairman or full IRB at least one month prior to the expiration date. This is the responsibility of the investigator.

Please be advised that this approval is given for one year. Should there be any addendums or administrative changes to the already approved protocol, they must also be submitted to the Board through use of the Addendum/Modification Request form. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur.

Should you have any questions, please do not hesitate to call me at 407-823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,

Joanne Muratori
(FWA0000351 Exp. 5/7/2010, IRB00001138)

Copies: IRB File

Figure 57: IRB letter of approval for study (expiration 5/14/2008).
June 2, 2006

Valerie Sims, Ph.D. and
Matthew Chin, Ph.D.
University of Central Florida
Department of Psychology
PH 309C
Orlando, FL 32816-1390

Dear Drs. Sims and Chin:

With reference to your protocol #06-3459 entitled, "Analysis of Perceived Control and Vocal Intonation during Dog Training," I am enclosing for your records the approved, expedited document of the UCFIRB Form you had submitted to our office. **This study was approved on 6/2/06. The expiration date will be 6/1/07.** Should there be a need to extend this study, a Continuing Review form must be submitted to the IRB Office for review by the Chairman or full IRB at least one month prior to the expiration date. This is the responsibility of the investigator. **Please notify the IRB office when you have completed this research study.**

Please be advised that this approval is given for one year. Should there be any addendums or administrative changes to the already approved protocol, they must also be submitted to the Board through use of the Addendum/Modification Request form. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur.

Should you have any questions, please do not hesitate to call me at 407-823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,

Barbara Ward

Barbara Ward, CIM
UCF IRB Coordinator
(FWA00000351 Exp. 5/13/07, IRB00001138)

Copies: IRB File

BW: jm

Figure 58: IRB letter of approval for study (expiration 06/01/2007).
Study two

Informed Consent

Please read this consent document carefully before you decide to participate in this study. You must be 18 years of age or older to participate.

Project title: Applying the Appraisal Theory of Emotion to Human-Agent Interaction

Purpose of the research study: The purpose of this research is to determine the impact of agent type on perceived appraisal of a situation. The current effort seeks to determine under what conditions agent type influences perceived control and situation conduciveness.

What you will be asked to do in the study: This study involves the use of an online questionnaire. You will read a hypothetic scenario, imagining yourself in that situation. You will be asked to answer some questions about how you interpret and feel about this hypothetical situation. You will also be asked to fill out a survey about your mood today and a brief demographics questionnaire.

Time required: Approximately 30 minutes.

Risks: Minimal.

Benefits/Compensation: Participants will be offered the benefit of 1 point of course credit in undergraduate psychology (equivalent to 30 minutes research). Credit will be tracked through the UCF Sona Systems software.

Confidentiality: Your identity will be kept confidential. Your information will be assigned a participant number. The list connecting your name to this number will not be released to anyone who is not directly involved in conducting this study. Your name will not be used in any report. The analysis of this research will be in aggregate form and individual answers will not be published.

Voluntary participation: Your participation in this study is voluntary. There is no penalty for not participating. You have the right to withdraw from the study at any time without penalty.

Whom to contact if you have questions about the study:
Primary Investigator: Aaron Pepe
Graduate Research Assistant
University of Central Florida
Cell: 321 – 278- 0311
aaronpepe@hotmail.com

Faculty Supervisor: Valerie Sims, PhD
Whom to contact about your rights in the study: Research at the University of Central Florida is conducted under the oversight of the UCF Institutional Review Board. Questions or concerns about research participants' rights may be directed to the UCF IRB office,

University of Central Florida
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, FL 32826-3246.
The telephone number is 407-823-2901

By pressing the "next" button, I have read the procedure described above and I voluntarily agree to participate in the study.
1. Informed Consent

Informed Consent Form

Please read this consent document carefully before you decide to participate in this study.

You must be 18 years of age or older to participate.

Project title: Applying the Appraisal Theory of Emotion to Human-Agent Interaction

Purpose of the research study: The purpose of this research is to determine the impact of agent type on perceived appraisal of a situation. The current effort seeks to determine under what conditions agent type influences perceived control and situation conduciveness.

What you will be asked to do in the study: This study involves the use of an online questionnaire. You will read a hypothetical scenario, imagining yourself in that situation. You will be asked to answer some questions about how you interpret and feel about this hypothetical situation. You will also be asked to fill out a survey about your mood today and a brief demographics questionnaire.

Time required: Approximately 30 minutes.

Risks: Minimal.

Benefits/Compensation: Participants will be offered the benefit of 1 point of course credit in undergraduate psychology (equivalent to 30 minutes research). Credit will be tracked through the UCF Sona Systems software.

Confidentiality: Your identity will be kept confidential. Your information will be assigned a participant number. The list connecting your name to this number will not be released to anyone who is not directly involved in conducting this study. Your name will not be used in any report. The analysis of this research will be in aggregate form and individual answers will not be published.

Voluntary participation: Your participation in this study is voluntary. There is no penalty for not participating. You have the right to withdraw from the study at any time without penalty.

Whom to contact if you have questions about the study:
Primary Investigator: Aaron Pepe
Graduate Research Assistant
University of Central Florida
Cell: 321-278-0511
eaoropepe@hotmail.com

Faculty Supervisor: Valerie Sims, PhD
Department of Psychology
University of Central Florida
(407) 823-3442
vsims@pegasus.cc.ucf.edu

Whom to contact about your rights in the study: Research at the University of Central Florida is conducted under the oversight of the UCF Institutional Review Board. Questions or concerns about research participants' rights may be directed to the UCF IRB office.

University of Central Florida
Office of Research & Commercialization
12201 Research Parkway, Suite 501, Orlando,
FL 32826-3246. The telephone number is 407-823-2901

By pressing the "next" button, I have read the procedure described above and I voluntarily agree to participate in the study.
2. Demographics

1. Age:

2. Gender
   - Male
   - Female

3. Have you ever had a pet?
   - Yes
   - No

4. If you answered yes to the previous question, what kind? *please check all that apply*
   - dog
   - cat
   - bird
   - fish
   - reptile
   - small mammal
   - other

5. Have you ever had a robot or mechanical toy?
   - Yes
   - No

6. If you answered yes to the previous question, what kind? *Please check all that apply*
   - Roomba
   - AIBO
   - RoboSapien
   - RoboReptile
   - Remote control vehicle
7. Do you have any children?
- Yes
- No

8. If you answered yes to the previous question, what age and gender?

9. Please answer the following:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you like dogs?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you like robots or mechanical toys?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Randomization Question

1. Please select the choice that appears on the top of the following list:
- Proceed to survey 9
- Proceed to survey 6
- Proceed to survey 2
- Proceed to survey 10
- Proceed to survey 1
3. PANAS

1. Directions

This scale consists of a number of words that describe different feelings and emotions. Read each item and then circle the appropriate answer next to that word. Indicate to what extent you have felt this way today.

<table>
<thead>
<tr>
<th>Word</th>
<th>Very slightly or not at all</th>
<th>A little</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interested</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Distressed</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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</tr>
<tr>
<td>Excited</td>
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<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Upset</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Strong</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Guilty</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Scared</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Hostile</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Enthusiastic</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Proud</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Irritable</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Alert</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Ashamed</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Inspired</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Nervous</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Determined</td>
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<td>○</td>
<td>○</td>
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</tr>
<tr>
<td>Attentive</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<td>○</td>
</tr>
<tr>
<td>Jittery</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Active</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Afraid</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<td>○</td>
</tr>
</tbody>
</table>
You tell your teammate in a loud, clear voice, “move forward and identify the bomb with TNT”. Your teammate moves to the end of the field and stops briefly at each of the devices. Your teammate then goes to stand by the device to the far right.

The judge raises his flag and declares that your teammate has identified the correct one. You will receive the $400 prize.
3. To what extent does each of the following describe what you would be feeling towards your teammate at this moment?

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dislike</td>
<td></td>
<td></td>
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<tr>
<td>Appreciation</td>
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<tr>
<td>Anger</td>
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<tr>
<td>Proud</td>
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<td>Disappointment</td>
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<tr>
<td>Gratitude</td>
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<tr>
<td>Affection</td>
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<tr>
<td>Happy</td>
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<td></td>
</tr>
<tr>
<td>Frustration</td>
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<td></td>
</tr>
</tbody>
</table>

4. Who was responsible for the outcome of the task?

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>My teammate's actions were responsible for the outcome of this task</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Circumstances that were beyond anyone's control were responsible for the outcome of this task.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>My actions were responsible for the outcome of the task</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Please take a moment to write down any thoughts you have about the situation described:
Debriefing form

Thank you for your involvement in the preceding experiment entitled: Applying the Appraisal Theory of Emotion to Human-Agent Interaction. Your participation will help in the understanding of how users interact differently with human and nonhuman teammates depending on the situation that they are in. We request that you do not discuss the aspects of this experiment with others as we would like for everyone that participates to have a similar experience as yourself. Please feel free to email the experimenter any questions you may have about this research (see below) and thank you again for your time.

You should receive credit in 48 hours. Please contact the experimenter if you do not receive credit.

For questions contact:
Aaron Pepe
Graduate Research Assistant
Applied Cognition and Technology Lab
aaronpepe@hotmail.com
321-278-0311
LIST OF REFERENCES


*Speech Communication, 40*(1), 227-256.


Unit Command Climate Assessment and Survey System. from

http://www.bigredspark.com/survey.html
