# UNDERSTANDING THE CONSTRUCT OF HUMAN TRUST IN DOMESTIC SERVICE ROBOTS

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**UNDERSTANDING THE CONSTRUCT OF HUMAN TRUST IN DOMESTIC SERVICE ROBOTS**

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## SUMMARY

Ideologies surrounding the use of robots are changing. For example, the viewpoint that manufacturing robots can be left alone in a factory and take care of everything is fading. Next generation robots will collaborate with humans rather than replace them. Thus, the relationship between humans and robots will get more complex, especially as the use of robots expands past the manufacturing floor and moves into environments that require closer interactions with humans, such as domestic service robots (i.e., herein referred to just as robots) designed to assist in a home environment.

Simple robots such as the Roomba vacuum are already being deployed and adopted by some consumers for use at home. The robots currently in development for home use are far more sophisticated. However, it was not know the extent to which humans would trust them. Therefore this study was critical to understand what may influence human trust in robots.

This study provides a foundation for understanding the construct of human trust in robots within a range of potential users (e.g., younger and older adults) that may have different capabilities and experiences with technology. In this study, to account for the range of potential users, 12 younger adults (aged 18-28) and 24 older adults (12 low technology users and 12 high technology users) aged 65-75 participated in several activities for this study (e.g., structured interview, card-sorting task, and questionnaires).

Participants engaged in a three-section structured interview. During the first half of section one of the interview, participants were asked several questions to elicit how they would define trust in robots. In the second half of the section one interview, participants were asked questions to gauge what they would want to know about the robot

that would help them decide to trust or distrust it. In between the interview, a card-sorting task was used to identify the top five characteristics they associated with a trustworthy and untrustworthy robot. The second section of the interview asked about their trust in a robot for 12 different home-based tasks and the reasons that lead to their trust decision. After the second section of the interview, participants completed an assortment of questionnaires that was designed to assess their attitudes and opinions about their experience with robots, characteristics associated with trust and distrust in robots, and trust preferences for humans or robot assistance with tasks. The third and final section of the interview evaluated how participants visualized any robots they envisioned while participating throughout the study.

Most participants had very little experience with robots. However, most had positive opinions about robots and indicated they would trust a robot to assist with tasks in their homes, though it was dependent on the task. Before making a decision to trust a robot, participants wanted to know a lot of information about the robot such robot reliability, capabilities, and limitations. When asked to select their trust preference for human versus robot assistance for specific tasks, participants had preferences for both human and robot assistance, although it was dependent on the task. Many participants defined trust in robots similar to definitions of trust in automation. Additionally, they had high rates of selection for adjectives used to describe trust in automation and also selected some adjectives used to describe trust in humans, when asked to select characteristics they most associated with trustworthy and untrustworthy robots. Most participants visualized a robot during the study. Overall, there were some differences between age and technology experience groups, but there were far more similarities between groups.

# CHAPTER 1

# INTRODUCTION

Robots are moving out of the laboratory and into some professional health care settings. Physicians, caregivers, and patients are communicating through telepresence robots that have led to better care management (Vespa, Miller, Hu, Nenov, Buxey, & Martin, 2007). Robots are assisting doctors in a wide range of surgical procedures that are minimally invasive, result in quicker healing times, and lower patient risk for infection (Lanfranco, Castellanos, Desai, & Meyers, 2004). Robots are also being used to fill prescriptions in pharmacies and to deliver medications with high levels of success. Errors in refills and delivery have decreased significantly (Franklin, O'Grady, Voncina, & Popoola, 2008; Summerfield, Seagull, Vaidya & Xiao, 2011).

Plans are now in place to develop robots as assistants in home health care situations. However, there are many challenges in trying to bring this kind of technology into people's homes. It is not adequately known the extent that humans may trust these robots to perform tasks for them, or even with them as they might another human. Understanding how human trust in robots develops is currently not well understood, but is necessary for the successful integration of robots into a home environment.

## Trust in Human Relationships

Trust is an important mediator in human relationships (Barber, 1983; Rempel, Holmes, & Zanna, 1985). It is a central facilitator between humans in their interactions with each other and nurturing trust is important in sustaining and growing relationships (Blomqvist, 1997; Gambetta, 1988; McKnight, Cummings, & Chervany, 1998). Trust, as a construct can be abstract, variable, and dependent on many influences. The literature

on interpersonal trust describes trust as being an expectation based on predictability, dependability, competence, and faith (Barber, 1983; Deutsch, 1958; Giffin, 1967; Mayer, Davis, & Schoorman, 1995; Rempel et al., 1985; Rotter, 1971).

What influences the expectations between people that can lead to trust? One of the most widespread expectations a trustor (i.e., the person who is trusting) may have in a trustee (i.e., the person being trusted) is predictability. That is, the predictability of the trustees' behavior in a given situation is as the trustor expects (Rempel et al., 1985). For example, my brother's timeliness is predictable. I expect that every year my brother will send me a birthday card two weeks late.

Dependability has also been identified to influence trust. It refers to the trustors' stable experiences with the trustee being consistently reliable or not (Rempel et al., 1985). For instance, I know that my best friend will always return my calls.

Competence also has been acknowledged to influence trust. It refers to the expectation that the trustee is credible (Giffin, 1967). That is, the trustee is an expert about a particular knowledge set, has a given amount of ability or skill, or has performed a given routine everyday (Barber, 1983). For example, I expect that my doctor will perform a medical procedure properly.

Another identified influence for trust is faith. It is unique because faith is a belief in something without the support of evidence, such as religion. Trust therefore is defined as the trustors' attitude, rooted in their expectations, that is based on faith or the experiences of the trustees' predictability, dependability, and competence for particular event. Trust however, is not a construct that only exists between people; it also exists in

human-automation relationships (Dzindolet, Pierce, Beck, & Dawe, 2002; Lee & Moray, 1992; Muir, 1987).

## Trust in Human-Automation Relationships

I define human trust in automation as an attitude and expectation that the machine's functions and capabilities, although uncertain, is based on the predictability and reliability of the current or past state of the machine. Human trust in automation has been studied at length which suggests is critical for proper use of the machine or system (see for a review, Lee and See, 2004). However, humans can make misuse and disuse errors as a result of inappropriate trust in automation (Parasuraman & Riley, 1997). A misuse error is following the advice of automation, when it is incorrect. A disuse error is disregarding the advice of automation when it is correct. To mitigate these types of errors it is important to understand what can influence trust in automation.

There are many human and machine influences that can impact a humans' trust in an automated machine or system. I have identified seven that have empirical evidence that suggests having a direct influence on trust. They are the quality of system feedback, automation reliability, perceived automation reliability, detection of automation errors, operator self-confidence, extroversion, and perceived easiness of automation errors (see Table 1). Furthermore, there are additional variables that may indirectly influence are predicted to influence trust in automation such as operator knowledge, situation awareness, level of automation, workload, neuroticism, agreeableness, openness, and conscientiousness (see Table 2). The relationships between these variables and trust have been identified and are outlined in a framework I developed (see Figure 1). It is not known if, or to what extent, these variables also influence human trust in robots.

Table 1

*Human and Machine Variables Directly Influencing Trust in Automation*

| Variable | Domain | Effect on Trust | Citations |
|---|---|---|---|
| Quality of system feedback | Machine | The study found better calibration of appropriate trust when the quality of feedback is high. | Seong & Bisantz, 2008 |
| Automation reliability | Machine | Findings are mixed. Some studies found higher reliability leads to higher trust, but other studies found no affect of reliability on trust. | Dzindolet et al., 2001; Parasuraman et al., 1993; Wang et al., 2009; Wiegmann et al., 2001; |
| Perceived automation reliability | Human | Studies found that as perceived automation reliability increased, so did trust. | Madhaven & Wiegmann, 2007 |
| Detection of automation errors | Human | Findings are unclear. Initial detection of automation errors lead to distrust, however, trust was later recovered after multiple exposures of faulty automation. | Lee & Moray, 1992; Master et al., 2005; Muir & Moray, 1996 |
| Operator self-confidence | Human | Findings are mixed. Several studies suggest that operator self-confidence negatively affects trust, however, one study found no effect of self-confidence on trust. | De Vries et al., 2003; Lee & Moray, 1994; Moray et al., 2000 |
| Extroversion | Human | Study findings suggest a positive relationship between extroversion and trust. | Merritt & Ilgen, 2008. |
| Perceived easiness of automation errors | Human | The study found that the easier the type of error the automation made, the less trust people had in the automation. | Madhaven et al., 2006 |

*Note.* These variables are suggested to directly influence trust in automation.

Table 2

*Human and Machine Variables Indirectly or Predicted to Influence Trust in Automation*

| Variable | Domain | Effect on Trust | Citations |
|---|---|---|---|
| Operator knowledge | Human | Operator knowledge may indirectly influence trust. Studies found that greater knowledge increased self-confidence. | Will, 1991; Kantowitz et al., 1997 |
| Situation awareness (SA) | Human | Studies suggest that SA affects trust, but it was not empirically tested so the relationship is unknown. | Lui & Hwang, 2000; Lui & Su, 2006 |
| Level of automation | Machine | Studies suggest an intermediate level of automation positively affects SA. | Kaber & Endsley, 2004; Lui & Hwang, 2000; Lui & Su, 2006 |
| Workload | Human | Workload may have an indirect influence on trust. It was found that high workload negatively affected the detection of automation errors. | Biros et al., 2004; McBride, 2010 |
| Neuroticism, agreeableness, openness, and conscientiousness | Human | These personality traits are predicted to influence trust. Study found these traits influence human interactions with automation. It is plausible these traits may influence trust since other traits such as extroversion and self-confidence do. | Szalma & Taylor (2011) |

*Note.* These variables are suggested to indirectly or predicted to influence trust in automation.

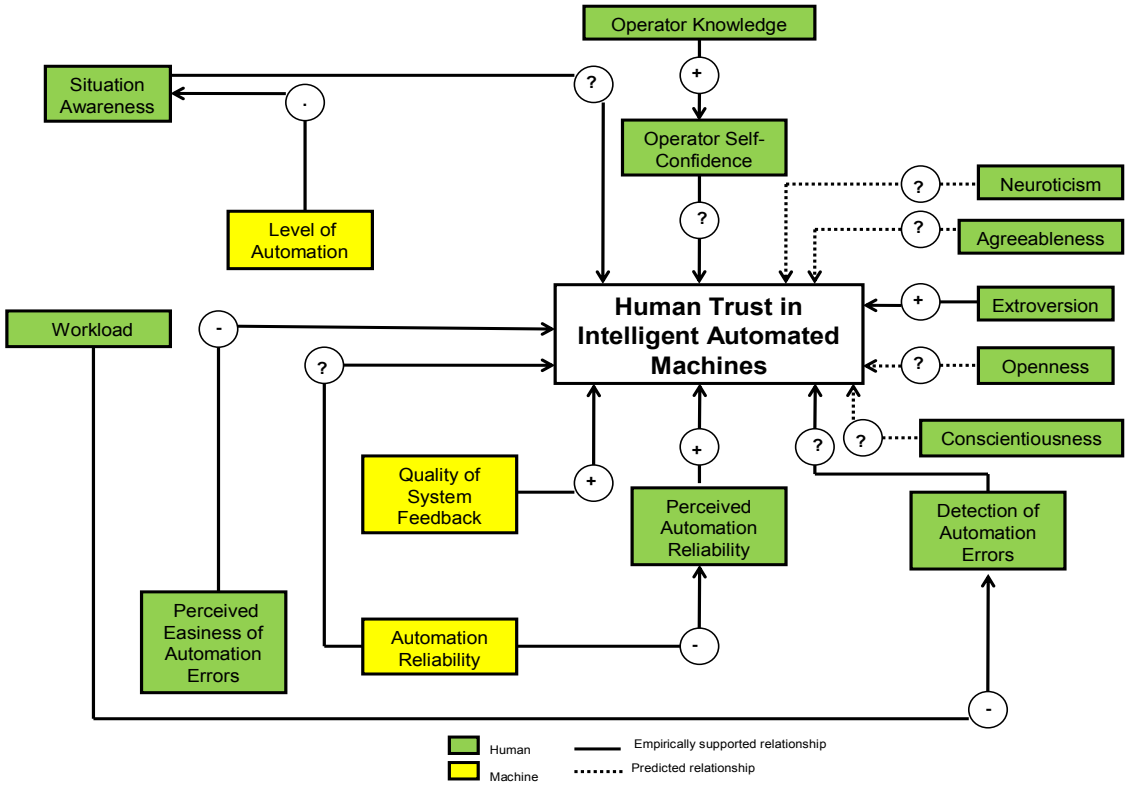



*Figure 1*. Proposed framework including variables thought to influence human trust in automated machines. The green boxes represent variables that are based on human characteristics and the gold boxes ones that are based on machine characteristics. The solid black lines represent empirically supported relationships between variables that either *directly* or *indirectly* affect trust. The dotted black lines represent a *predicted* relationship with trust. The direction of the relationship between variables and trust or between multiple variables is denoted by a plus sign (+), a minus sign, a question mark (?), or a dot (·). The plus sign represents a positive relationship between variables. The minus sign represents a negative relationship between variables. The question mark represents an unknown or unclear relationship between variables. The dot denotes a moderate amount of one variable positively influencing another variable.

## Trust in Human-Robot Relationships

It is thought that human trust in robots may be similar to human trust in automation (Hancock, Billings, Schaefer, Chen, de Visser, & Parasuraman, 2011). Robots can fall within the spectrum of what is considered "automation", although the research on automation primarily encompasses supervisory control and decision support systems. However, there are several important differences between automation and robots that may make the nature of their interactions with humans dissimilar and therefore need to be explored.

Automation is generally defined as the automatically controlled operation of a machine or system (Nof, 2009). In terms of human performance, automation is defined as being "a device or system that accomplishes (partially or fully) a function that was previously, or conceivably could be, carried out (partially or fully) by a human operator" (Parasuraman, Sheridan, & Wickens, 2000, p. 287). Robots can be considered automation in the defined sense because robots have mechanized parts and can accomplish tasks that once were carried out by humans. In the literature, when trust in a robot is defined, the description given is directly pulled from definitions of trust in automation (Wagner & Arkin, 2011). However, there are robots that may exceed what is normally described as automation. Robots can also be autonomous, proactive, reactive, and have social ability and therefore expectations that people have of robots may be different than automation (Wooldridge & Jennings, 1995). In the literature, there is a failure to evaluate if it is appropriate to use the definition of trust in automation as a definition for trust in a robot. This study evaluates whether repurposing the definition of trust in automation is sufficient or if a unique definition is needed.

A handful of studies have previously identified variables that potentially are important to human trust in robots (see Table 3). Only one study has provided direct insight into elements that influence trust in robots. Ezer (2008) surveyed younger and older adult participants and found almost 70% of participants indicated they would rather stay at home under the care of a robot rather than move to a care facility. These participants reported a moderate amount of trust in the robot (i.e., a score of 3.36 out of 5). When participants were asked what would influence their trust in a robot, they indicated ease of use, human likeness, own health condition, robot knowledge, price, trust in human care available/condition, and evidence of performance. Within the category of evidence of performance, Ezer (2008) found that 55% of participant responses related to the ability of the robot to perform the tasks. The study provides insight into elements that influences trust in robots, however, details behind why participants labeled those elements as influencing trust is unknown. Furthermore, there is a need to know more about the nature of the different tasks robots might be asked to do in the home and how that may impact trust.

Other studies have suggested additional performance elements and tasks that might be important especially if robots are to be trusted as caregiving assistants in the home. First, several studies have shown that trust increased when a robot's communication style was mapped on to the communication style of the user's culture (e.g., collectivistic or individualistic; Evers, Maldonado, Brodecki & Hinds, 2008; Rau, Li, & Li, 2009; Wang, Rau, Evers, Robinson, & Hinds, 2010). Second, higher robot's autonomy (i.e., no assistance from a human) appears to lessen a user's trust (Desai, Stubbs, Steinfeld, & Yanco, 2009). Lastly, people trusted robots that shared the same

space with them more than robots that did not (Bainbridge, Art, Kim, & Scassellati, 2008; Powers, Kiesler, Fussell, & Torrey, 2007). These studies suggest there are several variables involved in human-robot trust. However, they only provide anecdotal evidence as to why these variables are important and thus are not sufficient to provide a comprehensive understanding about trust in robots.

Table 3

*Variables Potentially Important to Human Trust in Robots*

| Variable | Domain | Effect on Trust | Citations |
|---|---|---|---|
| Ease of use, human likeness, own health condition, robot knowledge, price, human care available/condition, evidence of performance | Human and Robot | Some participants listed these variables as influencing their decision to trust a robot. | Ezer, 2008 |
| Communication style | Robot | Studies suggest trust in the robot is higher when the communication style of the robot maps onto that of the persons culture. | Evers et al., 2008; Rau et al., 2009; Wang et al., 2010 |
| Level of autonomy | Robot | The study suggests that humans trusted cars with lower levels of autonomy that higher. | Desai et al., 2009 |
| Robot Location | Robot | Studies indicate that trust in the robot is higher when the human is co-located with the robot. | Bainbridge et al., 2008; Powers et al., 2007 |

## Variability Among Humans

To understand trust in robots, we also need to recognize that there is a range of capabilities and experiences for people who may interact with robots. There cannot be an assumption that all users will think about trust in a robot the same way. Variability can exist as a result of the normal aging process and can affect psychomotor, perceptual, and cognitive abilities (Fisk, Rogers, Charness, Czaja, & Sharit, 2004). In addition, variability in humans can exist in technology experiences (Olson, O'Brien, Rogers, & Charness, 2011). Technology experience may be a contributing influence for trust evaluations of robots. Older adults are slower adopters of technology than younger adults (Czaja et al. 2006). However, this does not mean that older adults do not adopt new technologies.

Research by Olson and colleagues (2011) found the pattern of technology use across domains (e.g., communication, financial, health care) did not suggest that older adults were opposed to technology overall. Many older adults adopted different types of technologies, just at different rates and dependent on need. In the health care domain where older adults have more need, they reported a higher frequency of use than younger adults.

Younger and older adults are groups of potential robot users that have a large range of experiences, capabilities, and limitations that may contribute to trust decisions. Current research does not address these ranges and contributed to the motivation for this study. Younger adults and high tech older adult participants were matched in this study because of similarities in their technology experience. This comparison allowed for evaluating technology experience effects. Whereas, high tech older adults and low tech

older adults were matched because of their similarity in age. If robots are to be used as assistants in home health care related situations, it is important to be able to understand these differences so robots can be designed to adapt accordingly.

## Toward Further Insight About Trust in Robots

In past research studies if trust questions were asked, they often only elicited "yes" or "no" answers. Unfortunately, these types of trust responses provide an incomplete understanding on human attitudes about trust in robots. However, there are various techniques available that can provide insight, such as questionnaires, structured interviews, and closed card-sorting. Questionnaires can be an excellent mechanism for obtaining information and opinions about trust in robots. They can efficiently sample a broad spectrum of topics related to trust and provide responses that can be standardized. However, questionnaires are not a comprehensive means of evaluation, especially if in-depth assessment of how people make trust decisions is wanted. A systematic structured interview can supplement and support questionnaires to better evaluate trust decisions. This method can identify the rationale behind trust decisions by looking into the decision making process of why and how they arrived at their conclusion to trust or not trust a robot. Closed card-sorting is another technique to provide insight into trust in robots. Sorting cards into pre-determined groups can be used to identify how people group and categorize their perceptions about trust in robots (Hannah, 2005).

This study utilized a multi-methodological approach to investigate trust in robots. Questionnaires, a structured interview, and a card-sorting task provided meaningful data to contribute to the depth and breadth of the knowledge base on human trust in robots.

## Study Objectives

There were two main objectives of this study. The first objective was to determine if people would trust service robots in their homes. The second objective was to evaluate if the current framework of trust in automation I developed could be applied to service robots in a home environment. To address these objectives, this study focused on five open questions:

1. How do people define trust in robots? I assessed whether peoples' definitions of trust in robots differed from current definitions of human trust in automation.

2. What do people say influences their decisions to trust or distrust robots? I identified and evaluated whether any influencing variables differed from the existing framework for trust in automation.

3. What are the characteristics people associate with trustworthy and untrustworthy robots? I identified and evaluated characteristics associated with trust and distrust in robots.

4. What are the dimensions of trust that emerge as a function of the characteristics of the robot's task? I assessed whether the nature of the robots' task influenced trust.

5. Do trust decisions for robots vary among people? I assessed whether there were experience and age differences between younger adults and high tech older adults, and high tech older and low tech older adults.

# CHAPTER 2

# METHOD

## Participants

Twelve younger adults, aged 18-23, and 24 older adults, aged 65-75, participated in this study (see Table 4 for an overview of participant characteristics). All participants were native English speakers and had near visual acuity of at least 20/40 (corrected or uncorrected). Males and females were equally represented within each group. Younger adult participants were undergraduate students recruited from the Georgia Institute of Technology Experimetrix website. They received course extra credit for their participation. Older adult participants were from the Atlanta area and recruited through the Human Factors and Aging Laboratory participant database. In the older adult groups, there were an equal number of high and low technology users. Older adult participants were compensated $30 for their participation. As shown in Table 4, participants self-reported as being well-educated, healthy, and ethnically diverse.

Table 4

*Age, Gender, Self-Reported Health, Level of Education, and Race of Participants*

| | Younger Adults ($n$ = 12) | High Tech Older Adults ($n$ = 12) | Low Tech Older Adults ($n$ = 12) |
|---|---|---|---|
| Age *M* (*SD*) | 19.75 (1.54) | 71.08 (2.64) | 70.41 (3.09) |
| Gender | | | |
| % Male | 50% | 50% | 50% |
| % Female | 50% | 50% | 50% |

*Note:* Percentages were rounded

Table 4 (continued)

| | Younger Adults ($n$ = 12) | High Tech Older Adults ($n$ = 12) | Low Tech Older Adults ($n$ = 12) |
|---|---|---|---|
| Health | | | |
| % Fair | 0% | 17% | 25% |
| % Good | 25% | 17% | 50% |
| % Very good | 58% | 50% | 17% |
| % Excellent | 17% | 17% | 8% |
| Highest Level of Education | | | |
| % High school GED | 17% | 17% | 17% |
| % Vocational training | 0% | 0% | 8% |
| % Some college/Associate's | 83% | 42% | 17% |
| % Bachelor's degree | 0% | 33% | 25% |
| % Master's degree | 0% | 8% | 33% |
| Race | | | |
| % White/Caucasian | 58% | 75% | 58% |
| % Black/African American | 17% | 25% | 42% |
| % Asian | 8% | 0% | 0% |
| % Multi racial | 17% | 0% | 0% |

*Note:* Percentages were rounded

## Materials

Technology Experience Pre-Screening Questionnaire

The Technology Experience Pre-Screening Questionnaire (O'Brien, 2010) asks 11 questions about usage of everyday technologies, computers, and the Internet (see Appendix A). The questionnaire was administered by telephone when older adult participants were being recruited for the study. Scores from the questionnaire determined whether older adults were categorized as being low, medium, or high technology users for placement into groups. Participants with a score of eight or lower were categorized as low technology users, nine to fourteen as medium technology users, and a score of fifteen or higher as high technology users. Only older adults who scored within the low or high technology experience ranges participated in this study.

Demographics and Health Questionnaire

Participant demographic and health information was obtained from the Demographics and Health Questionnaire (Czaja et al., 2006a). The demographic section of the questionnaire is intended to collect information about participants': age, gender, marital status, race, education level, housing, income, primary language, primary mode of transportation, and occupational status. The health section of the questionnaire is intended to collect information about participants' self-reported general health, health compared to their cohorts, and satisfaction of their current health. In addition, the questionnaire asked about medical conditions, limitations of physical activity, and medication regimen (see Appendix B).

Technology Experience Profile

Participants' technology experience was assessed using the Technology Experience Profile (locally developed, see Appendix C). The 36-item questionnaire was designed to identify the depth, breadth, and frequency of use for different technologies. The technologies were categorized into six different technology domains (e.g., communication technologies, everyday technologies, recreational technologies, computer technologies, health technologies, and transportation technologies).

In each technology domain there were six different technologies for which participants had to rate their frequency of use. For example, in the communication domain, participants rated their frequency of use for: answering machines/voicemail, automated telephone menu system, fax, mobile phone, text messaging, and video conferencing. Participants rated their frequency of use from a 5-point Likert-type scale.

The rating options were: 1 = not sure what it is, 2 = not used, 3 = used once, 4 = used occasionally, and 5 = used frequently.

Structured Interview and Task Script

A structured interview and task script was developed to ensure consistency between participants during the study. First, participants were informed that they would be participating in a three-section interview that would be audio recorded. Then they would partake in a card sorting task and ability tests. Finally, they would fill out various questionnaires (see Appendix D).

The remaining script was split into three sections. The first section of the script was the General Trust in Robots section and assessed how participants defined trust in people and trust in robots, whether they would trust a robot in their home, and what they would want to know about a robot to help them decide whether to trust it. The remaining interview questions in the first section of the script related to trust and distrust of a robot for participant-generated home-based tasks, followed by their reasons for their trust decisions. In addition to the main questions, when participant responses were vague or unclear, the script included several probe questions such as, "Can you tell me a little more about that?" or "I want to make sure I understand what you mean, would you describe it for me again?"

The second section of the script started with instructions for the card-sorting task followed by instructions to explain the ability tests. The script then described the second section of the structured interview, the Trust in Robots for Tasks section. The script prompted the researcher to ask participants to verbally rate their level of trust agreement for statements about robot assisting in 12 specific home-based tasks (see Appendix E)

and then discuss their reasoning behind their rating decisions. Again the script listed several probes to assist the researcher when participant responses were too vague or unclear such as, "Can you tell me what your thinking was when you gave it that rating?" After the second section of the interview was completed, the script described the process the researcher needed to follow for administering the four robot-related questionnaires.

The third section of the script described the process for the end of the interview: the Robot Descriptions section. It contained questions about the appearance of any robots that the participant might have imagined while they were participating in the study. The script also listed several follow-up questions when participants did not mention certain pre-determined robot characteristics. Example follow-up questions included: "What is the size of the robot?" or "What is the robot made of?" In addition to the follow-up questions, the script also included previously mentioned probe questions (e.g., "Can you talk a little more about that?") when participant responses were vague or unclear.

Card-Sorting Task

Another tool to understand and elicit participants' definition of trust in robots was card sorting. The 30 words for the card-sorting task were developed based on previous research that identified known characteristics used to describe human-human and human-automation trust and distrust (Ezer, 2008; Jian, Bisantz, & Drury, 2000). There were 30 cards, each of which had an adjective on it (see Appendix F). Fifteen of the adjectives were positive (e.g., efficient, friendly, reliable) and fifteen were negative (e.g., deceptive, risky, unreliable).

## Ability Tests

For this study, three cognitive-based ability tests were used to describe the participants. They were the Digit-Symbol Substitution test (Wechsler, 1997), the Reverse Digit Span test (Wechsler, 1981), and the Shipley Institute of Living Scale Vocabulary test (Shipley, 1986) (see Appendices G thru I). These ability tests are listed and described in Table 5. Participants also completed the Snellen near vision acuity test to rule out potential problems that would make reading the questionnaires difficult (see Appendix J).

Table 5

*Ability Tests*

| Ability Test | Measures | Max Score | Reference |
|---|---|---|---|
| Digit-Symbol Substitution | Perceptual Speed | 100 | Wechsler (1997) |
| Shipley Institute of Living Scale | Semantic Knowledge (Vocabulary) | 40 | Shipley (1986) |
| Reverse Digit Span | Memory Span | 14 | Wechsler (1997) |

## Trust in Tasks Response Card

The Trust in Tasks Response Card was developed to aid in measuring participants' level of trust agreement for robot assistance with 12 home-based tasks (e.g., bathing, medication reminding, cleaning the kitchen). On the response card was the statement, "I would trust a robot to help me with _____." Also listed on the card were Likert-scale response options that participants chose following each statement (see Appendix K). Participants chose one response from the following Likert scale options, 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, and 5 = strongly agree.

Robot Familiarity and Use Questionnaire

Participants' experience with robots was assessed using the Robot Familiarity and Use Questionnaire (Mitzner et al., 2011, see Appendix L). The questionnaire was designed to measure different aspects of robot familiarity and usage, such as: hearing about robots, using robots, and operating robots. There were 13 different robots listed in the questionnaire (e.g., Autonomous Car, Domestic/Home robot, Entertainment/toy robot). For each robot, participants selected their level of familiarity and or usage from a 5-point Likert-type scale, 0 = not sure what this is, 1 = never heard about, see, or used this robot, 2 = have only heard about or seen this robot, 3 = have used or operated this robot only occasionally, and 4 = have used or operated this robot frequently.

Robot Opinions Questionnaire

Attitudes about robots was assessed using the Robot Opinions Questionnaire (Mitzner et al., 2011, see Appendix M). The questionnaire consisted of 12 questions designed to assess robot acceptance (e.g., "My interaction with a robot would be clear and understandable."). Then participants selected a response that best represented their opinion about each question from a 7-point Likert-type scale. The response options were: 1 = extremely likely, 2 = quite unlikely, 3 = slightly unlikely, 4 = neither, 5 = slightly likely, 6 = quite likely, and 7 = extremely unlikely.

Robot Trust Characteristics Questionnaire

The Robot Trust Characteristics Questionnaire assessed the characteristics people associate with trust and distrust in a robot (see Appendix N). The questionnaire contained two sections. Each section contained 30 positive and negative adjectives that had been identified as known characteristics used to describe human-human and human-

automation trust and distrust and presented in alphabetical order (Ezer, 2008; Jian et al., 2000).

In each section, the instructions asked participants to imagine a robot in their home. Then they were asked to indicate how much those words matched the characteristics of what they would imagine a trustworthy robot would possess in section one, and untrustworthy robot in section two. The sections were counterbalanced to avoid order effects. Participants indicated their responses using a 6-point Likert-type scale. The response options were, 0 = don't know, 1 = not at all, 2 = to a limited extent, 3 = to a moderate extent, 4 = to a large extent, and 5 = to a great extent.

Trust in Assistance Checklist

The Trust in Assistance Checklist assessed participants' trust preferences for human or robot assistance for 20 home-based tasks (e.g., bathing, delivering medication, entertaining guests, walking) (see Appendix O). Participants were instructed to imagine that they needed assistance in their everyday life. Then, they had to indicate their trust for human versus robot assistance for each task by selecting an item from a 5-point Likert-type scale. The response options were, 1 = only trust a human, 2 = trust a human more, 3 = trust either a human or a robot, 4 = trust a robot more, and 5 = only trust a robot.

**Equipment**

Voice Recording Device

The structured interviews were recorded using an Olympus WS-6005 digital voice recorder. After the completion of each session, the audio files were directly transferred from the device to a personal computer for later transcription.

Qualitative Data Analysis Software

The transcripts from the structured interviews were coded using the MAXQDA (version 11) qualitative data analysis software program.

**Procedure**

Older adults aged 65-75 from the Human Factors and Aging Laboratory participant database were contacted by telephone. They were asked if they would be interested in participating in a study concerning technology use. If they indicated they wished to participate, they were given details regarding the study length and compensation. They were also pre-screened for technology experience, and, if qualified, categorized as either a low technology or high technology experience user. Those people characterized with moderate technology experience were not eligible for the study.

If participants met the eligibility criteria they were scheduled for their study session. After participants were scheduled, a packet containing a letter confirming the date, time, and location of their session were mailed to them. In addition to the confirmation letter, they were mailed two informed consent forms (see Appendix P), the Demographics and Health Questionnaire, the Technology Experience Profile, directions, and parking instructions and a parking pass (if needed). Participants were asked to complete the forms in advance and bring them to their scheduled study session.

Younger adults were recruited from the Georgia Institute of Technology Experimetrix website. They were given instructions to obtain a packet containing informed consent forms (see Appendix Q), the Demographics and Health Questionnaire, and the Technology Experience Profile. The packets were left in a box marked with the study number outside of a designated room in the J.S. Coon building at the Georgia

Institute of Technology. They were asked to complete the forms in advance and bring them to their scheduled study session.

At the start of the sessions, the researcher made certain that informed consent was obtained. The researcher then collected the questionnaires that were filled out in advance, and reviewed them for completeness. The participants were told that the interview portion of the study session would be digitally recorded and transcribed at a later date. Next, participants' near vision was tested.

After the vision test, the researcher read the introduction to the General Trust in Robots section of the interview script and offered to answer any questions. Afterward, the researcher turned on the digital recorder and followed the script prompts to commence the interview. Next, participants were instructed to define in their own words, how they would define trust in a human and then trust in a robot. Afterward they were asked to think about whether they would trust a robot to help them in their home. Next they were asked what their first thought was when asked if they would trust a robot in their home. Next participants were asked what they would want to know about the robot that would help them decide whether or not to trust the robot.

Participants were then asked to think specifically about the tasks they do on a daily or weekly basis in their home. Next they were asked if there were any particular tasks they would most trust a robot to do or assist them with in the foyer, living room, dining room, kitchen, bathroom, bedroom, and laundry room. After participants listed any tasks in those rooms, they were asked to explain the reasoning behind their trust decisions. Next participants were asked if there were particular tasks they would not trust a robot to do or assist them with in the same rooms, and asked to explain the reasoning

behind their distrust decisions. Note that this section of the structured interview, brainstorming about trust for tasks throughout the rooms, was a warm up task to get participants to think about trust for tasks and was not analyzed in this study. After this section of the interview, the digital recorder was stopped and participants were told they were finished with the first part of the interview.

Next, participants were told they would be performing an exercise related to trust in robots. They were given instructions for the card-sorting task. Participants were shown a stack of 30 cards and were told that each card had an adjective on it that might be used to describe a characteristic that a robot might have. Then they were asked to select five cards, in any order, that they thought best represented characteristics of a trustworthy robot and five cards they thought best represented characteristics of an untrustworthy robot. After they selected the cards, the researcher recorded their card selections. Following the card-sorting task, participants completed the ability tests and took a mandatory 5-minute break.

After the break, the researcher introduced the second section of the interview, the Trust for Tasks section, and answered any questions. Then, the researcher restarted the digital recorder and continued the interview. The researcher asked the participants to imagine that they needed assistance to complete tasks at home. Participants were then handed response cards. The researcher then described a task and then directed the participants to select an answer from the response card. The researcher then recorded the response. After each response, the researcher asked participants what led them to give that specific rating. The researcher continued the iterative process until the participants went through all 12 tasks. The order of tasks was counterbalanced using a Latin Square

scheme (see Appendix R). Following that section of the interview, the digital recorder was stopped and participants were asked to complete a series of questionnaires (e.g., Robot Familiarity and Use, Robot Opinions, Robot Trust Characteristics, and Trust in Assistance Checklist). After completing the questionnaires, the researcher introduced the final section of the interview, the Robot Description section. The digital recorder was turned on again and the researcher asked participants to describe the robot or robots they were visualizing while they were participating in the study. Participants were also asked if their visualized robots changed depending on the tasks they were being asked about. After the participants answered the questions, the digital recorder was turned off. Participants were debriefed (see Appendix S), compensated, and thanked for their time and participation. After the study sessions ended, the digital recordings were uploaded and transcribed.

## Qualitative Data Analysis Procedure

### Data Segmentation

After the digital recording files were transcribed, they were uploaded to the MAXQDA Version 11 qualitative data analysis software. Prior to data analysis, the data first had to be segmented into meaningful chunks of text. Each segment pertained to an individual question. For example, participants were asked, "How do you define trust in a robot?" The entire response to that question was chunked into one segment. This pattern was continued for each participant's transcribed file until all questions were segmented.

### Coding Scheme Category Development and Procedures

When all transcribed files were segmented, a top-down and bottom-up (two from each group of randomly selected transcripts) approach was used to develop the initial

labels for the coding scheme. A top-down approach refers to gathering information from what is previously known, whereas a bottom-up approach refers to pulling information directly from the data. The author and one additional coder went through each segment and applied the initial labels to each segment. If no existing labels were deemed appropriate by the coder, she created a new label to describe the segment. After all segments were labeled with the initial labels and new labels, both coders collaboratively sorted through the labels to combine and rename similar categories until the coders reached a consensus. After the final coding scheme was developed, the author coded 24 transcribed files (8 files from each of the 3 groups) and the remaining 12 transcribed files (4 files from each of the 3 groups) were coded by the other coder. See Appendix T for the final coding scheme.

**Intercoder Reliability**

To ensure intercoder agreement consistency was obtained between the two coders, Cohen's Kappa was calculated. Cohen's Kappa determines the level of agreement past chance between the two coders. Kappas between 0 - .20 are considered "slight", .21 - .40 "fair", .41 - .60 "moderate", .61 - .80 "substantial", and .81 - 1 as "near perfect" agreement (Landis & Koch, 1977). The Cohen's Kappa between the author and the other coder was .91, which implies a robust agreement.

# CHAPTER 3

# RESULTS

This chapter describes the results of the questionnaires, card-sorting task, and structured interview. The chapter is organized into four sections that directly relate to the research questions. The first section gives us insight about the study populations' technology and robot experience including how they visualized robots in the study. Using non-parametric statistical analyses, similarities and differences between groups were evaluated from the Technology Experience Profile and the Robot Familiarity and Use Questionnaire data. Also evaluated were the frequencies in participant responses about their visualized robots, as described in the structured interview. Comparisons were made between younger and high tech older adults, and high and low tech older adults.

The second part addresses how people defined trust in robots. Participant definitions of trust in robots from the structured interview were evaluated using thematic analysis to identify trends within and between groups. Thematic analysis is a six-phased method (i.e., become familiar with the data, coding, searching for themes, reviewing themes, defining themes, and reporting) for evaluating qualitative data that involves identifying themes and repeated patterns of meaning within the data (Braun & Clarke, 2006).

The next part investigates the attitudes that influence trust in robots and the characteristics that people associate with a trustworthy and untrustworthy robot. One way attitudes were evaluated was from data from the structured interview. Specifically, participants were asked about trusting a robot in their home and what they wanted to know about a robot before trusting it. These data were evaluated using thematic analyses.

Attitudes were also evaluated from the Robot Opinions Questionnaire, where non-parametric statistical analysis identified similarities and differences within and between groups. Characteristics of a trustworthy and untrustworthy robot were identified by non-parametric analyses from the Robot Trust Characteristics Questionnaire and from thematic analysis and frequency counts from the card-sorting task.

The fourth and final part of the results chapter addresses if trust varies by task. Trust variance by task was evaluated from data from the Trust in Assistance Checklist and from the Trust for Tasks section of the structured interview.

## Results Part 1: Technology and Robot Experience and How Robots in The Study Were Visualized

### What Kind of Experience Do People Have With Technology?

Technology experience was measured by asking participants about the frequency of use in the past year for 36 different technologies within six different technology domains (i.e., communication technology, computer technology, everyday technology, health technology, recreational technology, and transportation technology). Participant response options were: 1 = not sure what it is, 2 = not used, 3 = used once, 4 = used occasionally, and 5 = used frequently. See Appendix U for the means and standard deviations for frequency of use of each type of technology.

Across all groups, the most frequently used technologies ($M \geq 4$ = used occasionally) were answering machines, mobile phones, desktop or laptop computers, and microwave ovens. The younger adult group reported using 58% of the listed technologies at least occasionally whereas the high tech older adult group reported using 33%. The low tech older adult group reported only using 14% of the listed technologies

at least occasionally within the past year. A one-way analysis of variance was conducted and found there was a significant difference in the mean number of technologies used, at least once, between groups, $F(2, 33) = 51.97$, $p < .001$. A Tukey HSD test indicated the mean number of technologies between younger adults ($M = 30.67$, $SD = 3.77$) was significantly different than high tech older adults ($M = 20.42$, $SD = 4.56$). There was also a significant difference between high tech older adults ($M = 20.42$, $SD = 4.56$) and low tech older adults ($M = 13.25$, $SD = 4.25$).

To determine if there were significant differences in the distribution of ranked overall scores between groups in technology experience, non-parametric Mann Whitney U tests were conducted. There was a significant difference in overall technology experience ($U = 34.5$, $p = .02$) between younger adults ($Mdn = 4$, *Range* = 1-5) and high tech older adults ($Mdn = 4$, Range = 2-5). There was also a significant difference ($U = 26.5$, $p < .01$) between high ($Mdn = 4$, *Range* = 2-5) and low tech older adults ($Mdn = 2$, *Range* = 1-5). See Appendix V for specific differences between groups and within each of the six technology domains.

The differences in technology experience between groups are not surprising. However, these data serve as a manipulation check for the initial pre-screening categorization of (i.e., high tech or low tech) the older adult participants, thus confirming that they were appropriately grouped. This validation is necessary when determining if trust in robots (e.g., how trust is defined, characteristics of trust, trust in robot tasks, etc.) vary among age and technology experience groups.

**What Kind of Experience Do People Have With Robots?**

Participants' experience with robots was assessed using the Robot Familiarity and Use Questionnaire. For each of the 13 robots listed, participants selected their level of familiarity and usage from a 5-point Likert-type scale: 0 = not sure what this is, 1 = never heard about, seen, or used this robot, 2 = have only heard about or seen this robot, 3 = have used or operated this robot only occasionally, and 4 = have used or operated this robot frequently.

In general, younger adults ($M$ = 2.67, $SD$ = .32), high tech older adults ($M$ = 2.56, $SD$ = .35), and low tech older adults ($M$ = 2.40, $SD$ = .44) mean ratings of familiarity and use of the robots suggest that most participants had at least heard about or seen many of listed robots. Younger adults ($M$ = 1.75, $SD$ = .45), high tech older adults ($M$ = 1.92, $SD$ = .67), and low tech older adults ($M$ = 1.58, $SD$ = .67) reported the least amount of familiarity and use for remote presence robots. Younger adults ($M$ = 3.83, $SD$ = .72) reported the most familiarity and use for entertainment/toy robots, whereas high tech older adults ($M$ = 3.17, $SD$ = .39) reported having higher familiarity and use for manufacturing robots. Low tech older adults reported equal familiarity and use for entertainment/toy robots ($M$ = 2.92, $SD$ = 1.08) and manufacturing robots ($M$ = 2.92, $SD$ = .51). See Appendix W for all the means and standard deviations for robot familiarity and use of each type of robot.

To determine if there were significant differences in the distribution of ranked scores between groups in robot familiarity and use, non-parametric Mann Whitney U tests were conducted on the data (see Appendix X).

A significant difference between younger and high tech older adults ($U = 17$, $p = .001$) familiarity and use of robots was only found for entertainment/toy robots. Younger adults (*Mdn* = 4, *Range* = 2-5) had higher familiarity and use than high tech older adults (*Mdn* = 3, *Range* = 1-4). There were no significant differences between high and low tech older adults.

Although participants were familiar with hearing about or seeing some types of robots, they generally had very little experience interacting with them. This suggests that for most participants, their responses to trust or distrust robot-related questions were based on something other than direct experience with robots.

**What Do People Visualize Robot Assistants to Look Like?**

The final questions in the structured interview were designed to provide insight on the extent to which participants, if any, were visualizing robots during the study.

**General robot appearance.** First, participants were asked if they were visualizing a robot or robots while they were participating in the study. The majority of participants (i.e., 97%) said they were actively visualizing a robot or robots. Only one participant, a high tech older adult, did not. The participant indicated he intentionally did not visualize a robot because he did not want it to influence his response.

For participants who visualized a robot during the study, Figure 2 shows the categories of their descriptions of the robots' general appearance. Overall, there were three main categories for which participants indicated that the robot they were visualizing looked like: machine-like, human-like, or similar to those from television or movies. Both younger adults and high tech older adults showed similar patterns in their responses. Specifically, there were approximately an equal number of responses for the three main

categories. However, for low tech older adults there was a higher prevalence (i.e., 50% of responses) of their described visualized robot as being similar to those from television or movies.

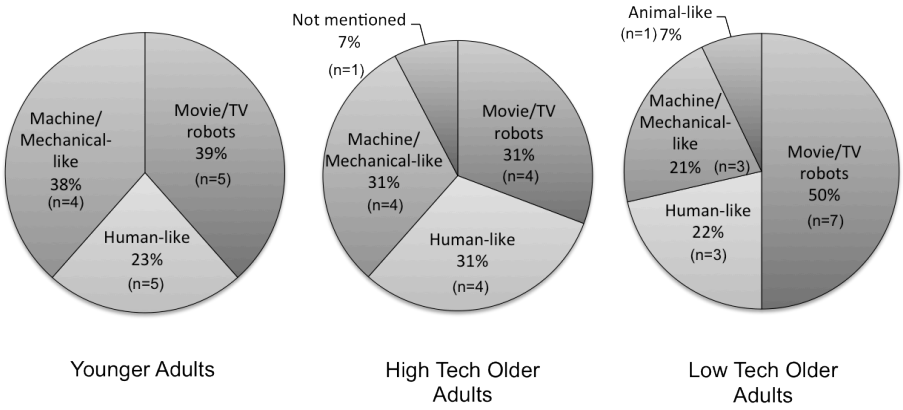



*Figure 2.* Pie charts represent the participant responses when asked to describe what the robot they were visualizing looked like when they were participating in the study. Frequency counts in each group may exceed 12 because some participants had multiple responses.

Table 6 contains participant quotes that highlight not only the general similarity between groups in their general robot description (i.e., movie/TV robot category), but also in their reference to specific science fiction movie genres (e.g., Star Wars).

Table 6

*Similarities in Participant Quotes for General Robot Descriptions*

| Group | Description | Quote |
|---|---|---|
| Younger Adults | Movie/TV robots | *"I was thinking about these little people robots, kind of like a Star Wars kind of thing like a R2-D2 traveling robot but with hands and arms kind of thing."* |
| High Tech Older Adults | Movie/TV robots | *"Either the R2-D2 or the C-3PO or whatever he was. He was the person, and it was all metal and it looked like a person kind of."* |
| Low Tech Older Adults | Movie/TV robots | *"Yeah, I was, uhm, imagining one that was probably from Star Wars or something, R2-D2."* |

**Robot material, shape, and size.** Those participants who visualized a robot or robots during the study were probed to speak more specifically about the robots' appearance. They were asked if they envisioned any specific materials the robot was made of, the shape of the robot, and the size of the robot. In general, a majority of participant responses in all groups indicate that they visualized the robot as being made of metal while some participants indicated plastic or a combination of metal and plastic. When it came to the shape of the robot, the responses within and between groups were varied. Almost 50% of responses within all groups indicated their robot to have a human shape, whereas other participants indicated the shape of the robot to be round, square, or rectangle. There were a few participant responses that mentioned not really thinking about the robots' overall shape.

When describing robot height, half of the responses in each group indicate that the visualized robot was the same height as a 'normal sized' human (i.e., 5ft to 6ft). Almost a third of the responses describe the robot as being 'slightly shorter' than a human (i.e., 3ft to 5ft), whereas the remaining responses describe the height of the robot being 'much shorter' than a human (i.e., less than 3 ft.). No participant responses describe the robot as being 'larger than' a human (see Appendix Y for more details about robot appearance). When asked if the robots' appearance changed during the study, 75% of younger adults, and less than half of the older adults said 'yes', depending on the nature of the task. Understanding participants' visualizations of robot appearance is important because it could affect their preconceived notions of the robots' capabilities and limitations which may influence their trust decisions.

**Summary of Technology and Robot Experience, and How Robots in The Study Were Visualized**

The results from the Technology Experience Profile Questionnaire indicated significant differences between groups. Younger adults had more technology experience than high tech older adults, who in turn had more experience than low tech older adults. This confirmed the validity of the initial grouping of the older adults, based on the initial pre-screening, into technology experience categories (i.e., high tech or low tech) were valid.

For robot experience, it was found that most participants had heard about or seen some of the robots on the Robot Familiarity and Use Questionnaire, but had very little experience, if any, using them. However, there were some significant differences between groups, but only for entertainment/toy robots. Younger adults had more experience using these types of robots than high or low tech older adults.

An analysis of the third section of the structured interview revealed that almost all of the participants indicated they had visualized a robot while they were participating in this study. Those visualizations were very specific, not only providing a general description of the robot, but also specific robot characteristics such as the material the robot was made of, the shape, and height. The details that emerged from this section of the structured interview are important because it gives insight into the context for which participants were answering questions about trust in robots.

## Results Part 2: Defining Human Trust in Robots

The coding scheme for participant definitions of trust in a robot was developed from a combination of top-down and bottom-up processes. The top-down portion of the coding scheme came from adjectives used to define human trust in automated machines literature (Ezer, 2008; Jian et al., 2000). The bottom-up coding was based on descriptive adjectives from the interview that did not initially fall into any categories from the top-down scheme. Intercoder reliability for coding was for all higher and lower-level dimensions.

Participants defined trust in a robot using at least one of the seven different descriptors (see Figure 3). In general, 'reliability' and 'capability' were the most frequently used descriptors in trust definitions; more so for younger adults and high tech older adults. However, there was lots of variability within and between groups for the remaining descriptors. Table 7 provides an example from each group of how 'reliability' was mentioned in the context of defining trust.

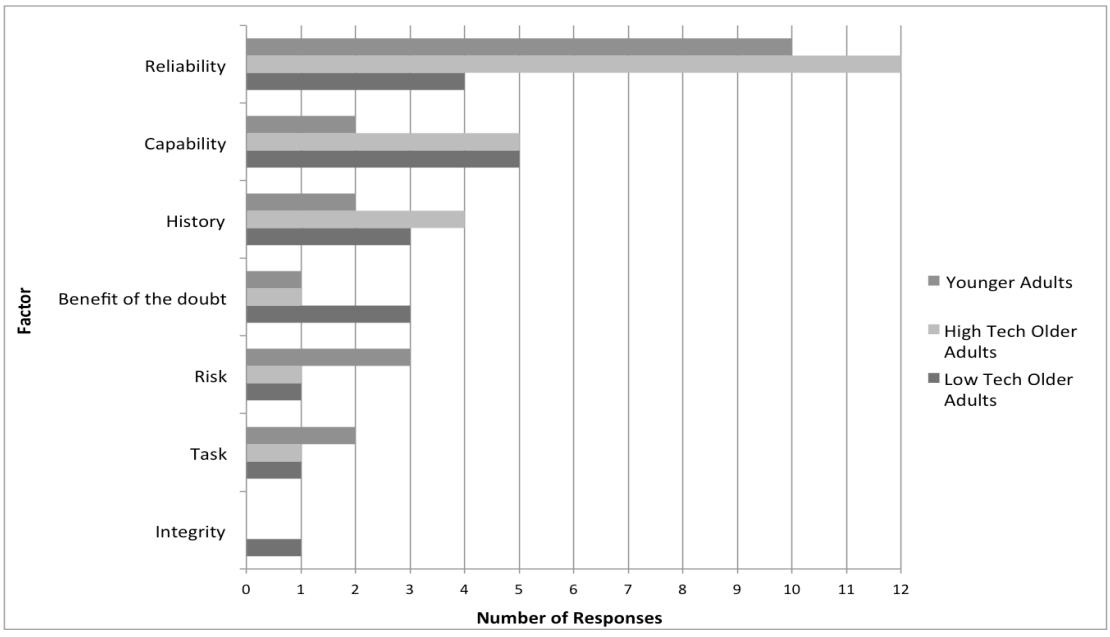



*Figure 3*. Frequency of participant responses for descriptors used to define trust in robots.

Table 7

*Participant Quotes With the Theme of Reliability for Defining Trust in a Robot*

| Group | Category | Quote |
|---|---|---|
| Younger Adult | Reliability | *"I guess, it's kind of the same thing, like if it's reliable. Like, if you can tell it something, it like listens or follows directions and doesn't, I don't know… completes it's like tasks, or something."* |
| High Tech Older Adult | Reliability | *"Same thing, it would have to do what it told me, what I've been told, that it would do."* |
| Low Tech Older Adult | Reliability | *"If I use it and it doesn't do it, then obviously I wouldn't trust it. If it does it, then I will trust it until it doesn't."* |

**Summary of Defining Trust in Robots**

It is clear from participant responses, that reliability and the capability of the robot are important factors when they were considering how they would define trust in a robot. However, there were others factors that were mentioned, although not at the same frequency within or between groups, that participants felt were important considerations in their definitions of trust in a robot. They were: history of the robot (e.g., established record), benefit of the doubt (e.g., trusting until a reason to distrust arises), risk (e.g., possibility of harm), task (e.g., job to be done), and integrity (e.g., adherence to a moral or ethical code).

## Results Part 3: Attitudes That Influence Trust in Robots

### Would People Trust a Robot in Their Homes?

In the structured interview, prior to discussing trust in robots for specific tasks, participants were asked if they would trust a robot in their homes. In general, the overall responses across groups were positive (see Figure 4). However, there were a few younger adult participants that said 'no' or 'depends'. Whereas there were no older adults who said 'no', only a few that said 'depends' or 'not sure or don't know'.

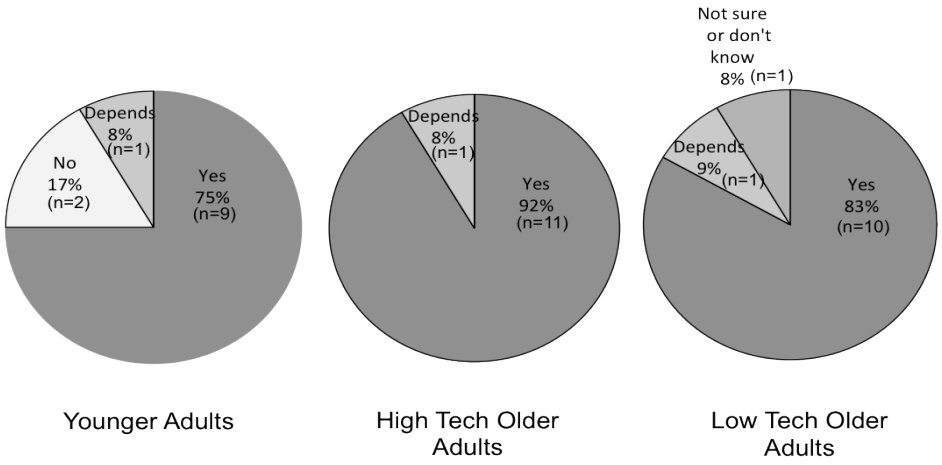



*Figure 4.* Pie charts representing the percentage of participant responses for the interview question asking, "Would you trust a robot to help you in your home?"

**What Would People Want to Know About a Robot Before Trusting it?**

In the structured interview, participants were asked what they would want to know about a robot to help them decide whether or not to trust it. Their responses suggested that they would want to know a lot about the robot. In Figure 5, 92 responses are shown for 14 different knowledge categories. It is clear that knowing about the capabilities and limitations of a robot were important to many participants; over 50% of participants in each group wanted to know about them.

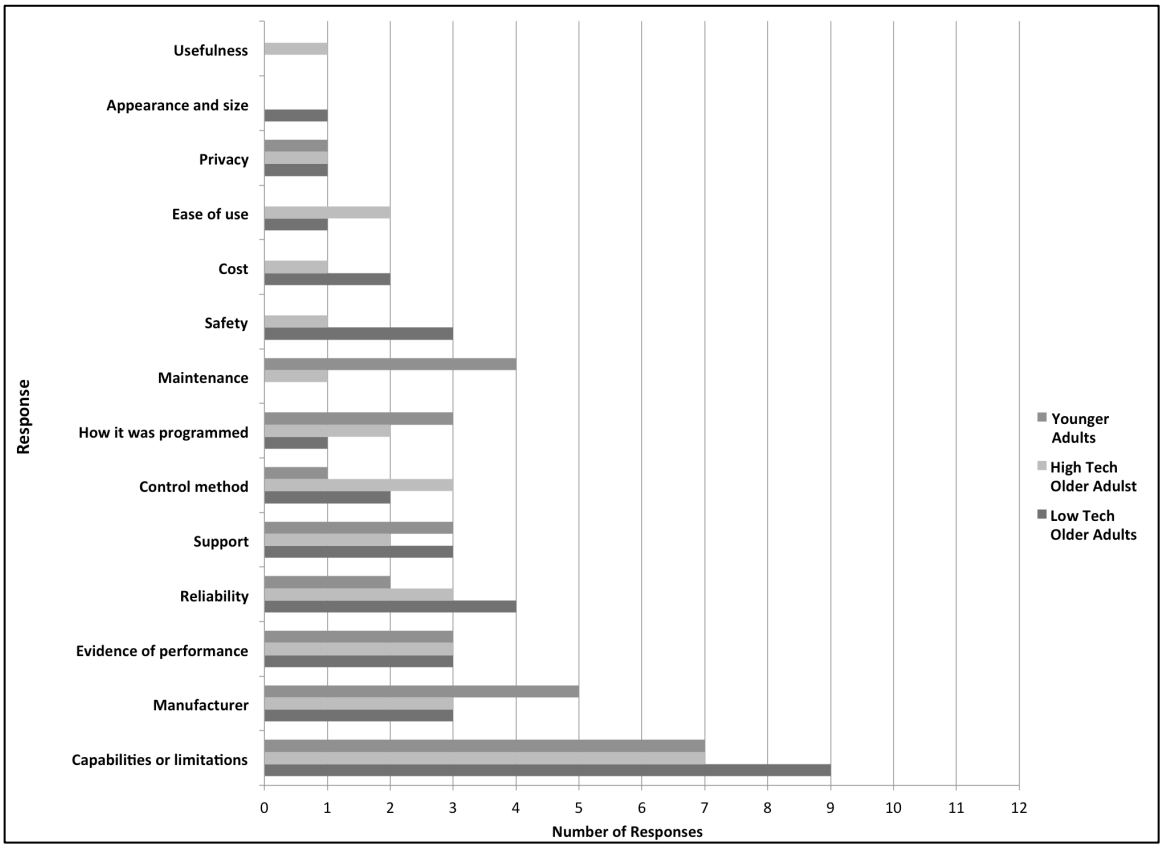



*Figure 5*. Graph of participant responses from the interview when asked, *"What would you want to know about a robot to help you decide whether or not to trust it?"*

Examples of quotes from each group are provided in Table 8. They highlight similarities in responses between groups for wanting to know about robot capabilities and limitations when making trust decisions. For the remaining 12 knowledge categories there were wide ranges in responses. Table 9 show quotes that highlight a range of knowledge categories that participants said they would want to know.

Table 8

*Similarities Between Groups in Quotes About What Participants Would Want to Know About a Robot to Help in Trust Decisions*

| Group | Knowledge Category | Quote |
|---|---|---|
| Younger Adult | Capabilities and limitations | *"First and foremost, its limitations. I would like to know what is the farthest it can go, what it can and can't do."* |
| High Tech Older Adult | Capabilities and limitations | *"What its limitations are. What they tell me it can and cannot do. That's the bottom line. "* |
| Low Tech Older Adult | Capabilities and limitations | *"What functions it could do? Does it do dishes? Does it clean? What it can't do?"* |

Table 9

*Quotes Highlighting the Range of Knowledge Categories for What Participants Would Want to Know About a Robot to Help in Trust Decisions*

| Group | Knowledge Category | Quote |
|---|---|---|
| Younger Adult | How it was programmed; Manufacturer | *"Who its from? How it is programmed? Making sure it is from a reliable source."* |
| High Tech Older Adult | How it was programmed; Control; Support; Capabilities and limitations | *"Well I would know exactly what it was programmed to do and how to control it, what to do if something went wrong, who to call or could I do something myself, and I'd want to know what its limitations were."* |
| Low Tech Older Adult | Safety | *"I think I would like to know how safe it is, you know. That would be a real issue if it is going to be in my home. What safety components would it have?"* |

**What Opinions Do People Have About Robots?**

The Robot Opinions Questionnaire assessed participants' attitudes (i.e., perceived ease of use and perceived usefulness) about robot acceptance, using standard questions adopted from Davis (1989). For each of the 12 questions (i.e., 6 perceived ease of use and 6 perceived usefulness), participants selected a response from a 7-point Likert-type scale: 1 = extremely unlikely, 2 = quite unlikely, 3 = slightly unlikely, 4 = neither, 5 = slightly likely, 6 = quite likely, and 7 = extremely likely. The mean composite responses for perceived ease of use for younger adults ($M$ = 5.40, S$D$ = .79), high tech older adults ($M$ = 5.22, $SD$ = 1.14), and low tech older adults ($M$ = 4.85. $SD$ = 1.70) were similar. For perceived usefulness, the mean composite responses for younger adults ($M$ = 5.51, S$D$ = .61), high tech older adults ($M$ = 5.94, $SD$ = .78), and low tech older adults ($M$ = 5.35. $SD$ = 1.60) were also similar. These composite scores for perceived ease of use and perceived usefulness suggest that all three groups in general had positive attitudes about robots. Mann Whitney U tests were conducted and no significant differences in the distributions of ranked scores were found between any of the groups (see Appendix Z).

**What Characteristics Do People Attribute to Trustworthy and Untrustworthy Robots?**

**The Robot Trust Characteristics Questionnaire.** The questionnaire was administered to assess the characteristics that participants associated with a trustworthy and untrustworthy robot. For each of the 30 adjectives (15 positive and 15 negative), participants rated the extent to which they felt the adjective matched the characteristics of a trustworthy and untrustworthy robot. Ratings were selected from a 6-point Likert-type scale: 0 = don't know, 1 = not at all, 2 = to a limited extent, 3 = to a moderate extent, 4 = to a large extent, and 5 = to a great extent.

Table 10 lists the younger adults' mean ranked adjective scores for characteristics they associated with a trustworthy and untrustworthy robot. The adjective most strongly associated with a trustworthy robot was 'reliable', followed by 'efficient' and 'safe'. Whereas the adjective least strongly associated with trustworthy robot was 'phony', followed by 'unreliable', 'sneaky', 'misleading', and 'deceptive'. The adjective most strongly associated with an untrustworthy robot was 'unreliable' followed by 'unpredictable', 'deceptive', and 'misleading'. The least strongly associated adjectives were 'safe', 'reliable', and 'loyal'.

Table 11 lists the mean ranked adjectives scores for characteristics they associated with a trustworthy and untrustworthy robot for high tech older adults. In this group, the adjectives that were associated strongest with a trustworthy robot were 'reliable', 'precise', 'safe', 'efficient', and 'predictable'. However, there were twice as many adjectives that were least associated with a trustworthy robot: 'boring', 'phony', 'non-human looking', 'hostile', 'misleading', 'deceptive', 'unreliable', 'unpredictable', 'sneaky', and 'pointless'. The adjectives associated strongest with an untrustworthy robot were 'unreliable', 'unpredictable, and 'risky'. The adjectives least associated were: 'human looking', 'non-human looking', 'loyal', 'familiar', 'social', and 'reliable'.
The low tech older adult participants' mean ranked adjective scores for characteristics they associated with a trustworthy and untrustworthy robot for low tech older adults are listed in Table 12. The adjectives that they ranked as being strongly associated with a trustworthy robot were 'reliable', 'precise', 'efficient', and 'safe'. Those adjectives least associated were 'unsocial', 'hostile', 'misleading', 'unreliable', 'phony', and 'deceptive'. On average, they did not rank any adjectives as strongly associated with an untrustworthy

robot. However, they did rank ‘familiar’, ‘agreeable’, ‘compassionate’, ‘social’, and ‘safe’ as being least associated with an untrustworthy robot.

Table 10

*Younger Adults' Mean Ranked Adjective Scores for Characteristics Associated with Trustworthy and Untrustworthy Robot*

| **Trustworthy Robot** | | | **Untrustworthy Robot** | | |
|---|---|---|---|---|---|
| Adjective | *M* | *SD* | Adjective | *M* | *SD* |
| **Reliable** | **4.92** | **0.29** | **Unreliable** | **4.92** | **0.29** |
| **Efficient** | **4.75** | **0.45** | **Unpredictable** | **4.83** | **0.39** |
| **Safe** | **4.75** | **0.62** | **Deceptive** | **4.75** | **0.45** |
| **Precise** | **4.33** | **0.65** | **Misleading** | **4.75** | **0.62** |
| **Predictable** | **4.33** | **1.15** | **Hostile** | **4.67** | **0.49** |
| **Familiar** | **4.08** | **0.9** | **Risky** | **4.67** | **0.65** |
| **Loyal** | **4.08** | **1.56** | **Sneaky** | **4.67** | **0.89** |
| **Calm** | **4** | **1.21** | Phony | 3.92 | 1.51 |
| **Friendly** | **4** | **0.95** | Pointless | 3.58 | 1.56 |
| Agreeable | 3.67 | 1.44 | Independent | 3.17 | 1.64 |
| Compassionate | 3.5 | 1.45 | Unsocial | 3.17 | 1.7 |
| Confident | 3.25 | 1.6 | Unfeeling | 2.58 | 2.02 |
| Dependent | 2.92 | 1.51 | Confident | 2.5 | 1.38 |
| Social | 2.92 | 1.31 | Dependent | 2.5 | 1.38 |
| Independent | 2.33 | 1.44 | Loud | 2.25 | 1.82 |
| Non-human looking | 1.83 | 1.59 | Social | 2 | 1.35 |
| Boring | 1.58 | 1.78 | Human looking | 1.75 | 1.6 |
| Human looking | 1.58 | 1.51 | Familiar | 1.67 | 1.23 |
| Pointless | 1.33 | 0.65 | Calm | 1.58 | 1.16 |
| Loud | 1.25 | 0.97 | Boring | 1.5 | 1.38 |
| Hostile | 1.17 | 0.58 | Compassionate | 1.42 | 1.24 |
| Unpredictable | 1.17 | 0.39 | Non-human looking | 1.42 | 1.31 |
| Unsocial | 1.17 | 0.83 | Precise | 1.42 | 0.9 |
| Risky | 1.08 | 0.29 | Predictable | 1.33 | 0.65 |
| Unfeeling | 1.08 | 0.79 | Agreeable | 1.25 | 0.62 |
| **Deceptive** | **1** | **--** | Efficient | 1.25 | 0.62 |
| **Misleading** | **1** | **--** | Friendly | 1.08 | 0.29 |
| **Sneaky** | **1** | **--** | **Loyal** | **1** | **0.43** |
| **Unreliable** | **1** | **0.43** | **Reliable** | **1** | **--** |
| **Phony** | **0.92** | **0.29** | **Safe** | **1** | **--** |

*Note*. 0 = don't know, 1= not at all, 2 = to a limited extent, 3 = to a moderate extent, 4 = to a large extent, 5 = to a great extent. The items highlighted indicated the adjective was associated, to a large extent or not at all, with a trustworthy or untrustworthy robot, respectively.

Table 11

*High Tech Older Adults' Mean Ranked Adjective Scores for Characteristics Associated with Trustworthy and Untrustworthy Robots*

| **Trustworthy Robot** | | | **Untrustworthy Robot** | | |
|---|---|---|---|---|---|
| Adjective | *M* | *SD* | Adjective | *M* | *SD* |
| **Reliable** | **4.92** | **0.29** | **Unreliable** | **4.75** | **0.45** |
| **Precise** | **4.83** | **0.39** | **Unpredictable** | **4.67** | **0.65** |
| **Safe** | **4.83** | **0.39** | **Risky** | **4.25** | **1.14** |
| **Efficient** | **4.75** | **0.62** | Misleading | 3.83 | 1.4 |
| **Predictable** | **4.67** | **0.65** | Pointless | 3.58 | 1.88 |
| Familiar | 3.42 | 1.68 | Deceptive | 3.5 | 2.02 |
| Agreeable | 3.08 | 1.68 | Sneaky | 3 | 2.22 |
| Independent | 3 | 1.65 | Hostile | 2.83 | 2.08 |
| Dependent | 2.5 | 1.98 | Dependent | 2.58 | 2.02 |
| Loyal | 2.33 | 2.15 | Phony | 2.42 | 2.11 |
| Confident | 2.17 | 2.21 | Independent | 2.17 | 1.64 |
| Calm | 2.08 | 2.11 | Boring | 1.92 | 2.11 |
| Friendly | 1.92 | 1.88 | Unfeeling | 1.75 | 2.14 |
| Human looking | 1.5 | 1.45 | Unsocial | 1.5 | 2.2 |
| Compassionate | 1.25 | 1.54 | Calm | 1.33 | 1.56 |
| Unfeeling | 1.25 | 1.66 | Confident | 1.33 | 1.83 |
| Loud | 1.17 | 1.19 | Loud | 1.33 | 1.92 |
| Unsocial | 1.17 | 1.27 | Precise | 1.33 | 0.49 |
| Risky | 1.08 | 0.29 | Agreeable | 1.25 | 1.29 |
| Social | 1.08 | 1.51 | Compassionate | 1.25 | 1.6 |
| **Pointless** | **1** | **0.43** | Friendly | 1.25 | 1.36 |
| **Sneaky** | **1** | **0.74** | Efficient | 1.17 | 0.39 |
| **Unpredictable** | **1** | **--** | Predictable | 1.17 | 0.39 |
| **Unreliable** | **1** | **--** | Safe | 1.17 | 0.39 |
| **Deceptive** | **0.92** | **0.51** | **Reliable** | **1** | **--** |
| **Misleading** | **0.92** | **0.29** | **Social** | **1** | **1.6** |
| **Hostile** | **0.83** | **0.39** | **Familiar** | **0.92** | **0.9** |
| **Non-human looking** | **0.83** | **1.03** | **Loyal** | **0.83** | **1.4** |
| **Phony** | **0.83** | **0.58** | **Non-human looking** | **0.58** | **0.67** |
| **Boring** | **0.67** | **0.49** | **Human looking** | **0.42** | **0.67** |

*Note*. 0 = don't know, 1= not at all, 2 = to a limited extent, 3 = to a moderate extent, 4 = to a large extent, 5 = to a great extent. The items highlighted indicated the adjective was associated, to a large extent or not at all, with a trustworthy or untrustworthy robot, respectively.

Table 12

*Low Tech Older Adults' Mean Ranked Adjective Scores for Characteristics Associated with Trustworthy and Untrustworthy Robots*

| **Trustworthy Robot** | | | **Untrustworthy Robot** | | |
|---|---|---|---|---|---|
| Adjective | *M* | *SD* | Adjective | *M* | *SD* |
| **Reliable** | **4.42** | **0.67** | Unreliable | 3.5 | 1.45 |
| **Precise** | **4.33** | **0.89** | Phony | 3.42 | 1.83 |
| **Efficient** | **4.17** | **0.94** | Sneaky | 3.25 | 2.14 |
| **Safe** | **4** | **0.85** | Unpredictable | 3.17 | 1.47 |
| Predictable | 3.92 | 1.16 | Misleading | 2.92 | 2.31 |
| Familiar | 3.83 | 1.11 | Deceptive | 2.75 | 2.45 |
| Calm | 3.58 | 1.83 | Hostile | 2.58 | 2.27 |
| Confident | 3.42 | 1.51 | Risky | 2.58 | 2.15 |
| Loyal | 3 | 1.91 | Pointless | 2.5 | 2.02 |
| Independent | 2.92 | 1.51 | Calm | 2.08 | 1.62 |
| Agreeable | 2.5 | 1.78 | Loud | 2.08 | 1.73 |
| Dependent | 2.08 | 1.44 | Dependent | 1.75 | 1.54 |
| Compassionate | 1.92 | 1.68 | Independent | 1.58 | 1.38 |
| Friendly | 1.92 | 1.78 | Non-human looking | 1.58 | 1.73 |
| Unfeeling | 1.83 | 1.53 | Unfeeling | 1.58 | 1.98 |
| Human looking | 1.67 | 1.56 | Boring | 1.5 | 1.83 |
| Social | 1.67 | 1.37 | Confident | 1.5 | 1.38 |
| Risky | 1.33 | 0.49 | Precise | 1.42 | 1.16 |
| Non-human looking | 1.25 | 1.22 | Predictable | 1.42 | 1.38 |
| Boring | 1.17 | 1.11 | Reliable | 1.42 | 1.16 |
| Loud | 1.17 | 0.72 | Unsocial | 1.42 | 2.02 |
| Unpredictable | 1.17 | 0.58 | Efficient | 1.25 | 0.62 |
| Pointless | 1.08 | 0.29 | Human looking | 1.25 | 1.42 |
| **Deceptive** | **1** | **--** | Loyal | 1.17 | 0.72 |
| **Phony** | **1** | **0.74** | Friendly | 1.08 | 0.51 |
| **Unreliable** | **1** | **--** | **Safe** | **1** | **0.6** |
| **Misleading** | **0.92** | **0.29** | **Social** | **1** | **0.85** |
| **Sneaky** | **0.92** | **0.29** | **Compassionate** | **0.92** | **0.51** |
| **Hostile** | **0.83** | **0.39** | **Agreeable** | **0.75** | **0.62** |
| **Unsocial** | **0.83** | **0.72** | **Familiar** | **0.67** | **0.89** |

*Note*. 0 = don't know, 1= Not at all, 2 = to a limited extent, 3 = to a moderate extent, 4 = to a large extent, 5 = to a great extent. The items highlighted indicated the adjective was associated, to a large extent or not at all, with a trustworthy or untrustworthy robot, respectively.

Tables 10 – 12 also identify some important similarities across groups. The highest rated adjectives associated with trustworthy robots were the same for each group: 'reliable', 'precise', efficient', and 'safe'. To identify any differences in the distribution of ranked responses between groups, Mann Whitney U tests were conducted (see Appendix AA). Figure 6 highlights six adjectives that were significantly different in responses between younger and high tech older adults when asked to what extent the adjective matched what they imagined a trustworthy robot would possess. Except for 'precise', younger adults generally viewed these adjectives as being more highly associated with characteristics they imagined a trustworthy robot would possess. High tech older adults only associated them to a limited extent. A significant difference was also found for 'precise'. Both groups highly associated it with a characteristic a trustworthy robot would possess, although high technology experience older adults thought more so.

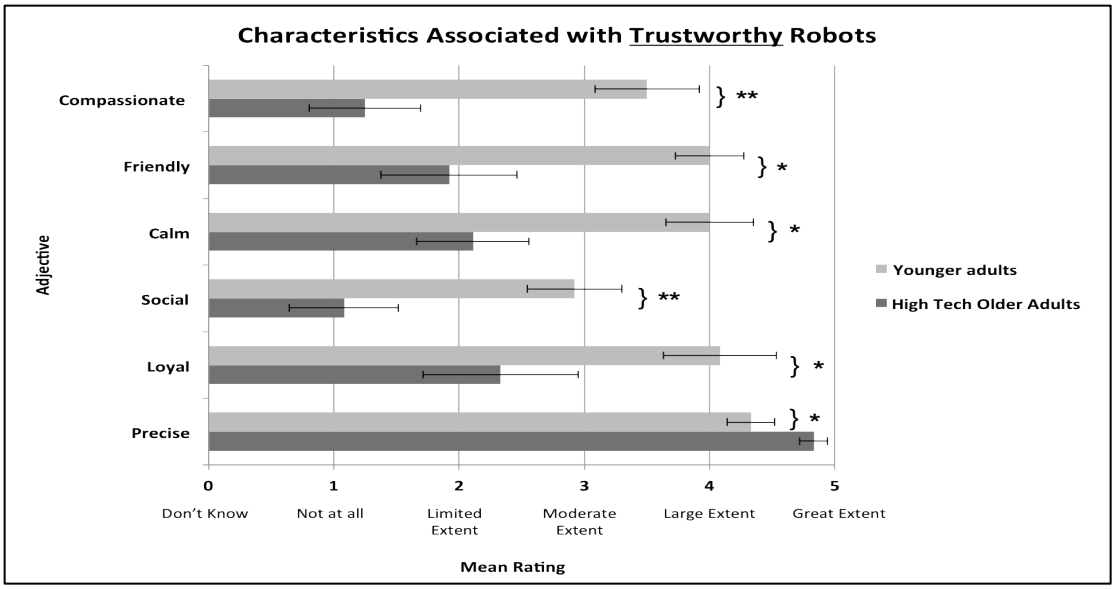



*Figure 6.* Significant differences between younger adults and high technology experience older adults for adjectives that match the characteristics they imagine a trustworthy robot would possess. Error bars represent standard error of the median. Groups are listed by magnitude of difference. Significance is $*p < .05$ and $**p < .01$

Figure 7 highlights the seven adjectives where significant differences were found between younger and high tech older adults for adjectives associated with untrustworthy robots. Younger adults indicated 'hostile', 'sneaky', and 'misleading' to be highly associated with untrustworthy robots, whereas high tech older adults only to a limited extent. Both younger and high tech older adults indicated 'unsocial', 'human looking', 'confident', and 'social' as only being associated with untrustworthy robots to a moderate or limited extent. However, high tech older adults' ratings were overall lower than younger adults.

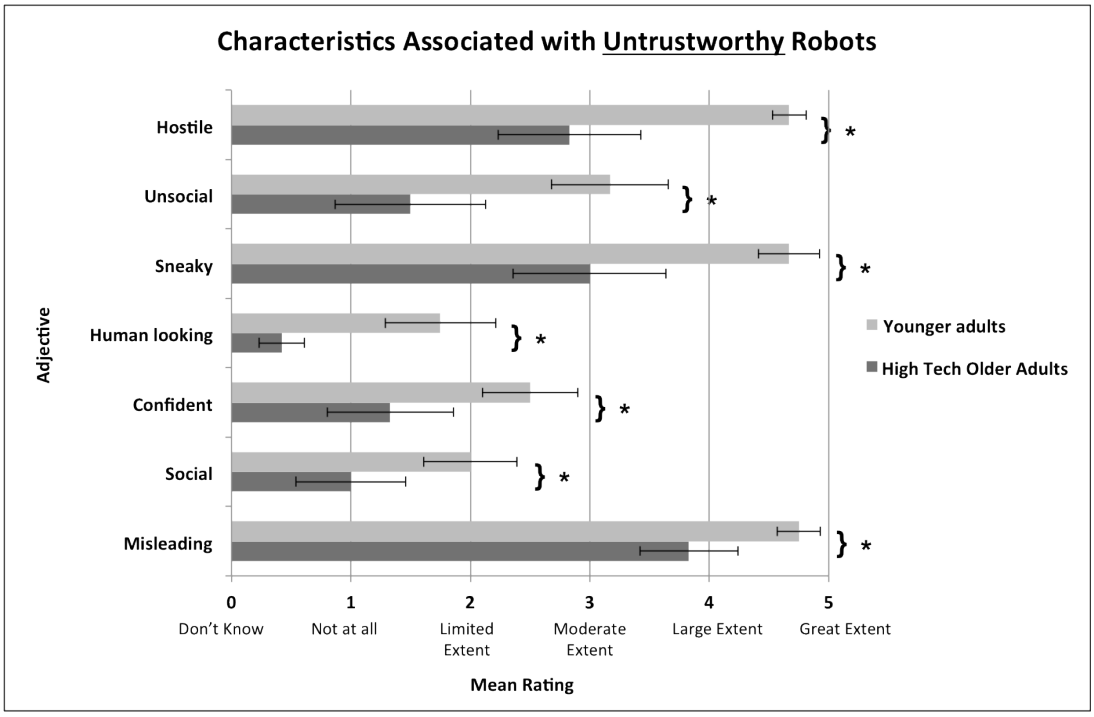



*Figure 7.* Significant differences between younger adults and high technology experience older adults for adjectives that match the characteristics they imagine an untrustworthy robot would possess. Error bars represent standard error of the median. Groups are listed by magnitude of difference. Significance is $*p < .05$.

In Figure 8, adjectives where there were significant differences between high tech and low tech older adults for adjectives used describe trustworthy robots were 'safe' and 'reliable'. Both groups attributed these, to a large extent, with trustworthy robots, however, more so for high tech older adults.

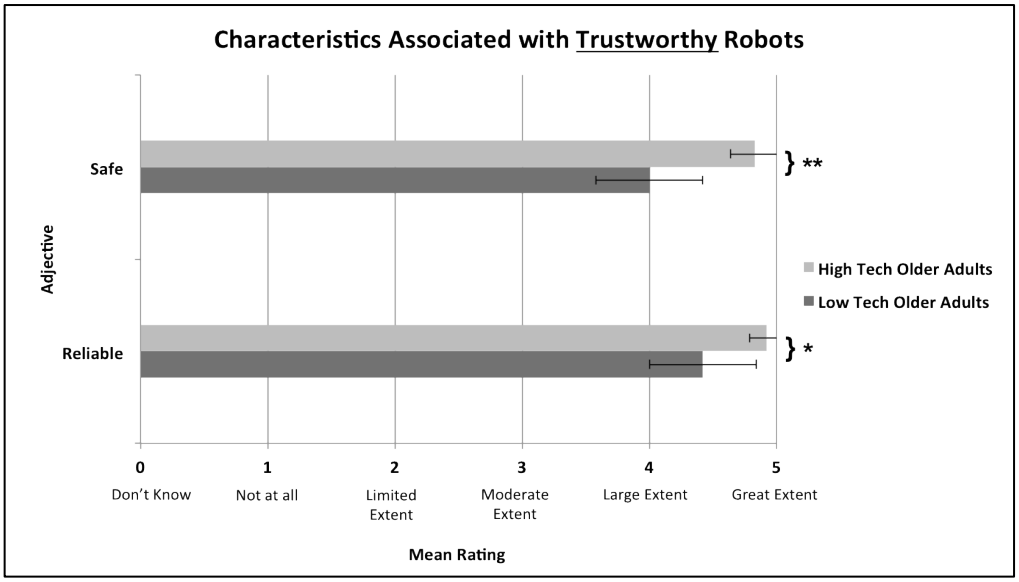



*Figure 8.* Significant differences between high and low technology experience older adults for adjectives that match the characteristics they imagine a trustworthy robot would possess. Error bars represent standard error of the median. Groups are listed by magnitude of difference. Significance is *$p < .05$ and ** $p < .01$.

Finally, there were only two adjectives where there were significant differences between high tech and low tech older adults for associations with untrustworthy robots; 'unpredictable' and 'unreliable' (see Figure 9). Both groups reported, at least to a moderate extent, that those two adjectives were associated with untrustworthy robots although high tech older adults more so. There were very little differences between the high and low tech older adults which suggests these groups are more similar, than different, in the characteristics they associate with trustworthy and untrustworthy robots.

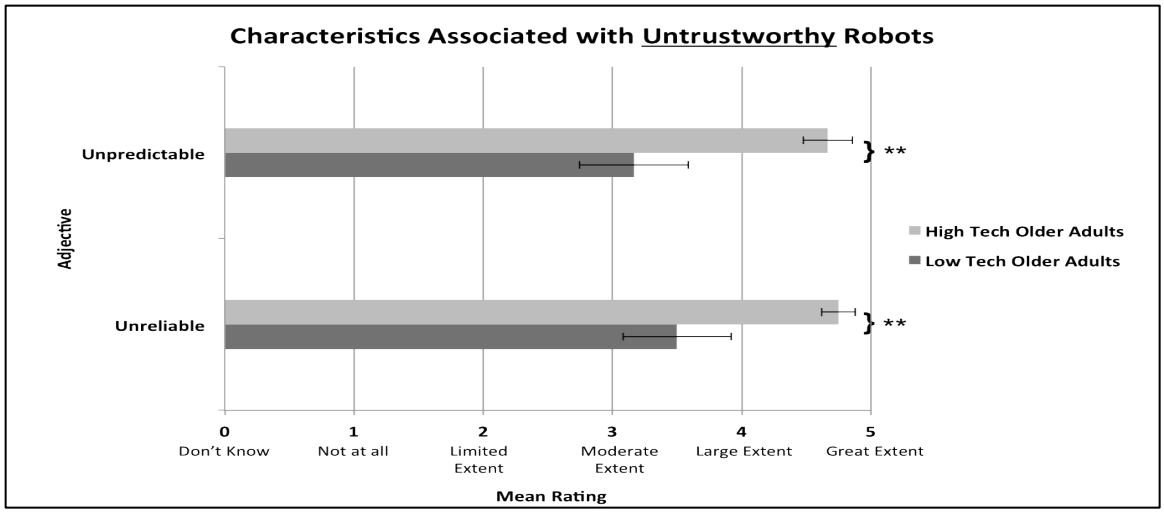



*Figure 9.* Significant differences between high and low technology experience older adults for adjectives that match the characteristics they imagine an untrustworthy robot would possess. Error bars represent standard error of the median. Groups are listed by magnitude of difference. Significance is ** $p < .01$.

These data show some significant differences between groups when asked to evaluate adjectives on how they best represented trustworthy and untrustworthy robots. However, the overall trend suggest that participants are more similar than different. This is particularly evident between high and low tech older adults.

**The Card-Sorting Task.**

***Characteristics of a trustworthy robot.*** Table 13 represents the selection frequency of participants on the card-sorting task when asked to select five adjectives (from 30) that best represent characteristics of a trustworthy robot. The adjectives 'predictable', 'reliable', and 'safe' were chosen by 75% of the younger adults as being best representative of characteristics associated with a trustworthy robot. The adjectives 'efficient', 'precise', 'predictable', and 'reliable' were chosen by 75% of the high tech older adults, while none of the adjectives were selected by 75% of the low tech older adults. The younger adult and high tech older adults participants' were similar in their

selections, whereas the low tech older adults' selections were more varied but their top responses were the same as the other groups.

Table 13

*Card Sorting Task Frequency Count of the Adjectives Representative of a **Trustworthy** Robot*

| Adjectives | Younger Adults (*n*=12) | High Tech Older Adults (*n*=12) | Low Tech Older Adults (*n*=12) | Total (*n*=36) |
|---|---|---|---|---|
| Agreeable | -- | 2 | 2 | 4 |
| Boring | -- | -- | 1 | 1 |
| Calm | 2 | 1 | 2 | 5 |
| Compassionate | -- | 1 | -- | 1 |
| Confident | -- | 3 | 1 | 4 |
| Dependent | 1 | -- | 3 | 4 |
| Efficient | 7 | **11** | 8 | 26 |
| Familiar | 2 | 1 | 2 | 5 |
| Friendly | 2 | -- | 4 | 6 |
| Human Looking | 1 | -- | 3 | 4 |
| Independent | 3 | 1 | 3 | 7 |
| Loyal | 5 | 2 | 3 | 10 |
| Non-human looking | 1 | -- | 1 | 2 |
| Precise | 6 | **11** | 6 | 23 |
| Predictable | **9** | **9** | 6 | 24 |
| Reliable | **12** | **10** | 6 | 28 |
| Safe | **9** | 8 | 7 | 24 |
| Unfeeling | -- | -- | 1 | 1 |
| Unsocial | -- | -- | 1 | 1 |
| Total | 60 | 60 | 60 | 180 |

*Note.* The sum of frequencies in each group is 60 because each participant selected five adjectives. Not all 30 adjectives are represented, only ones that were selected at least once by at least one group. Adjectives chosen by 75% or more in a group are highlighted.

Figure 10 highlights that the top five frequently selected adjectives were the same for each group. The pattern in the graph shows that regardless of age or technology experience, these adjectives are important characteristics in a trustworthy robot. Even at least 50% of low tech older adults chose these adjectives as their top five.

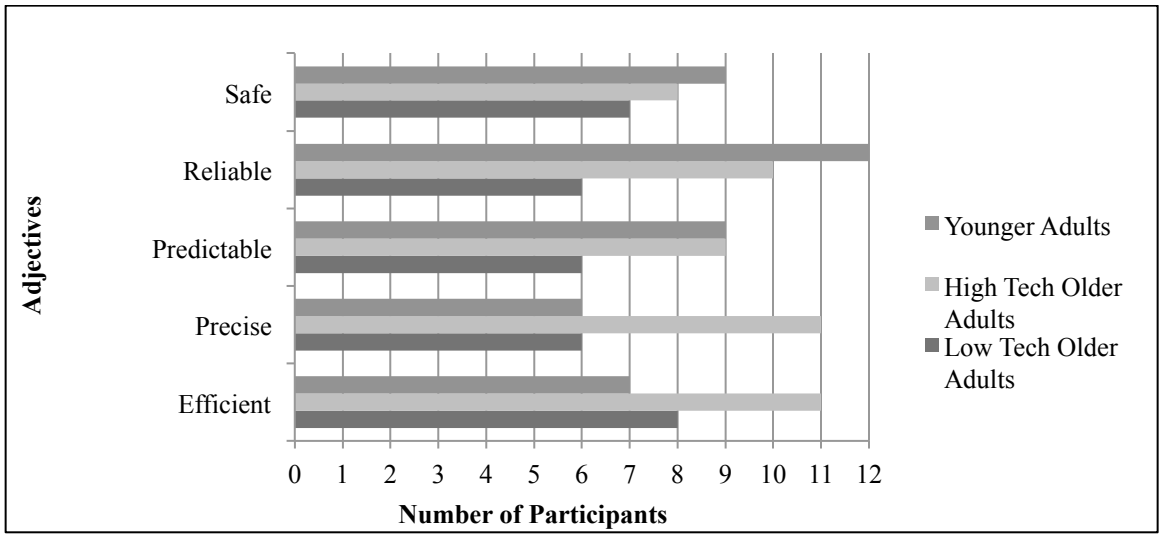



*Figure 10.* Frequencies for the five most selected adjectives that participants indicated match the characteristics they imagine a trustworthy robot would possess.

***Characteristics of an untrustworthy robot.*** Table 14 represents the selection frequency of participants on the card-sorting task when asked to select five adjectives (from 30) that best represent characteristics of an untrustworthy robot. The adjectives 'unpredictable' and 'unreliable' were selected by at least 75% of younger and high tech older adults. The only adjective that at least 75% of low tech older adults selected was 'unreliable'. Again, the overall pattern in adjective selection is similar between younger and high tech older adults, whereas low tech older adults are more varied in their selections.

Table 14

*Card Sorting Task Frequency Count of the Adjectives Representative of an **Untrustworthy** Robot*

| Adjectives | Younger Adults (*n*=12) | High Tech Older Adults (*n*=12) | Low Tech Older Adults (*n*=12) | Total |
|---|---|---|---|---|
| Boring | -- | -- | 1 | 1 |
| Compassionate | -- | -- | 1 | 1 |
| Deceptive | 7 | 3 | 3 | 13 |
| Dependent | -- | -- | 2 | 2 |
| Friendly | -- | -- | 1 | 1 |
| Hostile | 8 | 5 | 3 | 16 |
| Human Looking | 1 | 1 | 1 | 3 |
| Independent | 1 | 4 | 1 | 6 |
| Loud | 1 | 5 | 3 | 9 |
| Loyal | -- | -- | 1 | 1 |
| Misleading | 8 | 6 | 3 | 17 |
| Non-human looking | -- | -- | 3 | 3 |
| Phony | 1 | 1 | 4 | 6 |
| Pointless | 1 | 4 | 2 | 7 |
| Risky | 5 | 7 | 5 | 17 |
| Sneaky | 5 | 1 | 1 | 7 |
| Social | -- | -- | 1 | 1 |
| Unfeeling | 1 | 1 | 6 | 8 |
| Unpredictable | **12** | **11** | 6 | 29 |
| Unreliable | **9** | **11** | **9** | 29 |
| Unsocial | -- | -- | 3 | 3 |
| Total | 60 | 60 | 60 | 180 |

*Note.* The sum of frequencies in each group is 60 because each participant selected five adjectives. Not all 30 adjectives are represented, only ones that were selected at least once by at least one group. Adjectives chosen by 75% or more in a group are highlighted.

The top five adjectives that younger adults indicated as best representative of an untrustworthy robot were ‘unpredictable’, ‘unreliable’, ‘misleading’, ‘hostile’, and ‘deceptive’. For high tech older adults, their top five adjectives were ‘unreliable’, ‘unpredictable’, ‘risky’, ‘loud’, and ‘hostile’. Finally, for low tech older adults, ‘unreliable’, ‘unpredictable’, ‘unfeeling’, ‘risky’, and ‘phony’ were the top five adjectives selected as being best representative of an untrustworthy robot.

**Summary of Attitudes That Influence Trust in Robots**

Most participants had a positive attitude toward robots and indicated that they would trust a robot in their home. However before trusting a robot, they wanted to know

a lot of information about it, especially about the robots' capabilities and limitations. From both the evaluation of the card-sorting task and the Trust in Robot Characteristics Questionnaire, the data indicate that reliability and predictability are generally characteristics that are most associated with a trustworthy robot. Participants generally most associated with characteristics of an untrustworthy robot as being unreliable, unpredictable, and risky.

## Results Part 4: Trust Varying By Task

### Does Trust Vary By Task?

The Trust in Assistance Checklist was administered to directly contrast preferences for human or robot assistance for 20 home-based tasks. Participants indicated their trust for assistance for each task by selecting a response from a 5-point Likert-type scale. The five response options were, 1 = only trust a human, 2 = trust a human more, 3 = trust either a human or a robot, 4 = trust a robot more, and 5 = only trust a robot.

In this section, the results of 11 of the tasks, which directly parallel tasks discussed in the structured interview, are reviewed. The 11 tasks were grouped into four category domains. The first domain, activities of daily living (ADL), included the tasks, bathing, reaching for objects, and walking. The second domain, instrumental activities of daily living – Psychomotor (ADL – Psychomotor), included the tasks 'cleaning the kitchen', 'hand washing dishes', and 'opening and closing drawers'. The third domain, instrumental activities of daily living – cognitive (IADL – Cognitive), included the tasks 'deciding what medication to take', 'medication reminder', and 'monitoring the home or warning about dangers'. The final domain, enhanced activities of daily living (EADL), included the tasks 'entertaining', and 'learning new skills'.

In Figure 11, mean ratings are depicted for trust in a human versus robot assistance for 11 different tasks in each group. Within each task category domain, the tasks shown are ordered from highest mean preference for robot assistance to highest preference for human assistance. Although the preference was for trust in human assistance for four tasks (e.g., 'bathing', 'hand washing dishes', 'deciding what

medication to take') there were several tasks for which many participants indicated they would trust a robot more, such as 'medication reminding' and 'monitoring home/warning about dangers'.

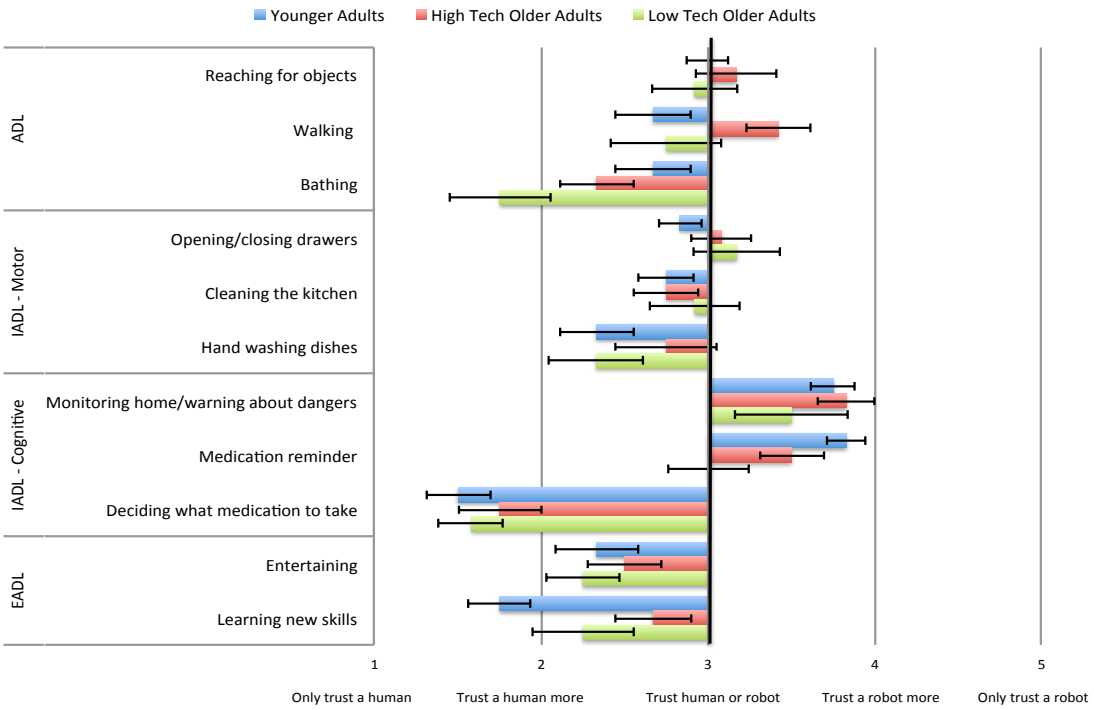



*Figure 11.* Mean group ratings for trust preference for a human versus robot assistance by task. Error bars represent standard error of the median.

**Preference for human versus robot assistance compared to no preference.**

To determine if each group had a significant preference for human assistance or robot assistance for each task, non-parametric one sample Wilcoxon sign-rank tests were performed to compare each tasks median against no preference for human or a robot assistance (no preference = 3) (see Appendix BB).

There were six tasks for which younger adults had a significant preference for assistance compared to no preference (see Table 15). Specifically, four tasks where there was a preference toward trusting a human more for assistance were: deciding what

medication to take, hand washing dishes, entertaining, and learning new skills. Two tasks where there were significant preferences for robot assistance compared with no preference were medication reminding, and monitoring home/warning about dangers. There were no significant differences compared to no preference for the remaining five tasks.

Table 15

Differences in Distribution of Ranked Scores for Tasks for Which Younger Adults Had a Significant Preference for Assistance Compared to No Preference

| Task | *M* | *SD* | *Mdn* | *Range* | *Z* | *n* | *p* |
|---|---|---|---|---|---|---|---|
| ADL | | | | | | | |
| Bathing | 2.67 | .78 | 2.5 | 2-4 | -1.41 | 12 | .16 |
| Reaching for objects | 3.00 | .43 | 3 | 2-4 | 0.00 | 12 | 1 |
| Walking | 2.67 | .78 | 3 | 1-4 | -1.41 | 12 | .16 |
| IADL Cognitive | | | | | | | |
| Deciding what medication to take | 1.50 | .67 | 1 | 1-3 | -3.04 | 12 | <.01** |
| Medication reminding | 3.83 | .39 | 4 | 3-4 | -3.16 | 12 | <.01** |
| Monitoring home/warning about dangers | 3.75 | .45 | 4 | 3-4 | -3.00 | 12 | <.01** |
| IADL Psychomotor | | | | | | | |
| Cleaning the kitchen | 2.75 | .45 | 3 | 2-3 | -1.73 | 12 | .08 |
| Hand washing dishes | 2.33 | .78 | 2.5 | 1-3 | -2.27 | 12 | .02* |
| Opening and closing drawers | 2.83 | .58 | 3 | 1-3 | -1.00 | 12 | .16 |
| EADL | | | | | | | |
| Entertaining | 2.33 | .65 | 2 | 1-3 | -2.53 | 12 | .01* |
| Learning new skills | 1.75 | .87 | 1.5 | 1-3 | -2.76 | 12 | .01* |

*Note.* 1 = Only trust a human, 2 = Trust a human more, 3 = Trust either a human or a robot, 4 = Trust a robot more, 5 = Only trust a robot.

*$p < .05$, **$p < .01$, ***$p < .001$

There were four tasks that were significantly different from no preference in the high technology experience older adult group (see Table 16). They preferred to trust a human more for assistance with bathing and deciding what medication to take. However,

they preferred to trust a robot more for assistance with medication reminding and monitoring home/warning about dangers. For the remaining seven tasks, they indicated no preference.

Table 16

Differences in Distribution of Ranked Scores for Tasks for Which High Tech Older Adults Had a Significant Preference for Assistance Compared to No Preference

| Task | *M* | *SD* | *Mdn* | *Range* | *Z* | *n* | *p* |
|---|---|---|---|---|---|---|---|
| ADL | | | | | | | |
| Bathing | 2.33 | .78 | 2.5 | 1-3 | -2.27 | 12 | .02* |
| Reaching for objects | 3.17 | .84 | 3 | 2-4 | -.71 | 12 | .48 |
| Walking | 3.42 | .67 | 3 | 3-5 | -1.89 | 12 | .06 |
| IADL Cognitive | | | | | | | |
| Deciding what medication to take | 1.75 | .87 | 1.5 | 1-3 | -2.76 | 12 | <.01** |
| Medication reminding | 3.50 | .67 | 4 | 2-4 | -2.12 | 12 | .03* |
| Monitoring home/warning about dangers | 3.83 | .58 | 4 | 3-5 | -2.89 | 12 | <.01** |
| IADL Psychomotor | | | | | | | |
| Cleaning the kitchen | 2.75 | .62 | 3 | 2-4 | -1.34 | 12 | .18 |
| Hand washing dishes | 2.75 | 1.06 | 3 | 1-5 | -.79 | 12 | .43 |
| Opening and closing drawers | 3.08 | .67 | 3 | 2-5 | -.45 | 12 | .66 |
| EADL | | | | | | | |
| Entertaining | 2.50 | .80 | 2.5 | 1-4 | -1.89 | 12 | .06 |
| Learning new skills | 2.67 | .78 | 2.5 | 2-4 | -1.41 | 12 | .16 |

*Note.* 1 = Only trust a human, 2 = Trust a human more, 3 = Trust either a human or a robot, 4 = Trust a robot more, 5 = Only trust a robot.

*$p < .05$, **$p < .01$, ***$p < .001$

The trust preferences for the low technology experience older adult group were significantly different than no preference for four tasks (see Table 17). The preferences were all toward trusting a human more with assistance: bathing, deciding what medication to take, entertaining, and learning new skills. The remaining seven tasks were not significantly different from no preference.

Table 17

Differences in Distribution of Ranked Scores for Tasks for Which Low Tech Older Adults Had a Significant Preference for Assistance Compared to No Preference

| Task | *M* | *SD* | *Mdn* | *Range* | *Z* | *n* | *p* |
|---|---|---|---|---|---|---|---|
| ADL | | | | | | | |
| Bathing | 1.75 | 1.06 | 1 | 1-4 | -2.71 | 12 | <.01** |
| Reaching for objects | 2.92 | .90 | 3 | 1-4 | -.33 | 12 | .74 |
| Walking | 2.75 | 1.14 | 3 | 1-4 | -.97 | 12 | .34 |
| IADL Cognitive | | | | | | | |
| Deciding what medication to take | 1.58 | .67 | 1.5 | 1-3 | -3.02 | 12 | <.01** |
| Medication reminding | 3 | .85 | 3 | 1-4 | .00 | 12 | 1 |
| Monitoring home/warning about dangers | 3.50 | 1.17 | 4 | 1-5 | -1.35 | 12 | .18 |
| IADL Psychomotor | | | | | | | |
| Cleaning the kitchen | 2.92 | .90 | 3 | 1-4 | -.33 | 12 | .74 |
| Hand washing dishes | 2.33 | .98 | 2.5 | 1-4 | -1.99 | 12 | .05 |
| Opening and closing drawers | 3.17 | .94 | 3 | 1-4 | -.63 | 12 | .53 |
| EADL | | | | | | | |
| Entertaining | 2.25 | 1.06 | 2.5 | 1-4 | -2.08 | 12 | .04* |
| Learning new skills | 2.25 | .75 | 2 | 1-3 | -2.46 | 12 | .01* |

*Note.* 1 = Only trust a human, 2 = Trust a human more, 3 = Trust either a human or a robot, 4 = Trust a robot more, 5 = Only trust a robot.

*$p < .05$, **$p < .01$, ***$p < .001$

**Preference for human versus robot assistance between groups.** To determine if there were any significant differences between groups in trust preferences for human versus robot assistance, non-parametric Mann-Whitney U tests were conducted on the median scores for each task. The tests indicated that there were significant differences in trust preferences for assistance between groups (see Appendix CC).

There were two tasks where there were significant differences in trust preferences between younger adults and high tech older adults. The first task difference was for

walking ($U = 37.5$, $p = .02$). Younger adults (*Mdn*= 3, *Range* = 1-4) preferred to trust a human more for assistance with walking, whereas high tech older adults (*Mdn* = 3, *Range* = 3-5) preferred to trust a robot more for assistance with walking. The second task difference was for learning new skills ($U = 33$, $p = .02$). Both younger adults (*Mdn* = 1.5, *Range* = 1-3) and high tech older adults (*Mdn* = 2.5, *Range* = 2-4) had preferences for human assistance with learning new skills. However, the preference for assistance was stronger for younger adults than high tech older adults. There were no significant differences in trust preferences for human assistance versus robot assistance between high tech and low tech experience older adults.

**Trust for Tasks Interview**

During the second section of the structured interview I asked participants to select the level agreement they had with statements about trusting robots for 12 home-based tasks in four domains (see Table 18). Participants chose one response from the following Likert scale options, 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, and 5 = strongly agree.

Table 18

*Twelve Home-Based Tasks by Domain*

| Domain | Tasks | | |
|---|---|---|---|
| ADL | Bathing | Reaching for objects | Walking |
| IADL (Psychomotor) | Cleaning the kitchen | Hand washing dishes | Opening and closing drawers |
| IADL (Cognitive) | Deciding what medication to take | Medication reminding | Monitoring home or warning about dangers |
| EADL | Entertaining | Learning new skills | Getting information on the weather or news |

*Note.* ADL = Activities of daily living; IADL = Instrumental activities of daily living; EADL = Enhanced activities of daily living.

As evident in Table 19, in general, most participants agreed they would trust a robot for assistance for many of the tasks. However, for 'bathing', 'deciding what medication to take', and 'hand washing dishes' most participants leaned more toward not trusting a robot or being undecided.

Table 19

*Level of Agreement Frequency Count For Trust in Tasks Interview*

| Level of Agreement | Younger Adults (*n*=12) | High Tech Older Adults (*n*=12) | Low Tech Older Adults (*n*=12) |
|---|---|---|---|
| Bathing | | | |
| Disagree | 6 | 3 | 7 |
| Undecided | 3 | 2 | 3 |
| Agree | 3 | 7 | 2 |
| Total Responses | 12 | 12 | 12 |
| Reaching for Objects | | | |
| Disagree | -- | 1 | 2 |
| Undecided | -- | 1 | 1 |
| Agree | 12 | 10 | 9 |
| Total Responses | 12 | 12 | 12 |
| Walking | | | |
| Disagree | 1 | 3 | 1 |
| Undecided | 1 | 1 | 1 |
| Agree | 10 | 8 | 10 |
| Total Responses | 12 | 12 | 12 |
| Deciding what medication to take | | | |
| Disagree | 8 | 10 | 9 |
| Undecided | 3 | 1 | 3 |
| Agree | 1 | 1 | -- |
| Total Responses | 12 | 12 | 12 |
| Medication reminding | | | |
| Disagree | -- | -- | 2 |
| Undecided | -- | 1 | -- |
| Agree | 12 | 11 | 10 |
| Total Responses | 12 | 12 | 12 |
| Monitoring home/warning about dangers | | | |
| Disagree | -- | -- | 1 |
| Undecided | -- | 3 | 2 |
| Agree | 12 | 9 | 9 |
| Total Responses | 12 | 12 | 12 |

| Level of Agreement | Younger Adults (*n*=12) | High Tech Older Adults (*n*=12) | Low Tech Older Adults (*n*=12) |
|---|---|---|---|
| Cleaning the kitchen | | | |
| Disagree | -- | 2 | 1 |
| Undecided | 1 | -- | 1 |
| Agree | 11 | 10 | 10 |
| Total Responses | 12 | 12 | 12 |
| Hand washing dishes | | | |
| Disagree | 2 | 4 | 6 |
| Undecided | 2 | 3 | 1 |
| Agree | 8 | 5 | 5 |
| Total Responses | 12 | 12 | 12 |
| Opening and closing drawers | | | |
| Disagree | -- | -- | -- |
| Undecided | -- | -- | 2 |
| Agree | 12 | 12 | 10 |
| Total Responses | 12 | 12 | 12 |
| Entertaining | | | |
| Disagree | 2 | 1 | 4 |
| Undecided | -- | 2 | 1 |
| Agree | 10 | 9 | 7 |
| Total Responses | 12 | 12 | 12 |
| Learning new skills | | | |
| Disagree | -- | -- | 1 |
| Undecided | 4 | 2 | 2 |
| Agree | 8 | 10 | 9 |
| Total Responses | 12 | 12 | 12 |
| Getting information on the weather or news | | | |
| Disagree | -- | -- | 2 |
| Undecided | -- | -- | 3 |
| Agree | 12 | 12 | 7 |
| Total Responses | 12 | 12 | 12 |

*Note.* Participants were asked to select their level of agreement (i.e., strongly disagree, disagree, undecided, agree, and strongly agree) for statements about trusting a robot to assist with tasks. Responses were combined for strongly disagree and disagree, and strongly agree and agree.

For each task, MannWhitney U tests were conducted to identify differences in level of agreement between groups (see Appendix DD). Between younger adults and high tech older adults, there was only a significant difference for the task 'monitoring

home/warning about dangers' ($U = 30$, $p = .01$). Both groups agreed that they would trust a robot for assistance. However, high tech older adults (*Mdn* = 5, *Range* = 4-5) agreed that they trusted a robot more than younger adults (*Mdn* = 4, *Range* = 4-5).

Between younger adults and low tech older adults, there was only a significant difference in agreement for the task 'getting information on the weather or news' ($U = 26$, $p = .01$). Both groups agreed that they would trust a robot for assistance with the task although younger adults (*Mdn* = 5, *Range* = 4-5) more so than low tech older adults (*Mdn* = 4, *Range* = 4-5).

There were also significant differences in agreement between high tech and low tech older adults for 'monitoring home/warning about danger' ($U = 32$, $p = .01$). Both group indicated they trusted a robot for assistance with the task. However, high tech older adults (*Mdn* = 5, *Range* = 4-5) trusted a robot more for assistance than low tech older adults (*Mdn* = 4, *Range* =1-5).

To understand the reasons behind participants' decision-making process, they were asked <u>why</u> they chose their level of agreement. For tasks that participants agreed that they would trust a robot for assistance, they provided up to 18 different types of reasons. When they disagreed, they had up to 13 different reasons, and when they were undecided, they gave up to 19 different reasons (see Table 20).

Table 20

*The Reasons Behind Participants' Trust Decisions When Asked About Trusting a Robot Across All Tasks*

| Agree | Disagree | Undecided |
|---|---|---|
| Benefit of the doubt | Concerns about robot capabilities | Concerns about robot capabilities |
| Benefit outweighs risk | Complicated task | Dehumanizing |
| Convenient | Dehumanizing | High risk for property damage |
| Do not like to do it | High risk for property damage | Human has difficulty doing the task |
| Human has difficulty doing the task | Human has more experience or better | Human has more experience or better |
| If robot is capable | Lack of robot sophistication | Lack of robot precision |
| Low risk to human | Like to do it themselves | Lack of robot sophistication |
| Low risk for property damage | Personal | Like to do it themselves |
| No different than a computer | Risk outweighs benefit | Low risk for property damage |
| Non-critical task | Robot not qualified to make those decisions | Non-critical task |
| Programmed to do it | Robot not proven reliable | Not qualified to make those decisions |
| Proven reliable | Safety risk to human | Programmed to do it |
| Robot more patient than a human | Waste of time | Robot not proven reliable |
| Robot would do a better job | | Robot not qualified to make those decisions |
| Safer for the robot to do it | | Robot would do a better job |
| Similar technology already exists | | Safety risk to human |
| Simple task | | Similar technology already exists |
| Time Saver | | Personal |
| | | Waste of time |

*Note.* Participants were asked to select their level of agreement (i.e., strongly disagree, disagree, undecided, agree, and strongly agree) for statements about trusting a robot to assist with tasks. Responses were combined for strongly disagree and disagree, and strongly agree and agree.

For each task there were wide ranges in the frequency of responses, within and between groups, in the reasons that participants gave when they were asked why they selected their level of trust agreement (see Appendix EE for graphs with specific

frequency counts for each task). However, the most prevalent overall reasons when participants 'agreed' that they would trust a robot for a specific task, was because of the simplicity of the task and that the robot was programmed to do it. When participants disagreed with trusting a robot, they provided many reasons. Most reasons were primarily related to safety concerns and privacy. To provide additional insight behind the reasons for participants' trust decisions, selected quotes from the interview are provided. Table 21 shows participant quotes about bathing that show the breadth of responses for three different levels of agreement (i.e., 'agree', 'disagree', and 'undecided'). Table 22 features quotes that show similarities between groups in participants' level of agreement and their reason for their agreement decisions.

Table 21

*Interview Quotes for Group Differences in Level of Agreement for Trusting a Robot for Assistance with 'Bathing'*

| Group | Level of Agreement | Reason | Quote |
|---|---|---|---|
| Younger Adult | Disagree | Concerns about robot capabilities | *"Right now, robots helping you bath is a new concept. Maybe after it has been around for a while and is proven. But for now I would disagree. "* |
| High Tech Older Adult | Agree | Human has difficulty doing the task | *"It could help you in and out of the tub. You know, it could lift you if you're disabled. I don't know what to tell you. People who are healthy can do a lot of things themselves, but people who are not healthy can't do it. Yeah I could, you know if you sit in a sort of bathing kind of seat. People who weigh more, it's hard to put them in and take them out. The arm could drop them in, hold them in there so they don't tip over. Yeah, I could agree with that. It could do that."* |
| Low Tech Older Adult | Undecided | Personal | *"Yeah, I don't know if I want it to be touching me like that."* |

Table 22

*Interview Quotes for Group Similarities in Level of Agreement and Reason for Trusting a Robot for Assistance with 'Deciding what medication to take'*

| Group | Level of Agreement | Reason | Quote |
|---|---|---|---|
| Younger Adult | Disagree | Robot not qualified to make those decisions | *"Deciding medication means something that doctor does, and doctors train for years to do that, and I just don't feel like a robot can store the information and decide medication you should take for you."* |
| High Tech Older Adult | Disagree | Robot not qualified to make those decisions | *"Well, I'm thinking because in order to help me decide they would have to know everything there is about the medicine. Well, did they go through colleges and whatever like the doctors do? I don't know, and who would be programming them? I just have a little problem with that."* |
| Low Tech Older Adult | Disagree | Robot not qualified to make those decisions | *"I rely on a doctor to do those things."* |

**Summary of Trust Varying By Task**

It is clear from the results of the Trust for Tasks Questionnaire and the Trust for Tasks section of the structured interview that trust in a robot does depend on the task. In general, participants were more willing to trust a robot for menial and rote tasks unless there were substantial safety risks (e.g., water causing an electrocution risk to human or damage to the robot). However, if the task involved high levels of decision making (e.g., deciding what medication to take) or were more safety-related in nature (e.g., bathing) participants were less willing to trust a robot.

# CHAPTER 4

# DISCUSSION

## Part 1: Summary of Key Findings

The main objective of this study was to determine if people would trust service robots in their homes. The second objective was to evaluate if the current framework of trust in automation I developed could be applied to service robots in a home environment. To address these objectives, this study focused on five open questions:

1. How do people define trust in robots?
2. What do people say influences their decisions to trust or distrust robots?
3. What are the characteristics people associate with trustworthy and untrustworthy robots?
4. What are the dimensions of trust that emerge as a characteristic of the robot's task?
5. Do trust decisions vary among people?

To answer these questions I used a multi-methodological approach, which included a structured interview, card-sorting tasks, and multiple questionnaires to collect relevant data.

### How Do People Define Trust in Robots?

Definitions of trust in robots that currently exist were repurposed from the definitions of trust in automation literature (Ezer, 2008; Jian et al., 2000). The definition of trust in automation that I developed in the past defined trust in automation as an attitude and expectation that the machines functions and capabilities, although uncertain, is based on the predictability and reliability of the current or past state of the machine.

Because there were no previous studies that investigated how people define (i.e., in their own words) trust in robots, I wanted to know if the repurposed definitions were sufficient to describe trust in robots too.

When participants were asked how they would define trust in a robot, there was some variability in the responses within and between groups. However, across groups it was found 'reliability' and 'capability' were the words most frequently used to describe trust in a robot, followed by 'history', 'benefit of the doubt', 'risk', and 'task'. These words map on well to the definition I previously developed for trust in automation. However, one addition to the definition should be added, the word 'task'. Although participants did not frequently mention 'task' in their specific definitions, it is clear from the data of other assessments that the nature of the task matters. I propose a definition of trust in a robot to be an attitude and expectation of robot functions and capabilities. Trust is based on the predictability and reliability of the robot and also influenced by the nature of the robot task.

**What Do People Say Influences Their Decisions to Trust or Distrust Robots?**

The structured interview was developed to give insight on factors that may influence decisions to trust or distrust a robot. Early on in the structured interview, participants were asked what they wanted to know about the robot before deciding whether or not to trust it. Overall, participants in all groups wanted to know a lot. Robot 'capabilities and limitations' were the most frequently mentioned type of information that participants wanted to know, followed by 'manufacturer' and 'reliability' of the robot. These types of knowledge responses, combined with what we learned about how participants define trust in robots, provide converging evidence about the importance of

robot reliability and robot capabilities. However, there was also a wide range and frequency of other types of responses within and between groups. This suggests that although there are some critical pieces of basic information necessary in making trust decisions for all groups, they were not the only pieces of information that were important to participants when making decisions about trusting a robot.

**What Are The Characteristics People Associate With Trustworthy and Untrustworthy Robots?**

The card-sorting task and Robot Trust Characteristics Questionnaire were developed to identify characteristics people associate with trustworthy and untrustworthy robots. Overall, participants selected 'reliability' and 'predictability' as adjectives they felt were characteristics that best described a trustworthy robot and 'unreliability' and 'unpredictability' best described characteristics of an untrustworthy robot. Again, the overall importance of robot reliability emerges from these data.

From evaluating the card-sorting data there were five adjectives, associated with a trustworthy robot that stood out because they were chosen by at least 50% of all participants. They were 'safe', 'reliable', 'predictable', 'precise', and 'efficient'. The selection of these adjectives is interesting because they are associated with trust in automated machines (Ezer, 2008; Jian et al., 2000). Although 'unpredictable' and 'unreliable' were the most selected adjectives associated with an untrustworthy robot across groups, there was a much wider range of adjectives selected by low tech older adults. Younger and high tech older adults selections were similar. They mainly selected adjectives associated with distrust in automation, however they did select some adjectives used to describe distrust in humans. Low tech older adults had a similar pattern,

however, they had higher rates of selecting adjectives used to describe trust in humans (Ezer, 2008; Jian et al., 2000).

The findings from the robot trust characteristics questionnaire showed similar patterns as the card-sorting task. All groups rated adjectives most highly associated with a trustworthy robot as 'reliable', 'efficient', 'safe', and 'precise'. Again, these adjectives are similar to those associated with trust in automation. Younger and high tech older adults rated 'unreliable' and 'unpredictable' as being highly associated with untrustworthy robots, whereas low tech older adults did not highly associate any adjectives with an untrustworthy robot, their ratings were more variable.

An interesting finding from the robot trust characteristics questionnaire is that younger adults also highly rated adjectives associated with trust in humans for both trustworthy (i.e., familiar, loyal, calm, friendly) and untrustworthy robots (i.e., deceptive, misleading, hostile, risky, sneaky), whereas older adults did not. This is interesting because in the card-sorting task, low tech older adults did select some adjectives, used to describe human trust, for trustworthy robots.

These findings suggest that both younger and older adults associate a trustworthy and untrustworthy robot with having similar qualities as automated machines. Furthermore, it seems that younger adults can attribute some human like qualities to trustworthy and untrustworthy robots more so than older adults.

**What Are The Dimensions of Trust That Emerge as a Characteristic of the Robot's Task?**

The Trust for Tasks section of the structured interview and the Trust in Assistance Checklist were developed to investigate the dimensions of trust that might occur as a characteristic of the robot's task. In the trust for tasks structured interview, participants were asked about trusting a robot for assistance with a variety of tasks. In general, most participants agreed that they would trust a robot for assistance with many of the tasks, especially menial or rote tasks related to cleaning. The tasks that participants did not trust a robot for assistance involved high levels of perceived risk to the robot or person, such as personal hygiene and medical decision-making.

The reasons participants gave for why they trusted or distrusted a robot were insightful. For most of the tasks, participants gave wide ranges of reasons. They mentioned 18 different types of reasons. In particular, what was striking was that low tech older adults, more so than any other group, said that they would trust a robot for assistance for many of the tasks because they believed that if a manufacturer programmed the robot to perform that task it, then it was trustworthy.

In the Trust in Assistance Checklist, when participants were asked about their trust preference for human versus robot assistance, their responses were similar to the structured interview. Many participants preferred to trust a human more for personal hygiene and medical decision-making tasks, whereas there was a preference to trust a robot more for reminding and monitoring tasks for which similar technology already exists. Participants also indicated that they did not have a preference for a human or robot for assistance with rote tasks such as reaching for objects and opening and closing

drawers. There were no tasks for which participants indicate that they would only trust a human or only trust a robot.

**Do Trust Decisions Vary Among People?**

The findings from this study suggest that in general, the similarities in participant trust decisions exceed the differences. In general, younger adults, high tech older adults, and low tech older adults all had little experience with robots, but still had positive attitudes about them and indicated that they would trust a robot for assistance in their homes. Additionally, groups defined trust in robots similarly and attributed many of the same characteristics they associated with trustworthy and untrustworthy robots. Although there were some group differences in tasks they would trust or distrust a robot to assist with them, in general, groups were similar.

## Part 2: Advancing the Understanding of Trust in Human-Robot Interaction

**What Did We Know Before?**

Prior to this study, we knew some about trust in robots. Past research from Ezer (2008) suggested that variables such as ease of use, tasks, and knowledge about the robot might influence trust (Ezer, 2008). Whereas other research suggested that communication style of the robot (Evers et al., 2008; Rau et al., 2009; Wang et al., 2010), level of robot autonomy (Desai et al., 2009), and robot location may influence trust in robot (Bainbridge et al., 2008; Powers et al., 2007).

**What Did We Not Know?**

In the past, a meta-analysis study of variables suggested to influence trust in robots was conducted. However, the analysis was based on automation studies, not robot studies (Hancock et al., 2011). Prior to this study, we did not know if people consider

robots the same as automated machines or how they defined trust in robots. Additionally, we did not know if other variables influenced trust in robots, such as the robots task. We also did not know if trust decisions were similar or different across a range of potential robot users. Finally, we did not know the rationale behind peoples trust decisions.

**What Do We Know Now?**

The findings from this study has significantly added to the knowledge base of human-robot interaction and extends what is known about the variables that influence human trust in robots. First, we know that the nature of the robot's task is important to people when making trust decisions and now we have insight on the rationale behind the trust decisions. We also know that people define trust in robots somewhat similar to trust in automation. However, when asked about characteristics associated with trustworthy and untrustworthy robots, people attribute characteristics associated with both trust in automation and trust in humans.

We know that the framework developed for trust in automation was a good starting point to identify potential variables that might influence trust in service robots. However, in this study, the only variable in the framework that was similar between automation and robots was reliability. An additional factor that influence trust in robots that was not been seen to influence trust in automation, was the nature of the task.

We also now have a broader understanding of trust in robots for people with varying levels of capabilities and experiences. Although there were some differences between groups in trust decisions, there were more similarities.

## Part 3: Scope, Limitations and Future Directions

All aspects of the study were carefully considered when designing this study. However, the study had several limitations. One limitation of the study was the small samples sizes of the groups. There were only twelve participants in each group. Although the results may not generalize to the U.S. population in its entirety, the sample size in each group is considered acceptable for studies that are qualitative in nature (Maykut & Morehouse, 1994). In the future, researchers may want to consider larger samples sizes to increase better generalizability.

Another limitation to this study is all participants were native English language speakers. Limiting participation only to native English language speakers was intentional so findings could not be attributed to differences in foreign language comprehension and generalizable to the US population. However, previous studies investigating human-robot interactions have found cultural differences (i.e., collectivistic and individualistic language styles) may influence human-robot interactions (Evers et al., 2008; Rau et al., 2009; Wang et al., 2010). Therefore, in future studies, researchers should consider investigating trust in robots across cultures to identify potential differences related to culture.

In this study, participants did not interact with a robot. Therefore their responses could be related to their limited understanding of robots. There were two reasons why this study was not conducted using actual robots. First, I did not want the results of this study to generalize to a specific robot or robots. Second, I wanted to understand participants' trust decisions based on their own perceptions of domestic service robots. The section of the structured interview about how participants visualized a robot while

they were participating in this study, gave perspective into the context for which participants were basing their trust decisions on. Because responses were based on perceptions of robots and not interactions, their responses give insight into their first exposure to think about trust in robots. Future studies can investigate if perceptions change after the initial exposure and if perceptions change based on actual interactions with the robot.

During the structured interview, participants were asked about their level of agreement, and their rationale behind their selections, for robot assistance for 12 different tasks. In the trust in assistance questionnaire, participants were asked about trust preferences for human versus robot assistance for 11 of those same tasks. These specific tasks were chosen because they were representative of ADL, IADL (i.e., cognitive and psychomotor), and EADLS tasks in independent living. However, the interpretations regarding the specific nature of the tasks were left up to participants. For example, when participants were asked about robot assistance for 'entertaining', they could have been thinking about entertaining in many different ways. In a future study, researchers could probe participants on how they were thinking about the tasks. Overall, these findings provide a foundation to which future empirical studies can be developed and tested.

**Part 4: Conclusion**

Simple domestic service robots, especially single-task ones are already commercially available and are used by some homeowners. More advanced service robots for the home are now being developed. These robots have the potential to assist people, especially older adults, with tasks to successfully age in place.

Researchers have suggested that some of the factors that influence trust in automation may also influence trust in robots (Hancock et al., 2011). However, there was little research to corroborate the comparisons. It was also unknown the extent to which people would trust service robots in their homes.

The main objective of this study was to determine if people would trust service robots in their homes. Another objective was to evaluate if the current framework of trust in automation could be applied to home-based service robots. This study addressed these objectives. The majority of younger adults and older adults in this study indicated that they would generally trust a service robot in their homes. However, participants indicated that trust was dependent on the nature of the task and for a variety of reasons. Although there were some differences between age and technology experience groups, there were more similarities.

The findings from this study also have practical implications for service robot designers. It is clear from the data that most of the participants were open to trusting a service robot for assistance in their homes. Regardless of age or technology experience level, participants indicated that robot reliability was the most important factor that would influence their trust decisions. Manufacturers should not deploy robots in a home environment that do not have high rates of reliability. If they do, it can be problematic, especially for low tech older adults who may think that because the robot is programmed to do a specific task, it automatically is trustworthy.

Robot designers also need to carefully consider the range of robot tasks when developing service robots because participants indicated that the nature of the robots task would highly influence their trust decisions. Many participants were open to accepting

robot assistance for many tasks such related to cleaning, reaching and opening, and reminding. However, some participants indicated they preferred to do some tasks themselves because of concerns related to complex decision-making (e.g., deciding what medication to take) and concerns about safety to the robot and human (e.g., bathing). By carefully considering user needs, robot designers can develop robots that have the potential to be adopted by a wide range of people.

## APPENDIX A

## TECHNOLOGY EXPERIENCE PRE-SCREENING QUESTIONNAIRE

**Please circle or check the participants' response to each question.**

**A.**

1. Do you use a cell phone? YES / NO
2. Do you use a microwave oven? YES/ NO
3. Do you use an ATM (automated teller machine)? YES / NO
4. Have you ever used a self-checkout machine at the grocery store? YES / NO
5. Do you listen to books on tape? YES / NO
6. Do you use a digital camera? YES / NO
7. Do you use any programmable devices like a programmable thermostat or coffee maker? YES/ NO
8. Have you ever used a copier? YES / NO

**B.** Do you ever use a computer? YES / NO
If YES, what do you use it for? (check all that apply)
__ Check email
__ Play games (e.g., Solitaire, Bejeweled)
__ Create graphics (anything graphical like Powerpoint, Paint, etc.)
__ Write letters/documents, etc. in word processing software (e.g., Word or WordPerfect)
__ Pay bills/ manage money (e.g., TurboTax, Quicken)
__ Use Excel to manage group of people (i.e., calling list for book club, tennis team) or anything else
__ create web pages
__ others (please list)
_____
_____
_____
_____

**C.** Do you use the internet? (YES / NO)
If Yes, how much do you use it each week? (circle one)

1. __ less than 1 hour/week
2. __1-5 hours/week
3. __6-10 hours/week
4. __ 11-15 hours/week
5. __ more than 15 hours/week

**D.** If YES, what do you use the internet for? (check all that are applicable)
__ banking/money management
__communication (email, instant messaging)
__community info (like community meetings, religious services)
__ education (including for instruction about technologies)
__entertainment (including checking movie times)
__ games (like online chess, Simcity, World of Warcraft)
__ government & official uses
__ social networking (e.g., facebook, user forums)
__ health information
__ news information
__ shopping (e.g., Amazon, ebay)
__travel

**A. Total YES for #1, 3, 4, 7. TOTAL _____**

**B. Total (for others, only count individually those items that seem reasonably complex) _____**

**C. Total _____**

**D. Total _____**

**Score total _____**

**Low: 8 or lower**
**High: 15 or higher**
**Medium: 9-14**

Scorer initials & date _____
Followed up? _____

# APPENDIX B

# DEMOGRAPHICS AND HEALTH QUESTIONNAIRE

Please answer the following questions. All of your answers will be treated confidentially. Any published document regarding these answers will not identify individuals with their answers. **If there is a question you do not wish to answer, please just leave it blank and go on to the next question.** Thank you in advance for your help.

## Demographics Questionnaire

**Gender: Male** ☐1 **Female** ☐2 **Date of Birth:** __ __ / __ __ / __ __ **Age:** _____

**1. What is your highest level of education?**

☐1 No formal education
☐2 Less than high school graduate
☐3 High school graduate/GED
☐4 Vocational training
☐5 Some college/Associate's degree
☐6 Bachelor's degree (BA, BS)
☐7 Master's degree (or other post-graduate training)
☐8 Doctoral degree (PhD, MD, EdD, DDS, JD, etc.)

**2. Current marital status (check one)**

☐1 Single
☐2 Married
☐3 Separated
☐4 Divorced
☐5 Widowed
☐6 Other (please specify) _____

**3. Do you consider yourself Hispanic or Latino?**

☐1 Yes
☐2 No

**3 a. If "Yes", would you describe yourself:**

☐1 Cuban
☐2 Mexican
☐3 Puerto Rican
☐4 Other (please specify) _____

4. **How would you describe your primary racial group?**

☐1 No Primary Group
☐2 White Caucasian
☐3 Black/African American
☐4 Asian
☐5 American Indian/Alaska Native
☐6 Native Hawaiian/Pacific Islander
☐7 Multi-racial
☐8 Other (please specify) _____

5. **In which type of housing do you live?**

☐1 Residence hall/College dormitory
☐2 House/Apartment/Condominium
☐3 Senior housing (independent)
☐4 Assisted living
☐5 Nursing home
☐6 Relative's home
☐7 Other (please specify) _____

6. **Which category best describes your yearly household income. Do not give the dollar amount, just check the category:**

☐1 Less than $5,000
☐2 $5,000 - $9,999
☐3 $10,000 - $14,999
☐4 $15,000 - $19,999
☐5 $20,000 - $29,999
☐6 $30,000 - $39,999
☐7 $40,000 - $49,999
☐8 $50,000 - $59,999
☐9 $60,000 - $69,999
☐10 $70,000 - $99,999
☐11 $100,000 or more
☐12 Do not know for certain
☐13 Do not wish to answer

**7. Is English your primary language?**

☐1 Yes
☐2 No

**7 a. If "No", What is your primary language?** _____

**8. What is your primary mode of transportation? (Check <u>one</u>)**

☐1 Drive my own vehicle
☐2 A friend or family member takes me to places I need to go
☐3 Transportation service provided by where I live
☐4 Use public transportation (e.g., bus, taxi, subway, van services)

**<u>Occupational Status</u>**

**9. What is your primary occupational status? (Check <u>one</u>)**

☐1 Work full-time
☐2 Work part-time
☐3 Student
☐4 Homemaker
☐5 Retired
☐6 Volunteer worker
☐7 Seeking employment, laid off, etc.
☐8 Other (please specify) _____

**10. Do you currently work for pay?**

☐1 Yes, Full-time
☐2 Yes, Part-time
☐3 No

**10 a. If "Yes", what is your primary occupation?** _____

**If retired:**

**11. What was your primary occupation? _____**

**12. What year did you retire? _____**

## Health Information

1. **In general, would you say your health is:**

| ☐1 | ☐2 | ☐3 | ☐4 | ☐5 |
|---|---|---|---|---|
| Poor | Fair | Good | Very good | Excellent |

2. **Compared to other people your own age, would you say your health is:**

| ☐1 | ☐2 | ☐3 | ☐4 | ☐5 |
|---|---|---|---|---|
| Poor | Fair | Good | Very good | Excellent |

3. **How satisfied are you with your present health?**

| ☐1 | ☐2 | ☐3 | ☐4 | ☐5 |
|---|---|---|---|---|
| Not at all satisfied | Not very satisfied | Neither satisfied nor dissatisfied | Somewhat satisfied | Extremely satisfied |

4. **How often do health problems stand in the way of your doing the things you want to do?**

| ☐1 | ☐2 | ☐3 | ☐4 | ☐5 |
|---|---|---|---|---|
| Never | Seldom | Sometimes | Often | Always |

5. **The following items are about activities you might do during a typical day. Does your health now limit you in these activities? Check <u>one</u> box for each type of activity.**

| | **Limited a lot**$_1$ | **Limited a little**$_2$ | **Not limited at all**$_3$ |
|---|---|---|---|
| **a.** Bathing or dressing yourself | | | |
| **b.** Bending, kneeling, or stooping | | | |
| **c.** Climbing **one** flight of stairs | | | |
| **d.** Climbing **several** flights of stairs | | | |
| **e.** Lifting or carrying groceries | | | |
| **f. Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf | | | |
| **g. Vigorous activities**, such as running, lifting heavy objects, or participating in strenuous sports (e.g., swimming laps) | | | |
| **h.** Walking **more than a mile** | | | |
| **i.** Walking **one block** | | | |
| **j.** Walking **several blocks** | | | |

6. **Are you on post-menopausal estrogen replacement therapy?**

☐1 Yes ☐2 No ☐3 Not applicable

7. **For each of the following conditions please indicate if you have ever had that condition in your life, have the condition now at this time or never had the condition. Check <u>one</u> box for each condition.**

| Condition | In your lifetime1 | Now2 | Never3 |
|---|---|---|---|
| **a.** Arthritis | | | |
| **b.** Asthma or Bronchitis | | | |
| **c.** Cancer (other than skin cancer) | | | |
| **d.** Diabetes | | | |
| **e.** Epilepsy | | | |
| **f.** Heart Disease | | | |
| **g.** Hearing Impairment | | | |
| **h.** Hypertension | | | |
| **i.** Stroke | | | |
| **j.** Vision Impairment | | | |
| **k.** Other significant illnesses (please list) | | | |

## Medication Usage Details

Please list all medical products that you are currently taking. Include medicinal herbs, vitamins, aspirin, antacid, nasal spray, laxatives, etc., as well as prescription medications (copy names from label if possible). This information will be completely confidential.

**EXAMPLE**

Name of Medication: Zarontin

Reason for taking: epilepsy Dosage (ea. time taken): 500 mg

How often do you take the medication? (circle one)

daily (every other day) weekly as needed

On days that you take the medication, how many times per day do you take it? 3

What time of day do you take the medication? morning, afternoon, evening

How long you have been taking the medication? 5 years Does this medication cause any problems? makes me sleepy

**1.** Name of Medication: _____

Reason for taking: _____ Dosage (ea. time taken): _____

How often do you take the medication? (circle one)

daily every other day weekly as needed

On days that you take the medication, how many times per day do you take it? _____

What time of day do you take the medication? _____

How long you have been taking medication? _____

Does this medication cause any problems? _____

_____

**APPENDIX C**

**TECHNOLOGY EXPERIENCE PROFILE**

# Technology Experience Profile

**1. Within the last year, please indicate how much you have used any of the technologies listed below.**

| | | Not sure what it is$_1$ | Not used$_2$ | Used once$_3$ | Used occasionally$_4$ | Used frequently$_5$ |
|---|---|---|---|---|---|---|
| **Communication Technology** | | | | | | |
| a. | Answering Machine/ Voicemail (e.g., record and retrieve messages) | | | | | |
| b. | Automated Telephone Menu System (e.g., pay bills, refill prescriptions) | | | | | |
| c. | Fax (e.g., receive and send printed documents) | | | | | |
| d. | Mobile Phone (e.g., make and receive calls) | | | | | |
| e. | Text Messaging (e.g., BBM, iMessage, SMS) | | | | | |
| f. | Video Conferencing (e.g., Skype, Facetime) | | | | | |

| | | Not sure what it is$_1$ | Not used$_2$ | Used once$_3$ | Used occasionally$_4$ | Used frequently$_5$ |
|---|---|---|---|---|---|---|
| **Computer Technology** | | | | | | |
| a. | Desktop/Laptop Computer | | | | | |
| b. | Email (e.g., Gmail, Yahoo) | | | | | |
| c. | Photo/Video Software (e.g., editing, organizing; iPhoto, Picture Manager, Photoshop) | | | | | |
| d. | Productivity Software (e.g., Excel, PowerPoint, Quicken, TurboTax, Word) | | | | | |
| e. | Social Networking (e.g., Facebook, MySpace) | | | | | |
| f. | Tablet Computer (e.g., iPad, Touchpad, Zoom) | | | | | |
| **Everyday Technology** | | | | | | |
| g. | Automatic Teller Machine (ATM) | | | | | |
| h. | Photocopier (e.g., Lexmark, Xerox) | | | | | |
| i. | Home Security System (e.g., Ackerman Security System, ADT) | | | | | |
| j. | In-Store Kiosk (e.g., grocery self-checkout, price checker) | | | | | |
| k. | Microwave Oven | | | | | |
| l. | Programmable Device (e.g., coffee maker, thermostat) | | | | | |

| | | Not sure what it is$_1$ | Not used$_2$ | Used once$_3$ | Used occasionally$_4$ | Used frequently$_5$ |
|---|---|---|---|---|---|---|
| **Health Technology** | | | | | | |
| a. | Blood Pressure Monitor (e.g., measure blood pressure) | | | | | |
| b. | Digital Thermometer (e.g., measure temperature) | | | | | |
| c. | Health Management Software (e.g., diet, exercise, keep track of weight) | | | | | |
| d. | Heart Rate Monitor (e.g., measure heart rate, pulse) | | | | | |
| e. | Medication Reminder Device (e.g., schedule electronic alerts) | | | | | |
| f. | Pedometer (e.g., measure walking distance) | | | | | |
| **Recreational Technology** | | | | | | |
| g. | Digital Music Player (e.g., iPod, MP3 player, Zune) | | | | | |
| h. | Digital Photography (e.g., camcorder, camera) | | | | | |
| i. | Electronic Book Reader (e.g., Kindle, Nook) | | | | | |
| j. | Gaming Console (e.g., Playstation, Wii, XBox) | | | | | |
| k. | Online Coupons/ Shopping (e.g., Amazon, Groupon, retail stores) | | | | | |
| l. | Recording and Playback Device (e.g., Blu-Ray, CD, DVD, DVR, VCR) | | | | | |

| | | Not sure what it is$_1$ | Not used$_2$ | Used once$_3$ | Used occasionally$_4$ | Used frequently$_5$ |
|---|---|---|---|---|---|---|
| **Transportation Technology** | | | | | | |
| a. | Airline Kiosk (e.g., check in, print boarding pass) | | | | | |
| b. | Bus Tracker (e.g., check location of buses, estimate time of arrival) | | | | | |
| c. | Map Software (e.g., get directions, plan routes; Google Maps, MapQuest) | | | | | |
| d. | Navigation System (e.g., GPS, OnStar) | | | | | |
| e. | Online Travel Reservation (e.g., airline website, Expedia, Travelocity) | | | | | |
| f. | Parking Payment System (e.g., exiting lot, paying for space) | | | | | |

## APPENDIX D

## STRUCTURED INTERVIEW AND TASK SCRIPT

*Italics/italics* = action items or reminders (not said to the participant)
**Bold** = said to participant

*Protocol Materials*

*Digital audio recorders (2)*
*Extra batteries (AAA's)*
*Pen (2)*
*Water*
*Consent (2)*
*Debriefing*
*Questionnaires (Robot Use and Familiarity, Robot Opinions, Robot Trust Characteristics, and Trust in Assistance)*
*Ability Tests*
*Card Sorting Task cards*
*Card Sorting Task and Trust in Tasks response form and response card*
*New participant database forms with contact information on the back*
*Participant folder*
*Checks to pay participant (if they are older adults)*

*Greet Participant*

- *Provide participant with water and ensure that they parked in designated psychology participant parking spots.*
- *Ask participant if they would like to use the restroom before starting the experiment.*

*Informed consent & questionnaires*

- *Administer informed consent.*
- *Collect two mailed questionnaires, home informed consent, & check for completeness:*
  - *Demographics and Health Questionnaire*
  - *Technology Experience Profile*
  - *Informed consent copy sent to participant home in packet with questionnaires*

*Set up for interview*

- *Ask participant to be seated in a chair in the participant testing room.*
- **To make sure the audio recorder captures everything, we would like to use a microphone. May I clip this microphone to the lapel of your shirt?**
  - *Clip microphone 2-3 inches from person's mouth (if possible). Make sure microphone is tilted away from the person's shirt.*

*General introduction*

**Thank you for participating in this study. Before we get started I would like you to please turn off your cell phone, so we do not have any interruptions. Thank you.**

**Welcome to the Human Factors and Aging Laboratory. My name is _____, and I work at Georgia Tech. Today you will be completing several questionnaires, completing a task, and participating in an interview. There are no right or wrong answers. We are interested in your thoughts and opinions.** *<Answer any questions the participant may have>*

*Topic and goal*

**This research is part of a 5-year grant, funded by the National Institutes of Health, in particular the National Institute on Aging. Our goal is to better understand what people think about robots, particularly trust in robots. Your information will help us to conduct research on this topic and, ultimately, to develop robots that are more useful and easier to use.**
**We are going to begin the study now. As I mentioned earlier in the consent form, some parts of this study will be recorded.** *<Turn on recorder>*

*General Trust in Robots Interview Questions*

**1. First I would like to ask you how you would define trust in a person? In other words, what does it mean for you to trust another person?**

---

*Probe if response is vague:* **Can you talk a little more about that?**
*Probe if response is unclear:* **I want to make sure I understand what you mean. Would you describe it for me again?**

---

**2. Next I would like to ask you how you would define trust in a robot? ? In other words, what does it mean for you to trust a robot?**

---

*Probe if response is vague:* **Can you talk a little more about that?**
*Probe if response is unclear:* **I want to make sure I understand what you mean. Would you describe it for me again?**

---

**3. I would like know your initial reaction to this question. Would you trust a robot to help you in your home.** *<Please give the participant a moment to pause and think about it>*

---

*Probe if someone is stuck:* **Think about it for a moment. Now that you had a moment to think about it…**
*Probe if response is vague:* **Can you talk a little more about that?**

*Probe if response is unclear:* **I want to make sure I understand what you mean. Would you describe it for me again?**

---

**4. What would you want to know about the robot that would help you decide whether or not to trust the robot?**

---

*Probe if the participant focuses on only one thing:* **Is there anything else you would want to know?**
*Probe if response is vague:* **Can you talk a little more about that?**
*Probe if response is unclear:* **I want to make sure I understand what you mean. Would you describe it for me again?**

---

**5. Spend a moment thinking about your home and everyday activities in your home. Of those tasks you do in your home, are there tasks you would trust a robot to do for you or help you with?** *<Give the participant a moment to pause and think about it>*

**Here is a list of the rooms in your home to help you brainstorm about activities and tasks.** *<Give the participant the list>*

*<Follow-up question: For each task that they list, ask the participant why>*

**Can you tell me why you would trust a robot to do that task?**

---

*Probe if the participant focuses on only one task in the room:* **Are there any other tasks you would trust a robot to do?**
*Probe if the participant focuses on only one room:* **Are there any other rooms you would trust a robot to do?**
*Probe if participant starts discussing outside of the home (like yard or garage):* **Right now we are only talking about tasks inside of your home.**
*Probe if response is vague:* **Can you talk a little more about that?**
*Probe if response is unclear:* **I want to make sure I understand what you mean. Would you describe it for me again?**

---

**6. Again, take a moment to think about your home and everyday activities in your home. Of those tasks you do in your home, are there tasks you would NOT TRUST a robot to do for you or help you with?** *<Give the participant a moment to pause and think about it>*

**Here is a list of the rooms in your home to help you brainstorm about activities and tasks.** *<Give the participant the list>*

*<Follow-up question: For each task that they list, ask the participant why>*

**Can you tell me why you would NOT TRUST a robot to do that task?**

---

*Probe if the participant focuses on only one task in the room:* **Are there any other tasks you would NOT TRUST a robot to do?**
*Probe if the participant focuses on only one room:* **Are there any other rooms you would NOT TRUST a robot to do?**
*Probe if participant starts discussing outside of the home (like yard or garage):* **Right now we are only talking about tasks inside of your home.**
*Probe if response is vague:* **Can you talk a little more about that?**
*Probe if response is unclear:* **I want to make sure I understand what you mean. Would you describe it for me again?**

---

*<After the participant is finished answering the questions, stop the recorder>*

---

*Card Sorting Task*

**7. Okay, now we are going to do something different. On this table there is a stack of cards. On each card there is a word that is a characteristic that a robot might have. Please select five cards, in any order, that you think best represents characteristics of a trustworthy robot and also five cards, in any order, that you think best represents characteristics of an untrustworthy robot. Please take as much time as you like.** *<Let the participant have as much time as they need>*

*After they select the cards, please record their selection on the Card Sorting Task Response Form. Then restack all of the cards and place them on the table.*

**8. Great. It's not necessary to do so, but if you wanted to add one more characteristics to each pile, what would it be? Feel free to use existing cards or feel free to write in your own word on one of these blank cards** *< wait for response and then record response>* **Great. Thank you very much.**

---

**9. Now we will be doing something different.**

*Abilities Tests*

*<Please administer the Digit Symbol Substitution, Reverse Digit Span, and Shipley Institute of Living Scale Vocabulary test. After the tests are completed, please put them away.>*

**Okay, thank you very much.**

*<Now get the Trust for Tasks respond card and response form. Hand the participant the response card.>*

**Now we are going to take a break.** *<Show the participant where the restroom is if necessary. Ask the participant if they would like to stay in the room or take a break in the participant waiting area outside of the lab>*

---

*<After the break is over lead the participant back into the testing room if necessary>*

*Trust for Tasks Interview*

**10. Now we are going to continue with the interview.** *<turn recorder on>***This time I would like you to imagine that you need assistance to complete tasks at home. I am going to ask you several questions about many different kinds of tasks.** *<Give the participant the Trust for Tasks response card>*

**First I would like you to choose an answer to this statement, "I would trust a robot to help me with _____." Please select your response from the response card I gave you.**
*<Follow the order of tasks on the response form and record their responses on response form>*

**I see that you gave that task a rating of** *<repeat rating>***. Can you please tell me what led you to give that rating?**

---

*Probe if the participant does not say why:* **Can you tell me what your thinking was when you have it that rating?**
*Probe if the participant does not select one of the ratings:* **Can you please select one of the ratings from the response card?**
*Probe if response is vague:* **Can you talk a little more about that?**
*Probe if response is unclear:* **I want to make sure I understand what you mean. Would you describe it for me again?**

---

<Continue the iterative process until the participant goes through all tasks on the guide.>

---

**11. Thank you very much for your responses.** *<Stop the recorder>* **Now I have a few questionnaires I would like for you to complete.**

*<Read the instructions for each questionnaire (Robot Use and Familiarity, Robot Opinions, Robot Trust Characteristics, and Trust in Assistance) when appropriate.>*

---

**12. I am going to turn on the recorder again because I would like to ask you a final interview question.** *<Turn on recorder>* **We talked about robots, can you please describe to me, what the robot or robots you were imagining while you were participating in this study looked like?**

---

*Follow-up if not mentioned already:*

*What is the size of the robot?*
*What is the robot made of?*
*Does the robot move around or stay in one place? If it moves around, what enables it to move around?*
*What is the shape of the robot?*
*If a face is described: Can you be more specific about what the robot's face looks like?*

*Probe if response is vague in the robot description:* **Can you talk a little more about that?**
*Probe if response is unclear:* **I want to make sure I understand what you mean. Would you describe it for me again?**

---

*<Follow up question>*
**Did your imagined robot change depending on the task? If so, can you tell me why?**

*<After the participant is finished with their response, turn off the recorder>*

---

*Probe if response is vague in the robot description:* **Can you talk a little more about that?**
*Probe if response is unclear:* **I want to make sure I understand what you mean. Would you describe it for me again?**

---

**12. Thank you so much. We are finished with the study now.**

*Please go over the participant debriefing form with the participant and answering any questions.*

*If they are not already in it, ask the participant if he or she would like to be added to our participant database.*

*Pay the participant (or assign them course credit) and thank them for their participation.*

*Escort the participant out of the laboratory (and the building if necessary).*

*Post Study Tasks*

*After the participant has departed, collect all participant questionnaires and response forms and place them in the participant folder and file in the designated location (except for the informed consent form and participant contact sheet).*

*Place the informed consent forms in the designated location separate from the participant folders. Place the participant contact sheet in the "To be Updated" tray near the back laboratory phone.*

*Update the participant study log for this particular study.*

*Upload audio files to the server and save a backup copy to your computer. Make sure the files play on the computer. If they play, delete the files from the audio recorder.*

## APPENDIX E

## ROBOT TASKS TABLE

| Domain | Human Preference | No Preference | Robot Preference |
|---|---|---|---|
| ADL (primarily psychomotor) | Bathing | Walking | Reaching for objects |
| IADL 1 (primarily psychomotor) | Hand washing dishes | Opening and closing drawers | Cleaning the kitchen |
| IADL 2 (primarily cognitive) | Deciding what medication to take | Medication reminder | Monitoring home/warning about dangers |
| EADL | Entertaining | Learning new skills | Getting information on weather/news |

**APPENDIX F**

**CARD-SORTING TASK WORDS**

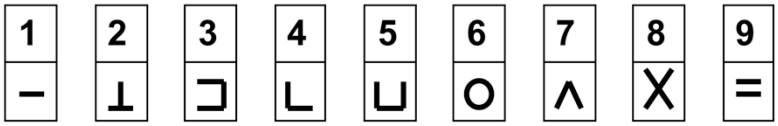
| | |
|---|---|
| AGREEABLE | MISLEADING |
| BORING | NON-HUMAN LOOKING |
| CALM | PREDICTABLE |
| CONFIDENT | PHONY |
| COMPASSIONATE | POINTLESS |
| DECEPTIVE | PRECISE |
| DEPENDENT | RELIABLE |
| EFFICIENT | RISKY |
| FAMILIAR | SAFE |
| FRIENDLY | SNEAKY |
| HOSTILE | SOCIAL |
| HUMAN LOOKING | UNFEELING |
| INDEPENDENT | UNPREDICTABLE |
| LOYAL | UNRELIABLE |
| LOUD | UNSOCIAL |
| | |

## APPENDIX G

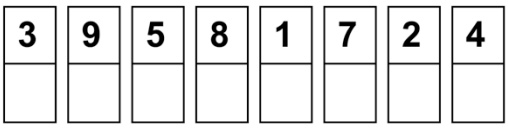
## ABILITY TEST – DIGIT SYMBOL SUBSTITUTION

### Digit-Symbol Substitution

**In this task you will be asked to write symbols that correspond to the numbers 1 through 9. The numbers and their symbols are:**




**When you turn the page, there will be rows of numbers. Each number has an empty box below it. Your task is to write the corresponding symbol below each number. Please try the following:**




**The numbers and their corresponding symbols will be given to you again on the next page. You will have 90 seconds to write as many symbols as possible.**

**Please start with the top row and work from left to right, without skipping any boxes.**

**Please do not turn the page until instructed to do so.**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| − | ⊥ | ⊐ | ⌞ | ⊔ | ○ | ∧ | X | = |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 3 | 7 | 2 | 4 | 8 | 1 | 5 | 4 | 2 | 1 | 3 | 2 | 1 | 4 | 2 | 3 | 5 | 2 | 3 | 1 | 4 | 6 | 3 | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 4 | 2 | 7 | 6 | 3 | 5 | 7 | 2 | 8 | 5 | 4 | 6 | 3 | 7 | 2 | 8 | 1 | 9 | 5 | 8 | 4 | 7 | 3 | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |

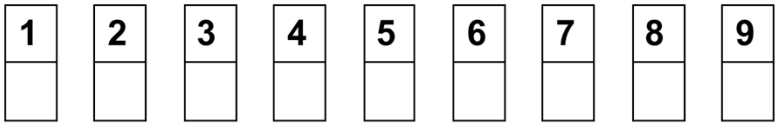
| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 5 | 1 | 9 | 2 | 8 | 3 | 7 | 4 | 6 | 5 | 9 | 4 | 8 | 3 | 7 | 2 | 6 | 1 | 5 | 4 | 6 | 3 | 7 | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 8 | 1 | 7 | 9 | 4 | 6 | 8 | 5 | 9 | 7 | 1 | 8 | 5 | 2 | 9 | 4 | 8 | 6 | 3 | 7 | 9 | 8 | 6 | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |

STOP! DO NOT TURN THE PAGE UNTIL ASKED TO DO SO.

Recall of Digit-Symbol Key

Without turning back to the previous pages, try to fill in the blanks.




Please do not turn the page until instructed to do so.

**APPENDIX H**

**ABILITY TEST – REVERSE DIGIT SPAN**

In this test you will be asked to remember digits presented orally and then to write them down in reverse order. After you hear each set of digits write your answer on the answer sheet provided. Please wait until all the digits are presented before writing your answer.

## EXAMPLE:

**Answer Sheet**

| (You will hear.) | (You should write:) |
|---|---|
| 5 – 8 – 2 | 2 – 8 – 5 |
| 4 – 2 – 7 – 3 – 1 | 1 – 3 – 7 – 2 – 4 |

Subject#_____ Date_____

**Answer Sheet**

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____

| Item | Trial | |
|---|---|---|
| 1. | Trial 1 | 2 – 4 |
| | Trial 2 | 5 – 7 |
| 2. | Trial 1 | 6 – 2 – 9 |
| | Trial 2 | 4 – 1 – 5 |
| 3. | Trial 1 | 3 – 2 – 7 – 9 |
| | Trial 2 | 4 – 9 – 6 – 8 |
| 4. | Trial 1 | 1 – 5 – 2 – 8 – 6 |
| | Trial 2 | 6 – 1 – 8 – 4 – 3 |
| 5. | Trial 1 | 5 – 3 – 9 – 4 – 1 – 8 |
| | Trial 2 | 7 – 2 – 4 – 8 – 5 – 6 |
| 6. | Trial 1 | 8 – 1 – 2 – 9 – 3 – 6 – 5 |
| | Trial 2 | 4 – 7 – 3 – 9 – 1 – 2 – 8 |
| 7. | Trial 1 | 9 – 4 – 3 – 7 – 6 – 2 – 5 – 8 |
| | Trial 2 | 7 – 2 – 8 – 1 – 9 – 6 – 5 – 3 |

### Scoring

Each item is scored 0, 1, or 2 points as follows:

- 2 points if the examinee passes both trials
- 1 point if the examinee passes only one trial
- 0 point if the examinee fails both trials

## Maximum Score on Digit Backward: 14 points
## Maximum Score on Digit Span: 30 points

**SCORING**: Use this template as a guide for scoring. Notice the digits are reversed from their original order of presentation.

| Item | Trial | |
|---|---|---|
| 1. | Trial 1 | 4 – 2 |
| | Trial 2 | 7 – 5 |
| 2. | Trial 1 | 9 – 2 – 6 |
| | Trial 2 | 5 – 1 – 4 |
| 3. | Trial 1 | 9 – 7 – 2 – 3 |
| | Trial 2 | 8 – 6 – 9 – 4 |
| 4. | Trial 1 | 6 – 8 – 2 – 5 – 1 |
| | Trial 2 | 3 – 4 – 8 – 1 – 6 |
| 5. | Trial 1 | 8 – 1 – 4 – 9 – 3 – 5 |
| | Trial 2 | 6 – 5 – 8 – 4 – 2 – 7 |
| 6. | Trial 1 | 5 – 6 – 3 – 9 – 2 – 1 – 8 |
| | Trial 2 | 8 – 2 – 1 – 9 – 3 – 7 – 4 |
| 7. | Trial 1 | 8 – 5 – 2 – 6 – 7 – 3 – 4 – 9 |
| | Trial 2 | 3 – 5 – 6 – 9 – 1 – 8 – 2 – 7 |

## APPENDIX I

## ABILITY TEST – SHIPLEY INSTITUTE OF LIVING SCALE

### Instructions:

In the test below, the first word in each line is printed in capital letters. Opposite it are four other words. Circle the *one word* which means the *same thing*, or most nearly the same thing, as the first word. If you don't know, guess. Be sure to circle the *one word* in each line that means the same thing as the first word.

**EXAMPLE:**

| | | | | |
|---|---|---|---|---|
| LARGE | red | (big) | silent | wet |

**PLEASE DO NOT TURN THE PAGE UNTIL INSTRUCTED TO DO SO.**

| | | | | | |
|---|---|---|---|---|---|
| 1) | TALK | draw | eat | speak | sleep |
| 2) | PERMIT | allow | sew | cut | drive |
| 3) | PARDON | forgive | pound | divide | tell |
| 4) | COUCH | pin | eraser | sofa | glass |
| 5) | REMEMBER | swim | recall | number | defy |
| 6) | TUMBLE | drink | dress | fall | think |
| 7) | HIDEOUS | silvery | tilted | young | dreadful |
| 8) | CORDIAL | swift | muddy | leafy | hearty |
| 9) | EVIDENT | green | obvious | skeptical | afraid |
| 10) | IMPOSTOR | conductor | officer | book | pretender |
| 11) | MERIT | deserve | distrust | fight | separate |
| 12) | FASCINATE | welcome | fix | stir | enchant |
| 13) | INDICATE | defy | excite | signify | bicker |
| 14) | IGNORANT | red | sharp | uninformed | precise |
| 15) | FORTIFY | submerge | strengthen | vent | deaden |
| 16) | RENOWN | length | head | fame | loyalty |
| 17) | NARRATE | yield | buy | associate | tell |
| 18) | MASSIVE | bright | large | speedy | low |
| 19) | HILARITY | laughter | speed | grace | malice |
| 20) | SMIRCHED | stolen | pointed | remade | soiled |

| | | | | | |
|---|---|---|---|---|---|
| 21) | SQUANDER | tease | belittle | cut | waste |
| 22) | CAPTION | drum | ballast | heading | ape |
| 23) | FACILITATE | help | turn | strip | bewilder |
| 24) | JOCOSE | humorous | paltry | fervid | plain |
| 25) | APPRISE | reduce | strew | inform | delight |
| 26) | RUE | eat | lament | dominate | cure |
| 27) | DENIZEN | senator | inhabitant | fish | atom |
| 28) | DIVEST | dispossess | intrude | rally | pledge |
| 29) | AMULET | charm | orphan | dingo | pond |
| 30) | INEXORABLE | untidy | involatile | rigid | sparse |
| 31) | SERRATED | dried | notched | armed | blunt |
| 32) | LISSOM | moldy | loose | supple | convex |
| 33) | MOLLIFY | mitigate | direct | pertain | abuse |
| 34) | PLAGIARIZE | appropriate | intend | revoke | maintain |
| 35) | ORIFICE | brush | hole | building | lute |
| 36) | QUERULOUS | maniacal | curious | devout | complaining |
| 37) | PARIAH | outcast | priest | lentil | locker |
| 38) | ABET | waken | ensue | incite | placate |
| 39) | TEMERITY | rashness | timidity | desire | kindness |
| 40) | PRISTINE | vain | sound | first | level |

**STOP**

PLEASE DO NOT TURN THE PAGE UNTIL INSTRUCTED TO DO SO.

**APPENDIX J**

**ABILITY TEST – VISION**

**Near (both eyes): _____**

| | |
|---|---|
| E | 200 |
| NZ | 120 |
| YLS | 80 |
| UFVP | 60 |
| NSTRF | 40 |
| RCLCTB | 30 |
| HTVPFRU | 20 |

**APPENDIX K**

**TRUST FOR TASKS RESPONSE CARD**

## Trust for Tasks Response Card

**Participant #** _____
**Date** _____

### Practice

**$T_0$ =** _____

**$T_1$ =** _____
**$T_2$ =** _____
**$T_3$ =** _____
**$T_4$ =** _____
**$T_5$ =** _____
**$T_6$ =** _____

**$T_7$ =** _____
**$T_8$ =** _____
**$T_9$ =** _____
**$T_{10}$ =** _____
**$T_{11}$ =** _____
**$T_{12}$ =** _____

*Note.* Participants within each of the groups (i.e., younger adults, low tech older adults, high tech older adults) will be randomly assigned to each of the twelve orders; $T_1$ = Bathing, $T_2$ = Walking, $T_3$ = Reaching for objects, $T_4$ = Hand washing dishes, $T_5$= Opening and closing drawers, $T_6$ = Cleaning the kitchen, $T_7$ = Deciding what medication to take, $T_8$ = Medication reminder, $T_9$ = Monitoring home / warning about dangers, $T_{10}$ = Entertaining, $T_{11}$ = Learning new skills, $T_{12}$ = Getting information on weather / news.

## APPENDIX L

## ROBOT FAMILIARITY AND USE QUESTIONNAIRE

**ROBOT FAMILIARITY AND USE QUESTIONNAIRE**

**For the following robots, please indicate your familiarity in terms of hearing about them, using them, or operating them. Please circle only one option.**

| Robots | Not sure what this is$_0$ | Never heard about, seen, or used this robot$_1$ | Have only heard about or seen this robot$_2$ | Have used or operated this robot only occasionally$_3$ | Have used or operated this robot frequently$_4$ |
|---|---|---|---|---|---|
| Autonomous Car | 0 | 1 | 2 | 3 | 4 |
| Domestic/Home robot (e.g., Roomba) | 0 | 1 | 2 | 3 | 4 |
| Entertainment/toy robot (e.g., Aibo, Furby) | 0 | 1 | 2 | 3 | 4 |
| Manufacturing robot (e.g., robotic arm in factory) | 0 | 1 | 2 | 3 | 4 |
| Military Robot (e.g., search and rescue) | 0 | 1 | 2 | 3 | 4 |
| Personal Robot 2 (PR2) | 0 | 1 | 2 | 3 | 4 |
| Remote presence robot (e.g., Texai, Anybot) | 0 | 1 | 2 | 3 | 4 |
| Research robot (e.g., at university or company) | 0 | 1 | 2 | 3 | 4 |
| Robot lawn mower | 0 | 1 | 2 | 3 | 4 |
| . Robot security guard | 0 | 1 | 2 | 3 | 4 |
| . Space exploration robot (e.g., Mars Rover) | 0 | 1 | 2 | 3 | 4 |
| . Surgical robot (e.g., da Vinci Surgical System) | 0 | 1 | 2 | 3 | 4 |

## APPENDIX M

## ROBOT OPINIONS QUESTIONNAIRE

### ROBOT OPINIONS QUESTIONNAIRE

**Imagine that you have the opportunity to use or operate a robot. Please place an X in the response box that best represents your general opinion (we understand that there may be exceptions).**

**1. My interaction with a robot would be clear and understandable.**

| ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 | ☐7 |
|---|---|---|---|---|---|---|
| Extremely Unlikely | Quite Unlikely | Slightly Unlikely | Neither | Slightly Likely | Quite Likely | Extremely Likely |

**2. I would find a robot useful in my daily life.**

| ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 | ☐7 |
|---|---|---|---|---|---|---|
| Extremely Unlikely | Quite Unlikely | Slightly Unlikely | Neither | Slightly Likely | Quite Likely | Extremely Likely |

**3. Using a robot would enhance my effectiveness in my daily life.**

| ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 | ☐7 |
|---|---|---|---|---|---|---|
| Extremely Unlikely | Quite Unlikely | Slightly Unlikely | Neither | Slightly Likely | Quite Likely | Extremely Likely |

**4. Using a robot in my daily life would increase my productivity.**

| ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 | ☐7 |
|---|---|---|---|---|---|---|
| Extremely Unlikely | Quite Unlikely | Slightly Unlikely | Neither | Slightly Likely | Quite Likely | Extremely Likely |

**5. Using a robot would make my daily life easier.**

| ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 | ☐7 |
|---|---|---|---|---|---|---|
| Extremely Unlikely | Quite Unlikely | Slightly Unlikely | Neither | Slightly Likely | Quite Likely | Extremely Likely |

**6. Using a robot would improve my daily life.**

| ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 | ☐7 |
|---|---|---|---|---|---|---|
| Extremely Unlikely | Quite Unlikely | Slightly Unlikely | Neither | Slightly Likely | Quite Likely | Extremely Likely |

## APPENDIX N

## ROBOT TRUST CHARACTERISTICS QUESTIONNAIRE

Instructions: In this questionnaire you will be presented with different words. Please imagine a robot in your home. Please indicate how much those words match with the robot you imagined in your home. Remember, we are interested in your views, so there are no right or wrong answers.

1. **How much does each of the following words match the characteristics of what you imagine a trustworthy robot would possess? Check one box for each description.**

| | **Not at all$_1$** | **To a limited extent$_2$** | **To a moderate extent$_3$** | **To a large extent$_4$** | **To a great extent$_5$** | **Don't know$_0$** |
|---|---|---|---|---|---|---|
| 1. Agreeable | | | | | | |
| 2. Boring | | | | | | |
| 3. Calm | | | | | | |
| 4. Compassionate | | | | | | |
| 5. Confident | | | | | | |
| 6. Deceptive | | | | | | |
| 7. Dependent | | | | | | |
| 8. Efficient | | | | | | |
| 9. Familiar | | | | | | |
| 10. Friendly | | | | | | |
| 11. Hostile | | | | | | |
| 12. Human looking | | | | | | |

**How much does each of the following words match the characteristics of what you imagine a <u>trustworthy</u> robot would possess? Check <u>one</u> box for each description.**

| | **Not at all$_1$** | **To a limited extent$_2$** | **To a moderate extent$_3$** | **To a large extent$_4$** | **To a great extent$_5$** | **Don't know$_0$** |
|---|---|---|---|---|---|---|
| 13. Independent | | | | | | |
| 14. Loud | | | | | | |
| 15. Loyal | | | | | | |
| 16. Misleading | | | | | | |
| 17. Non-human looking | | | | | | |
| 18. Phony | | | | | | |
| 19. Pointless | | | | | | |
| 20. Precise | | | | | | |
| 21. Predictable | | | | | | |
| 22. Reliable | | | | | | |
| 23. Risky | | | | | | |
| 24. Safe | | | | | | |
| 25. Sneaky | | | | | | |
| 26. Social | | | | | | |
| 27. Unfeeling | | | | | | |
| 28. Unpredictable | | | | | | |
| 29. Unreliable | | | | | | |
| 30. Unsocial | | | | | | |

**2. How much does each of the following words match the characteristics of what you imagine an <u>untrustworthy</u> robot would possess? Check one box for each description.**

| | **Not at all$_1$** | **To a limited extent$_2$** | **To a moderate extent$_3$** | **To a large extent$_4$** | **To a great extent$_5$** | **Don't know$_0$** |
|---|---|---|---|---|---|---|
| 1. Agreeable | | | | | | |
| 2. Boring | | | | | | |
| 3. Calm | | | | | | |
| 4. Compassionate | | | | | | |
| 5. Confident | | | | | | |
| 6. Deceptive | | | | | | |
| 7. Dependent | | | | | | |
| 8. Efficient | | | | | | |
| 9. Familiar | | | | | | |
| 10. Friendly | | | | | | |
| 11. Hostile | | | | | | |
| 12. Human looking | | | | | | |

**How much does each of the following words match the characteristics of what you imagine a <u>untrustworthy</u> robot would possess? Check <u>one</u> box for each description.**

| | **Not at all$_1$** | **To a limited extent$_2$** | **To a moderate extent$_3$** | **To a large extent$_4$** | **To a great extent$_5$** | **Don't know$_0$** |
|---|---|---|---|---|---|---|
| 13. Independent | | | | | | |
| 14. Loud | | | | | | |
| 15. Loyal | | | | | | |
| 16. Misleading | | | | | | |
| 17. Non-human looking | | | | | | |
| 18. Phony | | | | | | |
| 19. Pointless | | | | | | |
| 20. Precise | | | | | | |
| 21. Predictable | | | | | | |
| 22. Reliable | | | | | | |
| 23. Risky | | | | | | |
| 24. Safe | | | | | | |
| 25. Sneaky | | | | | | |
| 26. Social | | | | | | |
| 27. Unfeeling | | | | | | |
| 2<br>8. Unpredictable | | | | | | |
| 29. Unreliable | | | | | | |
| 30. Unsocial | | | | | | |

**APPENDIX O**

**TRUST IN ASSISTANCE CHECKLIST**

We are interested in learning about younger and older adults' preferences for assistance in performing daily living tasks. In particular, we are looking for opinions about **trust** in human assistance and robot assistance. When completing this questionnaire, please **imagine** you need assistance in everyday life with various tasks.

For each of the following tasks, please provide your opinion about:

- Trusting a human more to provide assistance
- No preference
- Trusting a robot more to provide assistance

**Assume that the robot could perform the task to the level of a human.** Please circle the most appropriate response for your general preference (we understand that there may be exceptions).

On the last page, there is space for you to provide additional comments about your preferences for having robot and human assistance.

1.

| If I needed assistance with... | If I needed assistance, I would be more likely to… | | | | |
|---|---|---|---|---|---|
| | Only trust a human | Trust a human more | Trust either a human or a robot | Trust a robot more | Only trust a robot |
| a. Bathing | ☐ | ☐ | ☐ | ☐ | ☐ |
| b. Being reminded to take medicine | ☐ | ☐ | ☐ | ☐ | ☐ |
| c. Cleaning bathrooms | ☐ | ☐ | ☐ | ☐ | ☐ |
| d. Cleaning kitchen | ☐ | ☐ | ☐ | ☐ | ☐ |
| e. Deciding what medication to take | ☐ | ☐ | ☐ | ☐ | ☐ |
| f. Delivering medication | ☐ | ☐ | ☐ | ☐ | ☐ |
| g. Entertaining guests | ☐ | ☐ | ☐ | ☐ | ☐ |
| h. Gardening/pruning | ☐ | ☐ | ☐ | ☐ | ☐ |
| i. Learning how to use new technologies | ☐ | ☐ | ☐ | ☐ | ☐ |
| j. Learning new physical skills (e.g., dancing) | ☐ | ☐ | ☐ | ☐ | ☐ |
| k. Learning new knowledge (e.g., second language | ☐ | ☐ | ☐ | ☐ | ☐ |
| l. Maintaining lawn/raking leaves | ☐ | ☐ | ☐ | ☐ | ☐ |
| m. Monitoring home/warning about dangers (e.g., fire) | ☐ | ☐ | ☐ | ☐ | ☐ |
| n. Opening and closing doors/drawers | ☐ | ☐ | ☐ | ☐ | ☐ |
| o. Painting (e.g., interior/exterior of home) | ☐ | ☐ | ☐ | ☐ | ☐ |
| p. Reaching for objects | ☐ | ☐ | ☐ | ☐ | ☐ |
| q. Repairing plumbing (e.g., fixing leaky faucets) | ☐ | ☐ | ☐ | ☐ | ☐ |
| r. Taking Medication | ☐ | ☐ | ☐ | ☐ | ☐ |
| s. Walking | ☐ | ☐ | ☐ | ☐ | ☐ |
| t. Washing dishes by hand | ☐ | ☐ | ☐ | ☐ | ☐ |

**2. If the robot could perform only 5 of the tasks listed on the previous pages, which 5 would you want it to do? (you may list from 0-5 tasks)**

**1) _____**
**2) _____**
**3) _____**
**4) _____**
**5) _____**

**3. Please write any comments about how you answered these questions here:**

**_____**
**_____**
**_____**
**_____**
**_____**
**_____**

**4. Are there any additional tasks with which you would like robotic assistance? (you may list from 0-5 additional tasks)**

**1) _____**
**2) _____**
**3) _____**
**4) _____**
**5) _____**

**APPENDIX P**

**OLDER ADULT INFORMED CONSENT FORM**

Georgia Institute of Technology
Project Title: Understanding the Construct of Human Trust in Robots

**Investigators:** Dr. Wendy A. Rogers, Dr. Tracy L. Mitzner (Principal Investigators), Katherine E. Olson, Jenay M. Beer (Student Investigators)

**Protocol and Consent Title:** Understanding the Construct of Human Trust in Robots

## Purpose:

You are being asked to be a volunteer in a research study. The purpose of this form is to tell you about the tasks you will be asked to complete in this research study and to inform you about your rights as a research volunteer. Feel free to ask any questions that you may have about the research study and what you will be asked to do.

Thank you for your interest in participating in this research study. Our work could not be completed without the help of volunteers. The purpose of our research is to investigate what factors influence people's attitudes about trust in robots. We expect to enroll 32 older adults in this research study.

## Exclusion/Inclusion Criteria:

To participate in this research study you must speak English and must be between 65 and 75 years of age.

## Procedures:

If you decide to be in this research study, you will be asked to complete several questionnaires to provide general demographic and health information, technology experience, robot familiarity and usage, robot opinions, attitudes about robot trust characteristics, and trust in human or

robot assistance. You will also be asked to take a number of general tests that measure your abilities, including vocabulary, memory, speed of responding, and vision.

You will be asked to think about whether you would trust a robot in your home and what you would want to know about the robot that would help you decide whether or not to trust the robot. You will also be asked what kinds of tasks in your home you would trust or not trust a robot to do. Next you will be asked to select five cards that best represent characteristics of a trustworthy robot. Then you will be asked to select five cards that best represent characteristics of an untrustworthy robot. Next you will be asked to imagine that you need assistance with thirteen different home-based tasks. For every task, you will be asked to rate the level of trust you would have in a robot to do that task and you will be asked why you chose that level.

If anything is unclear at any time, please do not hesitate to ask questions.

This one-day study will take approximately 2.5 hours of your time. You may stop at any time and for any reason.

**Risks or Discomforts:**

Participation in this research study involves minimal risk or discomfort to you. Risks are minimal and do not exceed those of daily activities, such as normal office work.

**Benefits:**

You are not likely to benefit in any way from joining this research study. But we hope that others will benefit from what we find from conducting this study.

**Compensation to You:**

You will be compensated $30 for completing this research study, which will take approximately 2.5 hours. If you do not complete the

research study, you will be compensated $12 per hour for your time and effort.

U.S. Tax Law requires a mandatory withholding of 30% for nonresident alien payments of any type. Your address and citizenship/visa status may be collected for compensation purposes only. This information will be shared only with the Georgia Institute of Technology department that issues compensation, if any, for your participation.

**Confidentiality:**

The following procedures will be followed to keep your personal information confidential in this study: The data collected about you will be kept private to the extent allowed by law. To protect your privacy, your records will be kept under a code number rather than by your name. Your records will be kept in locked files and only study staff will be allowed to look at them. Your name and any other fact that might point to you will not appear when results of this study are presented or published.

Audio files will be transcribed; no link will be maintained that could connect your identity with your responses. The audio files will be accessible only to the research team and will be kept for archival purposes.

We may use clips from audio recordings in research publications or presentations to other academics and the public. Please, select ONE of the following options for use of audio recordings by initialing your preference below.

Option 1: If you are willing to allow us to use an audio recording of any portion of your interview, please initial here _____. If you have initialed here, we may use a portion of your interview in a presentation, for example, but you will never be identified by name.

Option 2: If you would prefer that we use information from your audio recording only in transcribed form (rather than as an audio clip), please initial here_____.

To make sure that this research is being carried out in the proper way, the Georgia Institute of Technology IRB may review study records. The Georgia Institute of Technology Office of Research Integrity Assurance may also look over study records during required reviews. The sponsor of this study, the National Institutes of Health has the right to review study records as well.

**Costs to You:**

There are no costs to you, other than your time, for being in this study.

**In Case of Injury/Harm:**

If you are injured as a result of being in this study, please contact Dr. Wendy A. Rogers at (404) 894-6775 or Dr. Tracy L. Mitzner at (404) 385-0011. Neither the Georgia Institute of Technology nor the principal investigators have made provision for payment of costs associated with any injury resulting from participation in this study.

**Participant Rights:**

- Your participation in this study is voluntary. You do not have to be in this study if you do not want to be.
- You have the right to change your mind and leave the study at any time without giving any reason and without penalty.
- Any new information that may make you change your mind about being in this study will be given to you.
- You will be given a copy of this consent form to keep.
- You do not waive any of your legal rights by signing this consent form.

**Questions about the Study:**

If you have any questions about the study, you may contact Katherine Olson at (404) 894-8344 or kolson6@gatech.edu.

**Questions about Your Rights as a Research Participant:**

If you have any questions about your rights as a research participant, you may contact Ms. Kelly Winn, Georgia Institute of Technology Office of Research Integrity Assurance, at (404) 385- 2175.

If you sign below, it means that you have read (or have had read to you) the information given in this consent form, and you would like to be a volunteer in this study.

_____

Participant Name (printed)

_____

Participant Signature Date

_____

Name of Person Obtaining Consent (printed)

_____

Signature of Person Obtaining Consent Date

## APPENDIX Q

## YOUNGER ADULT INFORMED CONSENT FORM

Georgia Institute of Technology
Project Title: Understanding the Construct of Human Trust in Robots

**Investigators:** Dr. Wendy A. Rogers, Dr. Tracy L. Mitzner (Principal Investigators), Katherine E. Olson , Jenay M. Beer (Student Investigators).

**Protocol and Consent Title:** Understanding the Construct of Human Trust in Robots

**Purpose:**

You are being asked to be a volunteer in a research study. The purpose of this form is to tell you about the tasks you will be asked to complete in this research study and to inform you about your rights as a research volunteer. Feel free to ask any questions that you may have about the research study and what you will be asked to do.

Thank you for your interest in participating in this research study. Our work could not be completed without the help of volunteers. The purpose of our research is to investigate what factors influence people's attitudes about trust in robots. We expect to enroll 16 younger adults in this research study.

**Exclusion/Inclusion Criteria:**

To participate in this research study you must speak English and must be between 18 and 28 years of age.

**Procedures:**

If you decide to be in this research study, you will be asked to complete several questionnaires to provide general demographic and health information, technology experience, robot familiarity and usage, robot opinions, attitudes about robot trust characteristics, and trust in human or robotic assistance. You will also be asked to take a number of general tests that measure your abilities, including vocabulary, memory, speed of responding, and vision.

You will be asked to think about whether you would trust a robot in your home and what you would want to know about the robot that would help you decide whether or not to trust the robot. You will also be asked what kinds of tasks in your home you would trust or not trust a robot to do. Next you will be asked to select five cards that best represent characteristics of a trustworthy robot. Then you will be asked to select five cards that best represent characteristics of an untrustworthy robot. Next you will be asked to imagine that you need assistance with thirteen different home-based tasks. For every

task, you will be asked to rate the level of trust you would have in a robot to do that task and you will be asked why you chose that level.

If anything is unclear at any time, please do not hesitate to ask questions.

This one-day study will take approximately 2 hours of your time. You may stop at any time and for any reason.

**Risks or Discomforts:**

Participation in this research study involves minimal risk or discomfort to you. Risks are minimal and do not exceed those of daily activities, such as normal office work.

**Benefits:**

You are not likely to benefit in any way from joining this research study. But we hope that others will benefit from what we find from conducting this study.

**Compensation to You:**

You will spend approximately 2 hours participating in this research study for which you will receive 2 hours of Experimetrix credit. If you do not complete the research study, you will receive one hour of Experimetrix credit for each hour of your time and effort.

**Confidentiality:**

The following procedures will be followed to keep your personal information confidential in this study: The data collected about you will be kept private to the extent allowed by law. To protect your privacy, your records will be kept under a code number rather than by your name. Your records will be kept in locked files and only study staff will be allowed to look at them. Your name and any other fact that might point to you will not appear when results of this study are presented or published.

Audio files will be transcribed; no link will be maintained that could connect your identity with your responses. The audio files will be accessible only to the research team and will be kept for archival purposes.

We may use clips from audio recordings in research publications or presentations to other academics and the public. Please, select ONE of the following options for use of audio recordings by initialing your preference below.

Option 1: If you are willing to allow us to use an audio recording of any portion of your interview, please initial here _____. If you have initialed here, we may use a portion of your interview in a presentation, for example, but you will never be identified by name.

Option 2: If you would prefer that we use information from your audio recording only in transcribed form (rather than as an audio clip), please initial here_____.

To make sure that this research is being carried out in the proper way, the Georgia Institute of Technology IRB may review study records. The Georgia Institute of Technology Office of Research Integrity Assurance may also look over study records during required reviews. The sponsor of this study, the National Institutes of Health, has the right to review study records as well.

**Costs to You:**

There are no costs to you, other than your time, for being in this study.

**In Case of Injury/Harm:**

If you are injured as a result of being in this study, please contact Dr. Wendy A. Rogers at (404) 894-6775 or Dr. Arthur D. Fisk at (404) 894-6066. Neither the Georgia Institute of Technology nor the principal investigators have made provision for payment of costs associated with any injury resulting from participation in this study.

**Participant Rights:**

- Your participation in this study is voluntary. You do not have to be in this study if you do not want to be.
- You have the right to change your mind and leave the study at any time without giving any reason and without penalty.
- Any new information that may make you change your mind about being in this study will be given to you.
- You will be given a copy of this consent form to keep.
- You do not waive any of your legal rights by signing this consent form.

**Questions about the Study:**

If you have any questions about the study, you may contact Katherine Olson at (404) 894-8344 or kolson6@gatech.edu

**Questions about Your Rights as a Research Participant:**

If you have any questions about your rights as a research participant, you may contact Ms. Kelly Winn, Georgia Institute of Technology Office of Research Integrity Assurance, at (404) 385- 2175.

If you sign below, it means that you have read (or have had read to you) the information given in this consent form, and you would like to be a volunteer in this study.

_____
Participant Name (printed)

_____
Participant Signature Date

_____
Name of Person Obtaining Consent (printed)

_____
Signature of Person Obtaining Consent Date

## APPENDIX R

## LATIN SQUARE COUNTERBALANCE SCHEME

*Balanced Latin Square Design for Task Presentation in Trust for Tasks Interview*

| Participant Order | Task Order | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $T_1$ | $T_2$ | $T_{12}$ | $T_3$ | $T_{11}$ | $T_4$ | $T_{10}$ | $T_5$ | $T_9$ | $T_6$ | $T_8$ | $T_7$ |
| 2 | $T_2$ | $T_3$ | $T_1$ | $T_4$ | $T_{12}$ | $T_5$ | $T_{11}$ | $T_6$ | $T_{10}$ | $T_7$ | $T_9$ | $T_8$ |
| 3 | $T_3$ | $T_4$ | $T_2$ | $T_5$ | $T_1$ | $T_6$ | $T_{12}$ | $T_7$ | $T_{11}$ | $T_8$ | $T_{10}$ | $T_9$ |
| 4 | $T_4$ | $T_5$ | $T_3$ | $T_6$ | $T_2$ | $T_7$ | $T_1$ | $T_8$ | $T_{12}$ | $T_9$ | $T_{11}$ | $T_{10}$ |
| 5 | $T_5$ | $T_6$ | $T_4$ | $T_7$ | $T_3$ | $T_8$ | $T_2$ | $T_9$ | $T_1$ | $T_{10}$ | $T_{12}$ | $T_{11}$ |
| 6 | $T_6$ | $T_7$ | $T_5$ | $T_8$ | $T_4$ | $T_9$ | $T_3$ | $T_{10}$ | $T_2$ | $T_{11}$ | $T_1$ | $T_{12}$ |
| 7 | $T_7$ | $T_8$ | $T_6$ | $T_9$ | $T_5$ | $T_{10}$ | $T_4$ | $T_{11}$ | $T_3$ | $T_{12}$ | $T_2$ | $T_1$ |
| 8 | $T_8$ | $T_9$ | $T_7$ | $T_{10}$ | $T_6$ | $T_{11}$ | $T_5$ | $T_{12}$ | $T_4$ | $T_1$ | $T_3$ | $T_2$ |
| 9 | $T_9$ | $T_{10}$ | $T_8$ | $T_{11}$ | $T_7$ | $T_{12}$ | $T_6$ | $T_1$ | $T_5$ | $T_2$ | $T_4$ | $T_3$ |
| 10 | $T_{10}$ | $T_{11}$ | $T_9$ | $T_{12}$ | $T_8$ | $T_1$ | $T_7$ | $T_2$ | $T_6$ | $T_3$ | $T_5$ | $T_4$ |
| 11 | $T_{11}$ | $T_{12}$ | $T_{10}$ | $T_1$ | $T_9$ | $T_2$ | $T_8$ | $T_3$ | $T_7$ | $T_4$ | $T_6$ | $T_5$ |
| 12 | $T_{12}$ | $T_1$ | $T_{11}$ | $T_2$ | $T_{10}$ | $T_3$ | $T_9$ | $T_4$ | $T_8$ | $T_5$ | $T_7$ | $T_6$ |

*Note.* Participants within each of the groups (i.e., younger adults, low tech older adults, high tech older adults) will be randomly assigned to each of the twelve orders; $T_1$= Bathing, $T_2$= Walking, $T_3$= Reaching for objects, $T_4$= Hand washing dishes, $T_5$= Opening and closing drawers, $T_6$= Cleaning the kitchen, $T_7$= Deciding what medication to take, $T_8$= Medication reminder, $T_9$= Monitoring home/warning about dangers, $T_{10}$= Entertaining, $T_{11}$= Learning new skills, $T_{12}$= Getting information on weather/news.

## APPENDIX S

## PARTICIPANT DEBRIEFING

Thank you for participating in this research study. This research could not be conducted without your help. This study was designed to investigate if people's perceptions about trust in a robot are influenced by the task the robot is performing.

Robotics research is leading the development of robots that can provide assistance to people in performing home and healthcare tasks. Robot tasks can involve social interactions, such as helping the owner to learn a foreign language, providing company, entertaining guests. Robots can also potentially assist in managing finances and in making investment decisions. Additionally, home-based robots are being designed to perform chores and other home-maintenance tasks. Moreover, researchers are developing robots to assist people with disabilities and people who may require help in basic self-care tasks, such as toileting and bathing.

In this study you were interviewed about what you would want to know about a robot to help you decide whether or not to trust it. Next you were asked what tasks, if any, you would want your robot to do around your home. Afterward you completed a card-sorting task. You were presented with thirty cards with different words on them. You were asked to selected

five cards that you felt best represented characteristics of a trustworthy robot and five cards with characteristic of an untrustworthy robot. Then you were asked if you trusted a robot to do thirteen different tasks in your home. You also completed several questionnaires and ability tests. Remember there were no right or wrong answers. The ultimate goal is to use our results to guide the development of robots, such that they are designed to be acceptable by people.

Your individual information and answers will be kept confidential and any publication resulting from this study will not use any information that will directly identify you.

If you have any questions or ways to improve our research, then please feel free to contact Katherine Olson at 404-894-8344 or Dr. Wendy A. Rogers at 404-894-6775.

## APPENDIX T

## STRUCTURED INTERVIEW CODING SCHEME

**General Trust Interview**

**Question 1:** How do you define trust in a **person**? What does it mean for you to trust another person?

1. **Attitude** (Description: a way of thinking or feeling) E.g., "I don't know, sometimes if I have a good feeling about a person, I'll trust them."
    a. Mentioned
    b. Not mentioned
2. **Cooperation** (Definition: working together to the same end goal) E.g., "Depends on the person, but if my colleague and I are working on a publication, trust between us is implied, because we are both working together toward the same goal."
    a. Mentioned
    b. Not mentioned
3. **Competence** (Definition: scope of knowledge or group of knowledge or ability) E.g., "I guess I would trust someone if they were experts at what they do. So like, I trust my trainer to develop my exercise routine because I know he has gone through lots of classes for his certification."
    a. Mentioned
    b. Not mentioned
4. **Consequence** (Definition: a result of an effect, and action or condition) E.g., "Yeah, trust for me depends. So I guess I would trust my teenage daughter to drive my car. However, if she runs it out of gas, then I won't let her borrow it again, that trust would be broken."
    a. Mentioned
    b. Not mentioned
5. **Convincing** (Definition: leaving no margin or doubt; clear). E.g., "If I am certain that someone will not betray me, I'll trust them."
    a. Mentioned
    b. Not mentioned
6. **Dependability** (Definition: consistent in performance or behavior). E.g., "If I ask my friend to do something, I know she will, she always does. That's why I trust her."
    a. Mentioned
    b. Not mentioned

7. **Expectations** (Definition: a belief that something will happen or be the case in the future) E.g., "Trust is a belief in someone. For instance, I would like to believe that my daughter would take care of me if I couldn't take care of myself. I trust that she would do that."
    a. Mentioned
    b. Not mentioned
8. **Faith** (Definition: complete confidence in something or someone). E.g., "So trust to me is having absolute, no questions asked, confidence in someone, like I do with God."
    a. Mentioned
    b. Not mentioned
9. **Honesty** (Definition: being truthful) E.g., "For me to trust someone, they have to be truthful. So I totally trust my best friend because she will always tell me the truth, even if it might hurt my feelings."
    a. Mentioned
    b. Not mentioned
10. **History** (Definition: an established record) E.g., "For me to trust someone, we need to have known each other a while because trust takes time. You know, my co-worker and I have worked together for 10 years and her work is always excellent, so of course I trust she is always going to do a good job."
    a. Mentioned
    b. Not mentioned
11. **Integrity** (Definition: firm adherence to a moral or ethical code) E.g., "For me to trust someone, they would have to have the same morals and value system as I do."
    a. Mentioned
    b. Not mentioned
12. **Loyalty** (Definition: a strong feeling of support or allegiance) E.g., "For me to trust someone I have to I know that they will support me through good times and bad."
    a. Mentioned
    b. Not mentioned
13. **Obligation** (Definition: sense of duty) E.g., "You know, sometimes you kind of have to trust people. Like when I was in the military, I had to trust that my commander was doing what was right. I really didn't have a choice."
    a. Mentioned
    b. Not mentioned

14. **Perception** (Definition: the way you think about or understand someone) E.g., "Before I trust someone with something, I evaluate how I think they are as a whole, in their entirety, and then decide if they are trustworthy."
    a. Mentioned
    b. Not mentioned
15. **Probability** (Definition: chances that something will happen) E.g., "Sometimes trust is about taking chances. When I hand my keys over to a valet, I generally trust them. I figure that the chances they will hit something is pretty low since they are only driving a few feet."
    a. Mentioned
    b. Not mentioned
16. **Promise** (Definition: a statement telling someone that you will definitely do something now or in the future) E.g., "So if someone if says that they are going to do something and then they do, then I trust them. It's all about following through."
    a. Mentioned
    b. Not mentioned
17. **Reliability** (Definition: knowing the outcome from interactions will consistently be the same each time) E.g., "Trust is based off knowing that someone is always going to be the same. So when I go in to get my hair done I know that I'll be in and out in less than two hours."
    a. Mentioned
    b. Not mentioned
18. **Responsibility** (Definition: a duty or task that someone/something is required to do or expected to do) E.g., "So I know that my daughter trusts me to take care of her. It's expected, parents are supposed to take care of their kids."
    a. Mentioned
    b. Not mentioned
19. **Risk** (Definition: the possibility that something bad will happen) E.g., "When you trust someone for the first time, it's a bit of a gamble because there is a possibility that they will end up being untrustworthy. You just have to chance it."
    a. Mentioned
    b. Not mentioned
20. **Task** (Definition: a job to be done) Ex: "For me, sometimes what I trust someone with depends on what I am asking them to do. So I would trust my sister with my credit card because she is fiscally responsible, but would never trust her to drive my car because she not an aggressive enough driver to handle city drivers."
    a. Mentioned
    b. Not mentioned

21. **Uncertainty** (Definition: unknown outcome) Ex: "To me, trust sometimes involves
    a. Mentioned
    b. Not mentioned
22. **Other**
    a. Mentioned
    b. Not mentioned

**Question 2:** How would you define trust in a **robot**? What does it mean for you to trust a robot?

1. **Capability** (Definition: the ability to do something). E.g., "I would trust a robot if it was programmed to do what I wanted it to do."
    a. Mentioned
    b. Not mentioned
2. **Competence** (Definition: the scope of knowledge or group of knowledge or ability) E.g., "To trust a robot I would need to know the scope of what it knows, what's in its head."
    a. Mentioned
    b. Not mentioned
3. **Evidence of performance** (Definition: knowing that it is doing its job) E.g., "For me to trust a robot I would see for myself if it can do what they say it can do."
    a. Mentioned
    b. Not mentioned
4. **History** (Definition: an established record) E.g., "I guess I would trust a robot more after I have had it for a while."
    a. Mentioned
    b. Not mentioned
5. **Integrity** (Definition: firm adherence to a moral or ethical code) E.g., "I think for me to trust a robot, it would have to be designed so that someone couldn't hack into it and watch me without me knowing."
    a. Mentioned
    b. Not mentioned
6. **Predictability** (Definition: to declare or indicate in advance) E.g., "I don't want a robot to be able to do its own thing. If I am going to trust it, I want to know that it is going to be where I told it to be, not wandering around."
    a. Mentioned
    b. Not mentioned

7. **Purpose** (Definition: the reason why something is done or used) E.g., "If I were to trust a robot it couldn't just be taking up space in my living room just looking cute. It would have to actually do something for me."
    a. Mentioned
    b. Not mentioned
8. **Reliability** (Definition: knowing the outcome from interactions will consistently the be the same each time) E.g., "For me to trust a robot with something like laundry, I would need to know that it is going always do it the way I told it to."
    a. Mentioned
    b. Not mentioned
9. **Responsibility** (Definition: a duty or task that someone/something is required to do or expected to do) E.g., "If manufacturers are developing robots to put in peoples homes, they better make sure that if they say a robot can do something, it actually does it."
    a. Mentioned
    b. Not mentioned
10. **Risk** (Definition: the possibility that something bad will happen) E.g., "For me, trusting a robot involves understanding what can happen if the robot fails. What are the repercussions?"
    a. Mentioned
    b. Not mentioned
11. **Safety** (Definition: not being dangerous or harmful) E.g., "For me to trust a robot, I would need to know that it won't catch on fire or anything like that."
    a. Mentioned
    b. Not mentioned
12. **Other**
    a. Mentioned
    b. Not mentioned

**Question 3**: I would like to know your initial reaction to this question. Would you trust a robot to help you in your home?

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**
5. **Other**

**Question 4:** What would you want to know about the robot that would help you decide whether or not to trust it?

1. **Appearance** (Definition: what it looks like)
    a. **Human-like**
    b. **Machine-like**
    c. **Animal-like**
    d. **Other**
2. **Capability**
3. **Control method**
4. **Cost**
5. **Dependability**
6. **Ease of use**
7. **Evidence of performance**
8. **How it was programmed**
9. **Manufacturer**
10. **Reliability**
11. **Support**
12. **Usefulness**
13. **Other**

**Question 5a**: Spend a moment thinking about your home and everyday activities in your home. Of those tasks that you do in your home, are their tasks you would **TRUST** a robot to do for you or to help you with?

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**
5. **Other**

---

**Question 5b:** Here is a list of the rooms in your home to help you brainstorm about activities and tasks. So let's think about the _____ in your home. Is there anything, any task in your _____ that you would **TRUST** a robot to do for you or to help you with?

**<u>Foyer</u>**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**
5. **Other**

**Task (foyer)**

1. **Changing light bulbs**
2. **Cleaning**
    a. **Blinds/curtains**
    b. **Dusting**
    c. **Mopping/scrubbing/sweeping floors**
    d. **Pictures/Paintings**
    e. **Vacuuming**
    f. **Windows or glass**
    g. **Other**
3. **Answering the door**
4. **Watering the plants**
5. **Other**

---

**Living Room**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

**Task (living room)**

1. **Changing light bulbs**
2. **Cleaning**
    a. **Blinds/curtains**
    b. **Dusting**
    c. **Mopping/scrubbing/sweeping floors**
    d. **Pictures/Paintings**
    e. **Technology (e.g., stereo, television, etc.)**
    f. **Vacuuming**
    g. **Windows or glass**
    h. **Other**
3. **Moving furniture**
4. **Organizing (e.g., clearing clutter)**
5. **Turning on/off the lights**
6. **Turning on/off technology (e.g., stereo, television)**
7. **Other**

---

**Dining Room**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

**Task (dining room)**

1. **Changing light bulbs**
2. **Ceiling fan maintenance (e.g., adjusting, cleaning)**
3. **Changing light bulbs**
4. **Cleaning**
    a. **Blinds/curtains**
    b. **Dusting**
    c. **Mopping/scrubbing/sweeping floors**
    d. **Vacuuming**
    e. **Windows or glass**
    f. **Other**
5. **Clearing the table**
6. **Delivering/serving food**
7. **Setting the table**
8. **Turning on/off the lights**
9. **Other**

---

**Kitchen**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

**Tasks (kitchen)**

1. **Changing light bulbs**
    a. Mentioned
    b. Not mentioned
2. **Cleaning**
    a. **Blinds/curtains**
    b. **Countertops**
    c. **Dusting**
    d. **Hand washing dishes**
    e. **Loading/unload dishwasher**

   f. **Microwave**
   g. **Mopping/scrubbing/sweeping floors**
   h. **Refrigerator**
   i. **Stovetop/oven**
   j. **Vacuuming**
   k. **Windows or glass**
   l. **Other**
3. **Cooking**
4. **Food preparation (e.g., chopping, slicing, washing produce)**
5. **Operate microwave**
6. **Putting away groceries**
7. **Turning on/off the lights**
8. **Other**

---

**Bathroom**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

**Tasks (bathroom)**

1. **Changing light bulbs**
2. **Cleaning**
   a. **Bathtub**
   b. **Blinds/curtains**
   c. **Dusting**
   d. **Mopping/scrubbing/sweeping floors**
   e. **Sink**
   f. **Toilet**
   g. **Vacuuming**
   h. **Vanity (e.g., mirror, countertop)**
   i. **Windows or glass**
   j. **Other**
3. **Personal care tasks (e.g., toileting, bathing, showering)**
4. **Other**

---

**Bedroom**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

**Tasks (bedroom)**

1. **Changing light bulbs**
2. **Cleaning**
    a. **Blinds/curtains**
    b. **Dusting**
    c. **Making bed/changing sheets**
    d. **Mopping/scrubbing/sweeping floors**
    e. **Vacuuming**
    f. **Windows or glass**
    g. **Other**
3. **Folding clothes**
4. **Personal care tasks (e.g., dressing, bed transfers)**
5. **Organizing (e.g., putting clothes away, clearing clutter)**
6. **Other**

---

**Laundry Room**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

**Tasks (laundry room)**

1. **Changing light bulbs**
2. **Cleaning**
    a. **Dusting**
    b. **Mopping/scrubbing/sweeping floors**
    c. **Vacuuming**
    d. **Windows or glass**
    e. **Other**
3. **Folding clothes**
4. **Ironing**
5. **Sorting clothes**
6. **Washing clothes**
    a. **Controlling settings on washer/dryer**

   b. **Loading/unloading the washing machine/dryer**
   c. **Adding detergent/softener/bleach**
7. **Other**

---

**General Reasoning for All Tasks**

1. **Benefit of the doubt (until proven otherwise)**
2. **Benefit outweighs risk**
3. **Convenient**
4. **Difficulty doing the task (human)**
5. **Do not like to do it**
6. **Low risk for property damage (i.e., item is sturdy)**
7. **Low risk to human**
8. **No different than a computer**
9. **Non-critical task**
10. **Programmed to do it**
11. **Proven reliable**
12. **Robot more patient than human**
13. **Robot would do a better job**
14. **Safer for the robot to do it**
15. **Similar technology already exists**
16. **Simple task (i.e., easy for the robot to do, very repetitive)**
17. **Time saver**
18. **Other**

---

**Question 6a**: I would like you again to spend a moment thinking about your home and everyday activities in your home. Of those tasks that you do in your home, are their tasks you would **NOT TRUST** a robot to do for you or to help you with?

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

---

**Question 6b**: Here is a list of the rooms in your home to help you brainstorm about activities and tasks. So let's think about the _____ in your home. Is there anything, any task in your _____ that you would **NOT TRUST** a robot to do for you or to help you with?

**Foyer**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

**Task (foyer)**

1. **Changing light bulbs**
2. **Cleaning**
    a. **Blinds/curtains**
    b. **Dusting**
    c. **Mopping/scrubbing/sweeping floors**
    d. **Pictures/Paintings**
    e. **Vacuuming**
    f. **Windows or glass**
    g. **Other**
3. **Answering the door**
4. **Watering the plants**
5. **Other**

---

**Living Room**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

**Task (living room)**

1. **Changing light bulbs**
2. **Cleaning**
    a. **Blinds/curtains**
    b. **Dusting**
    c. **Mopping/scrubbing/sweeping floors**
    d. **Pictures/Paintings**
    e. **Technology (e.g., stereo, television, etc.)**
    f. **Vacuuming**
    g. **Windows or glass**
    h. **Other**
3. **Moving furniture**
4. **Organizing (e.g., clearing clutter)**

5. **Turning on/off the lights**
6. **Turning on/off technology (e.g., stereo, television)**
7. **Other**

---

**Dining Room**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

**Task (dining room)**

1. **Changing light bulbs**
2. **Ceiling fan maintenance (e.g., adjusting, cleaning)**
3. **Changing light bulbs**
4. **Cleaning**
    a. **Blinds/curtains**
    b. **Dusting**
    c. **Mopping/scrubbing/sweeping floors**
    d. **Vacuuming**
    e. **Windows or glass**
    f. **Other**
5. **Clearing the table**
6. **Delivering/serving food**
7. **Setting the table**
8. **Turning on/off the lights**
9. **Other**

---

**Kitchen**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

**Tasks (kitchen)**

1. **Changing light bulbs**
2. **Cleaning**
    a. **Blinds/curtains**
    b. **Countertops**
    c. **Dusting**

   d. **Hand washing dishes**
   e. **Loading/unload dishwasher**
   f. **Microwave**
   g. **Mopping/scrubbing/sweeping floors**
   h. **Refrigerator**
   i. **Stovetop/oven**
   j. **Vacuuming**
   k. **Windows or glass**
   l. **Other**
3. **Cooking**
4. **Food preparation (e.g., chopping, slicing, washing produce)**
5. **Operate microwave**
6. **Putting away groceries**
7. **Turning on/off the lights**
8. **Other**

---

**Bathroom**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

**Tasks (bathroom)**

1. **Changing light bulbs**
2. **Cleaning**
   a. **Bathtub**
   b. **Blinds/curtains**
   c. **Dusting**
   d. **Mopping/scrubbing/sweeping floors**
   e. **Sink**
   f. **Toilet**
   g. **Windows or glass**
   h. **Vacuuming**
   i. **Vanity (e.g., mirror, countertop)**
   j. **Other**
3. **Personal care tasks (e.g., toileting, bathing, showering)**
4. **Other**

---

**Bedroom**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

**Tasks (bedroom)**

1. **Changing light bulbs**
2. **Cleaning**
    a. **Blinds/curtains**
    b. **Dusting**
    c. **Making bed/changing sheets**
    d. **Mopping/scrubbing/sweeping floors**
    e. **Vacuuming**
    f. **Windows or glass**
    g. **Other**
3. **Folding clothes**
4. **Personal care tasks (e.g., dressing, bed transfers)**
5. **Organizing (e.g., putting clothes away, clearing cluttering)**
6. **Other**

---

**Laundry Room**

1. **Yes**
2. **No**
3. **Depends**
4. **Not sure/do not know**

**Tasks (laundry room)**

1. **Changing light bulbs**
2. **Cleaning**
    a. **Dusting**
    b. **Mopping/scrubbing/sweeping floors**
    c. **Vacuuming**
    d. **Windows or glass**
    e. **Other**
3. **Folding clothes**
4. **Ironing**
5. **Sorting clothes**
6. **Washing clothes**

   a. **Controlling settings on washer/dryer**
   b. **Loading/unloading the washing machine/dryer**
   c. **Adding detergent/softener/bleach**
7. **Other**

---

**General Reasoning (All tasks)**

1. **Complicated task (i.e., hard for the robot to do, not feasible, not practical, difficult to program)**
2. **Concerns about robot recognition capabilities**
3. **Dehumanizing**
4. **Inconvenient**
5. **High risk for property damage (e.g., item is delicate, irreplaceable)**
6. **Human has more experience/better**
7. **Lack of robot precision (e.g., does not have fine motor skills)**
8. **Lack of robot sophistication**
9. **Like to do it**
10. **Robot not proven reliable**
11. **Robot not qualified to make those decisions**
12. **Personal**
13. **Risk outweighs benefit**
14. **Safety risk to human**
15. **Slow reaction time (robot)**
16. **Waste of time**
17. **Other**

**Trust for Tasks Interview**

**Question 10**: First I would like you to choose an answer to this statement, "I would trust a robot to help me with_____."

1. **Bathing**
   a. Strongly disagree
   b. Disagree
   c. Undecided
   d. Agree
   e. Strongly Agree
2. **Walking**
   a. Strongly disagree
   b. Disagree
   c. Undecided
   d. Agree
   e. Strongly Agree

3. **Reaching for objects**
    a. Strongly disagree
    b. Disagree
    c. Undecided
    d. Agree
    e. Strongly Agree
4. **Hand washing dishes**
    a. Strongly disagree
    b. Disagree
    c. Undecided
    d. Agree
    e. Strongly Agree
5. **Opening and closing drawers**
    a. Strongly disagree
    b. Disagree
    c. Undecided
    d. Agree
    e. Strongly Agree
6. **Cleaning the kitchen**
    a. Strongly disagree
    b. Disagree
    c. Undecided
    d. Agree
    e. Strongly Agree
7. **Deciding what medication to take**
    a. Strongly disagree
    b. Disagree
    c. Undecided
    d. Agree
    e. Strongly Agree
8. **Medication reminder**
    a. Strongly disagree
    b. Disagree
    c. Undecided
    d. Agree
    e. Strongly Agree
9. **Monitoring home/warning about dangers**
    a. Strongly disagree
    b. Disagree
    c. Undecided

d. Agree
e. Strongly Agree

**10. Entertaining**

a. Strongly disagree
b. Disagree
c. Undecided
d. Agree
e. Strongly Agree

**11. Learning new skills**

a. Strongly disagree
b. Disagree
c. Undecided
d. Agree
e. Strongly Agree

**12. Getting information on the weather/news**

a. Strongly disagree
b. Disagree
c. Undecided
d. Agree
e. Strongly Agree

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**<u>General reasoning Positive</u>**

1. **Benefit of the doubt (until proven otherwise)**
2. **Benefit outweighs risk**
3. **Convenient**
4. **Difficulty doing the task (human)**
5. **Do not like to do it**
6. **Low risk for property damage (i.e., item is sturdy)**
7. **Low risk to human**
8. **No different than a computer**
9. **Non-critical task**
10. **No one else available**
11. **Programmed to do it**
12. **Proven reliable**
13. **Robot more patient than human**
14. **Robot would do a better job**
15. **Safer for the robot to do it**
16. **Similar technology already exists**

17. **Simple task (i.e., easy for the robot to do, very repetitive)**
18. **Time saver**

**General Reasoning Negative**

1. **Complicated task (i.e., hard for the robot to do, not feasible, not practical, difficult to program)**
2. **Concerns about robot recognition capabilities**
3. **Dehumanizing**
4. **Inconvenient**
5. **High risk for property damage (e.g., item is delicate, irreplaceable)**
6. **Human has more experience/better**
7. **Lack of robot precision (e.g., does not have fine motor skills)**
8. **Lack of robot sophistication**
9. **Like to do it**
10. **Robot not qualified to make those decisions**
11. **Robot not proven reliable**
12. **Personal**
13. **Risk outweighs benefit**
14. **Safety risk to human**
15. **Slow reaction time (robot)**
16. **Waste of time**
17. **Other**

**Question 11**: Can you please describe to me what the robot or robots you were imagining while you were participating in the study looked like?

1. **Imagined robot from television or the movies**
    a. **C-3PO**
    b. **R2-D2**
    c. **Robot from iRobot**
    d. **Robot from Lost in Space**
    e. **Other**
2. **Material robot was made of**
    a. **Metal**
    b. **Plastic**
    c. **Other**
3. **Overall appearance/shape**
    a. **Human-like**
    b. **Machine-like/mechanical**
    c. **Looks like an animal**
    d. **Round**
    e. **Square**
    f. **Other**

4. **Size of the robot**
    a. **Much shorter than a human of average height (approx. < 3 ft)**
    b. **Slightly shorter than a human of average height (approx.. 3ft >-<5ft)**
    c. **Same height as a human of average height (approx.. 5ft><6ft)**
    d. **Taller than a human**
    e. **Height changes or multiple heights**
    f. **Other**
5. **Robot head type**
    a. **Square/box-shaped head**
    b. **Round head**
    c. **Other**
6. **Robot Face**
    a. **Eyes**
    b. **Ears**
    c. **Nose**
    d. **Mouth**
    e. **Other**
7. **Did the robot move around?**
    a. Yes
    b. No
8. **If mobile, how did it move around?**
    a. **Legs/feet**
    b. **Wheels**
    c. **Tracks/tread**
    d. **Other**
9. **Robot arms**
    a. **Human-looking arms w/fingers**
    b. **Grippers**
    c. **Other**
10. **Robot Gender**
    a. **Male**
    b. **Female**
    c. **It**
    d. **Other**

**Question 12:** And if you were imagining any kind of robot, did the robot's look change depending on what kind of task you were thinking about?

1. **Yes**
2. **No**
3. **Not sure/do not know**

## APPENDIX U

## MEAN FREQUENCY OF TECHNOLOGY USE BY TECHNOLOGY DOMAIN

| | Younger Adults ($n$ = 12) | High Tech Older Adults ($n$ = 12) | Low Tech Older Adults ($n$ = 12) |
|---|---|---|---|
| | *M (SD)* | *M (SD)* | *M (SD)* |
| Communication Technology | | | |
| Answering Machine/Voice Mail | 4.50 (.52) | 5.00 (.00) | 4.58 (.90) |
| Automated Telephone Menu System | 3.92 (.79) | 4.58 (.51) | 4.00 (1.13) |
| Fax | 3.08 (.79) | 4.00 (1.13) | 3.08 (1.08) |
| Mobile Phone | 5.00 (.00) | 4.75 (.87) | 4.25 (1.14) |
| Text Messaging | 5.00 (.00) | 3.08 (1.38) | 2.58 (.90) |
| Video Conferencing | 4.33 (.49) | 2.50 (.80) | 1.92 (.29) |
| Computer Technology | | | |
| Desktop/Laptop Computer | 5.00 (.00) | 4.67 (.89) | 4.00 (1.28) |
| Email | 5.00 (.00) | 4.92 (.29) | 3.42 (1.31) |
| Photo/Video Software | 4.33 (.65) | 2.33 (.78) | 2.00 (.00) |
| Productivity Software | 4.92 (.29) | 2.75 (1.14) | 2.17 (.58) |
| Social Networking | 5.00 (.00) | 2.42 (1.00) | 2.08 (.67) |
| Tablet computer | 3.42 (1.24) | 2.42 (1.00) | 2.00 (.00) |
| Everyday Technology | | | |
| Automatic Teller Machine | 4.25 (.45) | 3.83 (1.40) | 3.58 (1.24) |
| Photocopier | 3.83 (1.11) | 3.92 (1.08) | 3.67 (1.07) |
| Home security System | 3.42 (1.16) | 2.67 (1.23) | 2.92 (1.38) |
| In-Store Kiosk | 4.58 (.51) | 4.42 (.90) | 3.25 (1.48) |
| Microwave Oven | 4.67 (.89) | 4.33 (1.15) | 4.67 (.89) |
| Programmable Device | 4.25 (.97) | 4.33 (1.15) | 3.58 (1.44) |
| Health Technology | | | |
| Blood Pressure Monitor | 2.75 (.87) | 4.00 (1.04) | 3.75 (1.14) |
| Digital Thermometer | 3.33 (.65) | 2.67 (.98) | 2.92 (1.16) |
| Health Management Software | 3.08 (1.08) | 2.42 (1.00) | 2.33 (.78) |
| Heart Rate Monitor | 3.00 (.85) | 2.58 (1.08) | 2.50 (1.17) |
| Medication Reminder Device | 2.33 (.98) | 2.00 (.00) | 2.25 (1.14) |
| Pedometer | 3.00 (.85) | 2.67 (.89) | 2.17 (.58) |

*Note.* 1 = Not sure what it is, 2 = Not used, 3 = Used once, 4 = Used occasionally, and 5 = Used frequently.

| | Younger Adults ($n$ = 12) | High Tech Older Adults ($n$ = 12) | Low Tech Older Adults ($n$ = 12) |
|---|---|---|---|
| | *M (SD)* | *M (SD)* | *M (SD)* |
| Recreational Technology | | | |
| Digital Music Player | 4.92 (.29) | 3.17 (1.11) | 2.67 (1.23) |
| Digital Photography | 4.50 (.52) | 3.42 (1.31) | 2.25 (.62) |
| Electric Book Reader | 3.50 (1.17) | 2.75 (1.36) | 2.17 (.94) |
| Gaming Console | 3.67 (1.23) | 2.75 (.97) | 2.00 (.00) |
| Online Coupons/Shopping | 4.17 (.58) | 3.42 (1.08) | 2.25 (.62) |
| Recording and Playback Device | 4.42 (.67) | 4.08 (1.08) | 3.25 (1.14) |
| Transportation Technology | | | |
| Airline Kiosk | 3.75 (1.06) | 3.25 (1.06) | 2.58 (1.08) |
| Bus Tracker | 4.25 (.97) | 2.42 (1.00) | 1.92 (.51) |
| Map Software | 4.83 (.39) | 4.25 (.45) | 2.50 (1.00) |
| Navigation System | 4.58 (.51) | 2.58 (1.00) | 2.50 (.90) |
| Online Travel Reservation | 3.33 (1.37) | 3.42 (1.00) | 2.33 (.78) |
| Parking Payment System | 3.42 (1.31) | 3.17 (1.11) | 2.75 (1.22) |
| Overall Tech Experience | 4.04 (.30) | 3.39 (.36) | 2.86 (.32) |

*Note.* 1 = Not sure what it is, 2 = Not used, 3 = Used once, 4 = Used occasionally, and 5 = Used frequently.

## APPENDIX V

## DIFFERENCES IN DISTRIBUTION OF RANKED SCORES BETWEEN YOUNGER AND HIGH TECH OLDER ADULTS FOR TECHNOLOGY EXPERIENCE PROFILE

| | Younger Adults | | High Tech Older Adults | | | | |
|---|---|---|---|---|---|---|---|
| Technology | *Mdn* | *Range* | *Mdn* | *Range* | *U* | *n* | *p* |
| Communication Technology | | | | | | | |
| Answering Machine/Voice Mail | 4.5 | 4-5 | 5 | 5 | 36 | 24 | .01* |
| Automated Telephone Menu System | 4 | 2-5 | 5 | 4-5 | 37 | 24 | .02* |
| Fax | 3 | 2-4 | 4 | 2-5 | 35.5 | 24 | .03* |
| Mobile Phone | 5 | 5 | 5 | 2-5 | 66 | 24 | .32 |
| Text Messaging | 5 | 5 | 2 | 2-5 | 18 | 24 | <.001*** |
| Video Conferencing | 4 | 4-5 | 2 | 2-4 | 8 | 24 | <.001*** |
| Computer Technology | | | | | | | |
| Desktop/Laptop Computer | 5 | 5 | 5 | 2-5 | 60 | 24 | .15 |
| Email | 5 | 5 | 5 | 4-5 | 66 | 24 | .32 |
| Photo/Video Software | 4 | 3-5 | 2 | 2-4 | 8 | 24 | <.001*** |
| Productivity Software | 4 | 4-5 | 2 | 2-5 | 8 | 24 | <.001*** |
| Social Networking | 5 | 5 | 2 | 2-5 | 6 | 24 | <.001*** |
| Tablet computer | 3.5 | 2-5 | 2 | 2-5 | 38 | 24 | .03* |
| Everyday Technology | | | | | | | |
| Automatic Teller Machine | 4 | 4-5 | 4.5 | 2-5 | 72 | 24 | 1 |
| Photocopier | 4 | 2-5 | 4 | 2-5 | 69 | 24 | .86 |
| Home security System | 4 | 2-5 | 2 | 2-5 | 47.5 | 24 | .12 |
| In-Store Kiosk | 5 | 4-5 | 5 | 2-5 | 69.5 | 24 | .87 |
| Microwave Oven | 5 | 2-5 | 5 | 2-5 | 60 | 24 | .36 |
| Programmable Device | 4.5 | 2-5 | 5 | 2-5 | 63 | 24 | .56 |

*Note.* 1 = Not sure what it is, 2 = Not used, 3 = Used once, 4 = Used Occasionally, and 5 = Used frequently.

*$p < .05$, **$p < .01$, ***$p < .001$

**DIFFERENCES IN DISTRIBUTION OF RANKED SCORES BETWEEN YOUNGER AND HIGH TECH OLDER ADULTS FOR TECHNOLOGY EXPERIENCE PROFILE CONTINUED**

| | Younger Adults | | High Tech Older Adults | | | | |
|---|---|---|---|---|---|---|---|
| Technology | *Mdn* | *Range* | *Mdn* | *Range* | *U* | *N* | *p* |
| Health Technology | | | | | | | |
| Blood Pressure Monitor | 2.5 | 2-4 | 4 | 2-5 | 27 | 24 | .01* |
| Digital Thermometer | 3 | 2-4 | 2 | 2-4 | 43 | 24 | .07 |
| Health Management Software | 3 | 2-4 | 2 | 2-5 | 45.5 | 24 | .08 |
| Heart Rate Monitor | 3 | 2-4 | 2 | 2-5 | 50 | 24 | .16 |
| Medication Reminder Device | 2 | 1-5 | 2 | 2 | 60 | 24 | .29 |
| Pedometer | 3 | 2-4 | 2 | 2-4 | 56 | 24 | .32 |
| Recreational Technology | | | | | | | |
| Digital Music Player | 5 | 4-5 | 3.5 | 2-5 | 9 | 24 | <.001*** |
| Digital Photography | 4.5 | 4-5 | 4 | 2-5 | 39 | 24 | .04* |
| Electric Book Reader | 3.5 | 2-5 | 2 | 2-5 | 45 | 24 | .09 |
| Gaming Console | 4 | 2-5 | 2 | 2-4 | 40.5 | 24 | .06 |
| Online Coupons/Shopping | 4 | 3-5 | 4 | 2-5 | 45.5 | 24 | .08 |
| Recording and Playback Device | 4.5 | 3-5 | 4 | 2-5 | 62.5 | 24 | .55 |
| Transportation Technology | | | | | | | |
| Airline Kiosk | 4 | 2-5 | 3.5 | 2-5 | 53 | 24 | .25 |
| Bus Tracker | 4.5 | 2-5 | 2 | 2-5 | 18 | 24 | <.001*** |
| Map Software | 5 | 4-5 | 4 | 4.50 | 30 | 24 | 0.01* |
| Navigation System | 5 | 4-5 | 2 | 2-5 | 11 | 24 | <.001*** |
| Online Travel Reservation | 3 | 2-5 | 4 | 2-5 | 69.5 | 24 | .88 |
| Parking Payment System | 4 | 2-5 | 3.5 | 2-5 | 63 | 24 | .58 |
| Overall Tech Experience | 4 | 1-5 | 4 | 2-5 | 34.5 | 24 | .02* |

*Note.* 1 = Not sure what it is, 2 = Not used, 3 = Used once, 4 = Used Occasionally, and 5 = Used frequently.

*$p < .05$, **$p < .01$, ***$p < .001$

**DIFFERENCES IN DISTRIBUTION OF RANKED SCORES BETWEEN HIGH TECH AND LOW TECH OLDER ADULTS FOR TECHNOLOGY EXPERIENCE PROFILE**

| | High Tech Older Adults | | Low Tech Older Adults | | | | |
|---|---|---|---|---|---|---|---|
| Technology | *Mdn* | *Range* | *Mdn* | *Range* | *U* | *n* | *p* |
| Communication Technology | | | | | | | |
| Answering Machine/Voice Mail | 5 | 5 | 5 | 2-5 | 54 | 24 | .07 |
| Automated Telephone Menu System | 5 | 4-5 | 4 | 2-5 | 52.5 | 24 | .22 |
| Fax | 4 | 2-5 | 3 | 2-5 | 39.5 | 24 | .05 |
| Mobile Phone | 5 | 2-5 | 5 | 2-5 | 49.5 | 24 | .09 |
| Text Messaging | 2 | 2-5 | 2 | 2-4 | 59 | 24 | .39 |
| Video Conferencing | 2 | 2-4 | 2 | 1-2 | 44 | 24 | .02* |
| Computer Technology | | | | | | | |
| Desktop/Laptop Computer | 5 | 2-5 | 4.5 | 2-5 | 48 | 24 | .10 |
| Email | 5 | 4-5 | 4 | 2-5 | 21 | 24 | .001** |
| Photo/Video Software | 2 | 2-4 | 2 | 2 | 60 | 24 | .15 |
| Productivity Software | 2 | 2-5 | 2 | 2-4 | 53.5 | 24 | .13 |
| Social Networking | 2 | 2-5 | 2 | 1-4 | 60.5 | 24 | .31 |
| Tablet computer | 2 | 2-5 | 2 | 2 | 60 | 24 | .15 |
| Everyday Technology | | | | | | | |
| Automatic Teller Machine | 4.5 | 2-5 | 4 | 2-5 | 60 | 24 | .46 |
| Photocopier | 4 | 2-5 | 4 | 2-5 | 61.5 | 24 | .51 |
| Home security System | 2 | 2-5 | 2 | 2-5 | 65.5 | 24 | .64 |
| In-Store Kiosk | 5 | 2-5 | 3 | 1-5 | 41 | 24 | .06 |
| Microwave Oven | 5 | 2-5 | 5 | 2-5 | 60 | 24 | .36 |
| Programmable Device | 5 | 2-5 | 4 | 1-5 | 47 | 24 | .12 |

*Note.* 1 = Not sure what it is, 2 = Not used, 3 = Used once, 4 = Used Occasionally, and 5 = Used frequently.

*$p < .05$, **$p < .01$, ***$p < .001$

**DIFFERENCES IN DISTRIBUTION OF RANKED SCORES BETWEEN HIGH TECH AND LOW TECH OLDER ADULTS FOR TECHNOLOGY EXPERIENCE PROFILE CONTINUED**

| | High Tech Older Adults | | Low Tech Older Adults | | | | |
|---|---|---|---|---|---|---|---|
| Technology | *Mdn* | *Range* | *Mdn* | *Range* | *U* | *n* | *p* |
| Health Technology | | | | | | | |
| Blood Pressure Monitor | 4 | 2-5 | 4 | 2-5 | 63 | 24 | .57 |
| Digital Thermometer | 2 | 2-4 | 4 | 2-5 | 64 | 24 | .59 |
| Health Management Software | 2 | 2-5 | 2 | 2-4 | 71 | 24 | .93 |
| Heart Rate Monitor | 2 | 2-5 | 2 | 1-5 | 67.5 | 24 | .75 |
| Medication Reminder Device | 2 | 2 | 2 | 1-5 | 72 | 24 | 1 |
| Pedometer | 2 | 2-4 | 2 | 2-4 | 49 | 24 | .08 |
| Recreational Technology | | | | | | | |
| Digital Music Player | 3.5 | 2-5 | 2 | 2-5 | 54 | 24 | .24 |
| Digital Photography | 4 | 2-5 | 2 | 2-4 | 37 | 24 | .02* |
| Electric Book Reader | 2 | 2-5 | 2 | 1-5 | 55.5 | 24 | .18 |
| Gaming Console | 2 | 2-4 | 2 | 2 | 42 | 24 | .01* |
| Online Coupons/Shopping | 4 | 2-5 | 2 | 2-4 | 31.5 | 24 | .01* |
| Recording and Playback Device | 4 | 2-5 | 4 | 2-5 | 41.5 | 24 | .06 |
| Transportation Technology | | | | | | | |
| Airline Kiosk | 3.5 | 2-5 | 2 | 1-4 | 48 | 24 | .13 |
| Bus Tracker | 2 | 2-5 | 2 | 1-3 | 55 | 24 | .17 |
| Map Software | 4 | 4-5 | 2 | 1-4 | 13.5 | 24 | <.001*** |
| Navigation System | 2 | 2-5 | 2 | 2-4 | 67.5 | 24 | .75 |
| Online Travel Reservation | 4 | 2-5 | 2 | 2-4 | 31 | 24 | .01* |
| Parking Payment System | 3.5 | 2-5 | 2 | 1-5 | 57.5 | 24 | .37 |
| Overall Tech Experience | 4 | 2-5 | 2 | 1-5 | 26.5 | 24 | <.01** |

*Note.* 1 = Not sure what it is, 2 = Not used, 3 = Used once, 4 = Used Occasionally, and 5 = Used frequently.

*$p < .05$, **$p < .01$, ***$p < .001$

## APPENDIX W

## MEAN SCORES FOR ROBOT FAMILIARITY AND USE ACROSS AGE AND TECHNOLOGY EXPERIENCE

| | Younger Adults ($n$ = 12) | | High Tech Older Adults ($n$ = 12) | | Low Tech Older Adults ($n$ = 12) | |
|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Robot Type | | | | | | |
| Autonomous Car | 2.50 | .80 | 2.42 | .90 | 1.83 | .94 |
| Domestic/Home Robot | 3.00 | .60 | 2.58 | .79 | 2.67 | .65 |
| Entertainment/Toy Robot | 3.83 | .72 | 2.50 | .90 | 2.92 | 1.08 |
| Manufacturing Robot | 3.17 | .58 | 3.17 | .39 | 2.92 | .51 |
| Military Robot | 2.92 | .29 | 2.92 | .29 | 2.67 | .49 |
| Personal Robot 2 | 1.83 | .58 | 1.92 | .79 | 1.75 | .62 |
| Remote Presence Robot | 1.75 | .45 | 1.92 | .67 | 1.58 | .67 |
| Research Robot | 2.42 | .79 | 2.17 | .94 | 2.42 | .79 |
| Robot Lawn Mower | 2.50 | .80 | 2.33 | .65 | 2.33 | .65 |
| Robot Security Guard | 2.33 | .78 | 2.42 | .67 | 2.50 | 1.09 |
| Space Exploration Robot | 3.00 | .00 | 3.00 | .00 | 2.67 | .78 |
| Surgical Robot | 2.67 | .89 | 3.00 | .00 | 2.58 | 1.00 |
| Unmanned Aerial Vehicle/Drone | 2.83 | .58 | 2.92 | .29 | 2.42 | .79 |
| Across All Robots | | | | | | |

*Note.* 1= Not sure what this is, 2 = Never heard about, seen, or used this robot, 3 = Have only heard about or seen this robot, 4 = Have only used or operated this robot only occasionally, 5 = Have used or operated this robot frequently.

## APPENDIX X

## DIFFERENCES IN DISTRIBUTION OF RANKED SCORES IN ROBOT FAMILIARITY AND USE BETWEEN YOUNGER AND HIGH TECH OLDER ADULTS

| | Younger Adults | | High Tech Older Adults | | | | |
|---|---|---|---|---|---|---|---|
| Type of Robot | *Mdn* | Range | *Mdn* | Range | *U* | *n* | *p* |
| Autonomous Car | 3 | 1-3 | 3 | 1-3 | 70 | 24 | .89 |
| Domestic/Home Robot | 3 | 2-4 | 3 | 1-3 | 55 | 24 | .22 |
| Entertainment/Toy Robot | 4 | 2-5 | 3 | 1-4 | 17 | 24 | .001** |
| Manufacturing Robot | 3 | 3-5 | 3 | 3-4 | 67 | 24 | .62 |
| Military Robot | 3 | 2-3 | 3 | 2-3 | 72 | 24 | 1 |
| Personal Robot 2 | 2 | 1-3 | 2 | 1-3 | 68.5 | 24 | .82 |
| Remote Presence Robot | 2 | 1-2 | 2 | 1-3 | 63 | 24 | .53 |
| Research Robot | 2 | 1-4 | 2.5 | 1-3 | 64 | 24 | .62 |
| Robot Lawn Mower | 2.5 | 1-4 | 2 | 1-3 | 64 | 24 | .61 |
| Robot Security Guard | 2 | 1-4 | 2.5 | 1-3 | 64 | 24 | .61 |
| Space Exploration Robot | 3 | 3 | 3 | 3 | 72 | 24 | 1 |
| Surgical Robot | 3 | 1-4 | 3 | 3 | 60 | 24 | .29 |
| Unmanned Aerial Vehicle/Drone | 3 | 2-4 | 3 | 2-3 | 65.5 | 24 | .60 |
| Across All Robots | 3 | 1-5 | 3 | 1-4 | 71 | 24 | .93 |

*Note.* 1 = Not sure what this is, 2 = Never heard about, seen, or used this robot, 3 = Have only heard about or seen this robot, 4 = Have only used or operated this robot only occasionally, 5 = Have used or operated this robot frequently.

**$p < .01$

## DIFFERENCES IN DISTRIBUTION OF RANKED SCORES IN ROBOT FAMILIARITY AND USE BETWEEN HIGH TECH AND LOW TECH OLDER ADULTS

| | High Tech Older Adults | | Low Tech Older Adults | | | | |
|---|---|---|---|---|---|---|---|
| Type of Robot | *Mdn* | Range | *Mdn* | Range | *U* | *N* | *p* |
| Autonomous Car | 3 | 1-3 | 1.5 | 1-3 | 48 | 24 | .13 |
| Domestic/Home Robot | 3 | 1-3 | 3 | 1-3 | 70.5 | 24 | .91 |
| Entertainment/Toy Robot | 3 | 1-4 | 3 | 1-5 | 57.5 | 24 | .37 |
| Manufacturing Robot | 3 | 3-4 | 3 | 2-4 | 56 | 24 | .19 |
| Military Robot | 3 | 2-3 | 2 | 2-3 | 54 | 24 | .14 |
| Personal Robot 2 | 2 | 1-3 | 1.5 | 1-3 | 64 | 24 | .61 |
| Remote Presence Robot | 2 | 1-3 | 3 | 1-3 | 52.5 | 24 | .21 |
| Research Robot | 2.5 | 1-3 | 2 | 1-3 | 62 | 24 | .52 |
| Robot Lawn Mower | 2 | 1-3 | 2.5 | 1-3 | 72 | 24 | 1 |
| Robot Security Guard | 2.5 | 1-3 | 3 | 1-5 | 72 | 24 | 1 |
| Space Exploration Robot | 3 | 3 | 3 | 1-3 | 60 | 24 | .15 |
| Surgical Robot | 3 | 3 | 3 | 1-4 | 60 | 24 | .29 |
| Unmanned Aerial Vehicle/Drone | 3 | 2-3 | 3 | 1-3 | 47 | 24 | .06 |
| Across All Robots | 3 | 1-4 | 3 | 1-5 | 61 | 24 | .40 |

*Note.* 1 = Not sure what this is, 2 = Never heard about, seen, or used this robot, 3 = Have only heard about or seen this robot, 4 = Have only used or operated this robot only occasionally, 5 = Have used or operated this robot frequently.

## APPENDIX Y

## STRUCTURED INTERVIEW DATA FROM VISUALIZED ROBOT APPEARANCE

| Coding Dimension | Younger Adults ($n$ = 12) | High Tech Older Adults ($n$ = 12) | Low Tech Older Adults ($n$ = 12) | Combined ($n$ = 36) |
|---|---|---|---|---|
| Imagined robot | | | | |
| Yes | 12 | 11 | 12 | 35 |
| No | -- | 1 | -- | 1 |
| Robot general appearance | | | | |
| C-3PO | -- | 1 | -- | 1 |
| R2-D2 | 1 | 1 | 3 | 5 |
| Robot from iRobot | 4 | -- | -- | 4 |
| Other movie or TV robot | -- | 2 | 4 | 6 |
| Human-like | 3 | 4 | 3 | 10 |
| Machine/Mechanical-like | 5 | 4 | 3 | 12 |
| Animal-like | -- | -- | 1 | 1 |
| Not mentioned | -- | 1 | -- | 1 |
| Robot material | | | | |
| Metal | 12 | 7 | 10 | 29 |
| Plastic | 3 | 3 | 4 | 10 |
| Resin | -- | 1 | -- | 1 |
| Don’t know | -- | -- | 1 | 1 |
| Shape of robot | | | | |
| Human-like | 6 | 7 | 6 | 19 |
| Round | 2 | -- | 3 | 5 |
| Square | 1 | 2 | 2 | 5 |
| Rectangle | -- | -- | 1 | 1 |
| No shape | 2 | 1 | -- | 3 |
| Not mentioned | -- | 1 | -- | 1 |
| Other | 1 | -- | 1 | 2 |
| Size of robot | | | | |
| Much shorter than human | 2 | 2 | 4 | 8 |
| Slightly shorter than human | 4 | 3 | 2 | 9 |
| Average human height | 6 | 6 | 6 | 18 |

## STRUCTURED INTERVIEW DATA FROM VISUALIZED ROBOT APPEARANCE CONTINUED

| Coding Dimension | Younger Adults (*n* = 12) | High Tech Older Adults (*n* = 12) | Low Tech Older Adults (*n* = 12) | Combined (*n* = 36) |
|---|---|---|---|---|
| Robot face | | | | |
| Eyes and eyebrows | 3 | 4 | 7 | 14 |
| Ears | 1 | 1 | 2 | 4 |
| Nose | -- | 1 | 3 | 4 |
| Mouth | 3 | 2 | 4 | 9 |
| Don't mentioned | 2 | 2 | 2 | 6 |
| No face | -- | 2 | 1 | 3 |
| Other | 5 | 3 | 2 | 10 |
| Robot move around? | | | | |
| Yes | 11 | 11 | 12 | 34 |
| No | 1 | -- | -- | 1 |
| How did robot move around? | | | | |
| Legs or feet | 5 | 6 | 10 | 21 |
| Wheels | 5 | 2 | 2 | 9 |
| Tracks or tread | -- | -- | 1 | 1 |
| Don't know | 1 | 2 | -- | 3 |
| Not mentioned | 1 | 1 | -- | 2 |
| Robot arms | | | | |
| Human-looking with arms | 3 | 5 | -- | 8 |
| Grippers | 2 | 1 | 1 | 4 |
| Non-specific arms | 6 | 4 | 9 | 19 |
| Not mentioned | 1 | 1 | 2 | 4 |
| Robot gender | | | | |
| Male | 1 | 4 | 6 | 11 |
| Female | -- | -- | 1 | 1 |
| It | 10 | 7 | 6 | 23 |
| Not mentioned | 1 | -- | -- | 1 |
| Did robot change? | | | | |
| Yes | 9 | 4 | 3 | 16 |
| No | 3 | 7 | 7 | 17 |
| Not mentioned | -- | -- | 2 | 2 |

## APPENDIX Z

## DIFFERENCES IN DISTRIBUTION OF RANKED SCORES IN ROBOT OPINIONS BETWEEN YOUNGER AND HIGH TECH OLDER ADULTS

| | Younger Adults | | High Tech Older Adults | | | | |
|---|---|---|---|---|---|---|---|
| Questionnaire Item | *Mdn* | Range | *Mdn* | Range | *U* | *N* | *P* |
| *My interaction with a robot would be clear and understandable. | 6 | 5-7 | 6 | 1-7 | 50 | 24 | .15 |
| I would find a robot useful in my daily life. | 6 | 3-7 | 6 | 4-7 | 57 | 24 | .28 |
| Using a robot would enhance my effectiveness in my daily life. | 6 | 4-6 | 6 | 3-7 | 53 | 24 | .23 |
| Using a robot in my daily life would increase my productivity. | 6 | 5-7 | 6 | 4-7 | 68 | 24 | .78 |
| Using a robot would make my daily life easier. | 6 | 4-7 | 6 | 4-7 | 50 | 24 | .16 |
| Using a robot would improve my daily life. | 5 | 2-6 | 6 | 4-7 | 21 | 24 | .002** |
| Using a robot in my daily life would enable me to accomplish tasks more quickly. | 6 | 5-7 | 6 | 4-7 | 51 | 24 | .18 |
| *I would find a robot easy to use. | 5 | 3-7 | 5.5 | 2-7 | 56.50 | 24 | .35 |
| *I would find a robot to be flexible for me to interact with. | 5 | 3-7 | 5 | 4-7 | 57 | 24 | .37 |
| *It would be easy for me to become skillful at using a robot. | 5.50 | 3-7 | 5.5 | 3-7 | 69.50 | 24 | .88 |
| *I would find it easy to get a robot to do what I want it to do. | 5.50 | 4-7 | 6 | 3-7 | 70.50 | 24 | .93 |
| *Learning to operate a robot would be easy for me. | 6 | 3-7 | 6 | 2-7 | 67.50 | 24 | .78 |
| Median of 12 Items | 5.75 | 3-7 | 6 | 1-7 | 59 | 24 | .41 |

**$p < .01$

**DIFFERENCES IN DISTRIBUTION OF RANKED SCORES IN ROBOT OPINIONS BETWEEN HIGH AND LOW TECH OLDER ADULTS**

| | High Tech Older Adults | | Low Tech Older Adults | | | | |
|---|---|---|---|---|---|---|---|
| Questionnaire Item | *Mdn* | Range | *Mdn* | Range | *U* | *N* | *p* |
| *My interaction with a robot would be clear and understandable. | 6 | 1-7 | 6 | 1-7 | 70 | 24 | .90 |
| I would find a robot useful in my daily life. | 6 | 4-7 | 6 | 1-7 | 53.50 | 24 | .23 |
| Using a robot would enhance my effectiveness in my daily life. | 6 | 3-7 | 6 | 1-7 | 54.50 | 24 | .29 |
| Using a robot in my daily life would increase my productivity. | 6 | 4-7 | 6 | 1-7 | 68 | 24 | .81 |
| Using a robot would make my daily life easier. | 6 | 4-7 | 6 | 1-7 | 71.5 | 24 | .98 |
| Using a robot would improve my daily life. | 6 | 4-7 | 6 | 1-7 | 50 | 24 | .18 |
| Using a robot in my daily life would enable me to accomplish tasks more quickly. | 6 | 4-7 | 5.5 | 1-7 | 46.5 | 24 | .12 |
| *I would find a robot easy to use. | 5.5 | 2-7 | 6 | 1-7 | 69 | 24 | .86 |
| *I would find a robot to be flexible for me to interact with. | 5 | 4-7 | 5.5 | 1-6 | 69 | 24 | .86 |
| *It would be easy for me to become skillful at using a robot. | 5.5 | 3-7 | 5.5 | 1-7 | 67.5 | 24 | .79 |
| *I would find it easy to get a robot to do what I want it to do. | 6 | 3-7 | 6 | 1-6 | 55.5 | 24 | .30 |
| *Learning to operate a robot would be easy for me. | 6 | 2-7 | 5.5 | 1-7 | 60 | 24 | .47 |
| Median of 12 Items | 6 | 1-7 | 6 | 1-7 | 64.50 | 24 | .67 |

## APPENDIX AA

## DIFFERENCES IN DISTRIBUTION OF RANKED SCORES BETWEEN YOUNGER AND HIGH TECH OLDER ADULTS FOR ADJECTIVES ASSOCIATED WITH CHARACTERISTICS OF A TRUSTWORTHY AND UNTRUSTWORTHY ROBOT

Trustworthy Robot

| | Younger Adults | | High Tech Older Adults | | | | | |
|---|---|---|---|---|---|---|---|---|
| Adjective | *Mdn* | *Range* | *Mdn* | *Range* | *U* | *Z* | *n* | *p* |
| Agreeable | 4 | 0-5 | 3.5 | 0-5 | 58 | -.84 | 24 | .40 |
| Boring | 1 | 0-5 | 1 | 0-1 | 58 | -.86 | 24 | .39 |
| Calm | 4 | 1-5 | 1 | 0-5 | 35.50 | -2.94 | 24 | .03* |
| Compassionate | 4 | 1-5 | 1 | 0-5 | 22 | -2.94 | 24 | .003** |
| Confident | 3 | 1-5 | 1 | 0-5 | 49.50 | -1.33 | 24 | .18 |
| Deceptive | 1 | 1 | 1 | 0-2 | 66 | -.60 | 24 | .55 |
| Dependent | 2.5 | 1-5 | 1.5 | 0-5 | 58 | -.83 | .24 | .40 |
| Efficient | 5 | 4-5 | 5 | 3-5 | 67.50 | -.37 | 24 | .71 |
| Familiar | 4 | 3-5 | 4 | 0-5 | 58.50 | -.81 | 24 | .42 |
| Friendly | 4 | 2-5 | 1 | 0-5 | 28 | -2.59 | 24 | .01* |
| Hostile | 1 | 1-3 | 1 | 0-1 | 55 | -1.71 | 24 | .09 |
| Human looking | 1 | 0-4 | 1 | 0-5 | 70 | -.02 | 24 | .91 |
| Independent | 2 | 1-5 | 4 | 1-5 | 55 | -1.02 | 24 | .31 |
| Loud | 1 | 0-3 | 1 | 0-4 | 63 | -.55 | .24 | .58 |
| Loyal | 5 | 0-5 | 2.5 | 0-5 | 35 | -2.23 | 24 | .03* |
| Misleading | 1 | 1 | 1 | 0-1 | 66 | -1 | 24 | .32 |
| Non-human looking | 2 | 0-5 | 0.5 | 0-3 | 45.50 | -1.61 | 24 | .11 |
| Phony | 1 | 0-1 | 1 | 0-2 | 65.50 | -.53 | 24 | .60 |
| Pointless | 1 | 1-3 | 1 | 0-2 | 55 | -1.38 | 24 | .17 |
| Precise | 4 | 3-5 | 5 | 4-5 | 41 | -2.11 | 24 | .04* |
| Predictable | 5 | 2-5 | 5 | 3-5 | 64 | -.58 | 24 | .56 |
| Reliable | 5 | 4-5 | 5 | 4-5 | 72 | 0 | 24 | 1 |
| Risky | 1 | 1-2 | 1 | 1-2 | 72 | 0 | 24 | 1 |
| Safe | 5 | 3-5 | 5 | 4-5 | 71 | -.09 | 24 | .93 |
| Sneaky | 1 | 1 | 1 | 0-3 | 66 | -.60 | 24 | .55 |
| Social | 3 | 0-5 | 1 | 0-5 | 25 | -2.76 | 24 | .01* |
| Unfeeling | 1 | 0-2 | 1 | 0-5 | 63.50 | -.52 | 24 | .61 |
| Unpredictable | 1 | 1-2 | 1 | 1 | 60 | -1.45 | 24 | .15 |
| Unreliable | 1 | 0-2 | 1 | 1 | 72 | 0 | 24 | 1 |
| Unsocial | 1 | 0-3 | 1 | 1-4 | 65 | -.44 | 24 | .66 |

*Note*. 0 = don't know, 1= Not at all, 2 = to a limited extent, 3 = to a moderate extent, 4 = to a large extent, 5 = to a great extent.

*$p < .05$, **$p < .01$, ***$p < .001$

Untrustworthy Robot

| | Younger Adults | | High Tech Older Adults | | | | | |
|---|---|---|---|---|---|---|---|---|
| Adjective | *Mdn* | *Range* | *Mdn* | *Range* | *U* | *Z* | *N* | *p* |
| Agreeable | 1 | 1-3 | 1 | 0-5 | 62.50 | -.72 | 24 | .47 |
| Boring | 1.5 | 0-5 | 1 | 0-5 | 71.50 | -.03 | 24 | .98 |
| Calm | 1 | 1-5 | 1 | 0-5 | 53.50 | -1.17 | 24 | .24 |
| Compassionate | 1 | 0-5 | 1 | 0-5 | 54.50 | -1.14 | 24 | .26 |
| Confident | 2.5 | 1-5 | 1 | 0-5 | 36 | -2.13 | 24 | .03* |
| Deceptive | 5 | 4-5 | 4.5 | 0-5 | 48 | -1.60 | 24 | .11 |
| Dependent | 2 | 1-5 | 1.5 | 0-5 | 66.50 | -.33 | 24 | .74 |
| Efficient | 1 | 1-3 | 1 | 1-2 | 71 | -.09 | 24 | .93 |
| Familiar | 1 | 1-5 | 1 | 0-3 | 43.50 | -1.85 | 24 | .07 |
| Friendly | 1 | 1-2 | 1 | 0-5 | 68 | -.29 | 24 | .77 |
| Hostile | 5 | 4-5 | 4 | 0-5 | 32 | -2.48 | 24 | .01* |
| Human looking | 1.5 | 0-5 | 0 | 0-2 | 33 | -2.39 | 24 | .02* |
| Independent | 3 | 1-5 | 2 | 0-5 | 47.50 | -1.45 | 24 | .15 |
| Loud | 2 | 0-5 | 0.5 | 0-5 | 49.50 | -1.34 | 24 | .18 |
| Loyal | 1 | 0-2 | 0.5 | 0-5 | 45 | -1.82 | 24 | .07 |
| Misleading | 5 | 3-5 | 4 | 0-5 | 36.50 | -2.31 | 24 | .02* |
| Non-human looking | 1.5 | 0-4 | 0.5 | 0-2 | 45 | -1.65 | 24 | .10 |
| Phony | 4.5 | 0-5 | 3 | 0-5 | 42 | -1.79 | 24 | .07 |
| Pointless | 3.5 | 0-5 | 4 | 0-5 | 68 | -.24 | 24 | .81 |
| Precise | 1 | 1-4 | 1 | 1-2 | 68 | -.29 | 24 | .77 |
| Predictable | 1 | 1-3 | 1 | 1-2 | 65 | -.57 | 24 | .57 |
| Reliable | 1 | 1 | 1 | 1 | 72 | .00 | 24 | 1 |
| Risky | 5 | 3-5 | 5 | 2-5 | 58.50 | -.94 | 24 | .35 |
| Safe | 1 | 1 | 1 | 1-2 | 60 | -1.45 | 24 | .15 |
| Sneaky | 5 | 2-5 | 4 | 0-5 | 38.50 | -2.23 | 24 | .03* |
| Social | 2 | 0-5 | 0 | 3-5 | 37 | -2.09 | 24 | .04* |
| Unfeeling | 2.5 | 0-5 | 0.5 | 0-5 | 54.50 | -1.05 | 24 | .30 |
| Unpredictable | 5 | 4-5 | 5 | 3-5 | 65 | -.57 | 24 | .57 |
| Unreliable | 5 | 4-5 | 5 | 4-5 | 60 | -1.07 | 24 | .28 |
| Unsocial | 3 | 0-5 | 0 | 0-5 | 38 | -2.03 | 24 | .04* |

*Note*. 0 = don't know, 1= Not at all, 2 = to a limited extent, 3 = to a moderate extent, 4 = to a large extent, 5 = to a great extent.

*$p < .05$, **$p < .01$, ***$p < .001$

**DIFFERENCES IN DISTRIBUTION OF RANKED SCORES BETWEEN HIGH TECH AND LOW TECH OLDER ADULTS FOR ADJECTIVES ASSOCIATED WITH CHARACTERISTICS OF A TRUSTWORTHY AND UNTRUSTWORTHY ROBOT**

Trustworthy

| | High Tech Older Adults | | Low Tech Older Adults | | | | | |
|---|---|---|---|---|---|---|---|---|
| Adjective | *Mdn* | *Range* | *Mdn* | *Range* | *U* | *Z* | *n* | *p* |
| Agreeable | 3.5 | 0-5 | 3 | 0-2 | 58 | -.82 | 24 | .41 |
| Boring | 1 | 0-1 | 1 | 0-5 | 54 | -1.18 | 24 | .24 |
| Calm | 1 | 0-5 | 4 | 0-5 | 45.50 | -1.58 | 24 | .12 |
| Compassionate | 1 | 0-5 | 1.5 | 0-2 | 52.50 | -1.16 | 24 | .25 |
| Confident | 1 | 0-5 | 3.5 | 0-5 | 47 | -1.48 | 24 | .14 |
| Deceptive | 1 | 0-2 | 1 | 0-5 | 66 | -.60 | 24 | .55 |
| Dependent | 1.5 | 0-5 | 1.5 | 1-5 | 63.50 | -.51 | 24 | .61 |
| Efficient | 5 | 3-5 | 4.5 | 1-3 | 47 | -1.73 | 24 | .08 |
| Familiar | 4 | 0-5 | 3.5 | 0-3 | 65 | -.42 | 24 | .67 |
| Friendly | 1 | 0-5 | 1.5 | 0-2 | 70.50 | -.09 | 24 | .93 |
| Hostile | 1 | 0-1 | 1 | 0-5 | 72 | .00 | 24 | 1 |
| Human looking | 1 | 0-5 | 1.5 | 0-4 | 68 | -.24 | 24 | .81 |
| Independent | 4 | 1-5 | 3 | 0-5 | 68 | -.24 | 24 | .81 |
| Loud | 1 | 0-4 | 1 | 0-5 | 63.50 | -.59 | 24 | .56 |
| Loyal | 2.5 | 0-5 | 3 | 0-3 | 59 | -.77 | 24 | .44 |
| Misleading | 1 | 0-1 | 1 | 0-5 | 72 | .00 | 24 | 1 |
| Non-human looking | 0.5 | 0-3 | 1 | 0-5 | 57.50 | -.88 | 24 | .38 |
| Phony | 1 | 0-2 | 1 | 0-5 | 66 | -.43 | 24 | .66 |
| Pointless | 1 | 0-2 | 1 | 0-5 | 66.50 | -.55 | 24 | .58 |
| Precise | 5 | 4-5 | 5 | 1-5 | 51 | -1.52 | 24 | .13 |
| Predictable | 5 | 3-5 | 4 | 0-5 | 41 | -1.98 | 24 | .05 |
| Reliable | 5 | 4-5 | 4.5 | 1-5 | 41.50 | -2.22 | 24 | .03* |
| Risky | 1 | 1-2 | 1 | 0-5 | 54 | -1.48 | 24 | .14 |
| Safe | 5 | 4-5 | 4 | 0-2 | 32 | -2.61 | 24 | .009** |
| Sneaky | 1 | 0-3 | 1 | 0-5 | 71.50 | -.5 | 24 | .96 |
| Social | 1 | 0-5 | 1.5 | 0-3 | 51.50 | -1.23 | 24 | .22 |
| Unfeeling | 1 | 0-5 | 1.5 | 0-5 | 50.50 | -1.28 | 24 | .20 |
| Unpredictable | 1 | 1 | 1 | 1-5 | 66 | -1 | 24 | .32 |
| Unreliable | 1 | 1 | 1 | 1-5 | 72 | .00 | 24 | 1 |
| Unsocial | 1 | 1-4 | 1 | 0-5 | 66 | -.37 | 24 | .71 |

*Note*. 0 = don't know, 1= Not at all, 2 = to a limited extent, 3 = to a moderate extent, 4 = to a large extent, 5 = to a great extent.

*$p < .05$, **$p < .01$, ***$p < .001$

Untrustworthy

| | High Tech Older Adults | | Low Tech Older Adults | | | | | |
|---|---|---|---|---|---|---|---|---|
| Adjective | *Mdn* | *Range* | *Mdn* | *Range* | *U* | *Z* | *n* | *p* |
| Agreeable | 1 | 0-5 | 1 | 0-2 | 56.50 | -1.04 | 24 | .30 |
| Boring | 1 | 0-5 | 1 | 0-5 | 66.50 | -.33 | 24 | .74 |
| Calm | 1 | 0-5 | 1.5 | 0-5 | 48.50 | -1.42 | 24 | .16 |
| Compassionate | 1 | 0-5 | 1 | 0-2 | 67 | -.34 | 24 | .74 |
| Confident | 1 | 0-5 | 1 | 0-5 | 57 | -.91 | 24 | .36 |
| Deceptive | 4.5 | 0-5 | 4 | 0-5 | 60 | -.74 | 24 | .46 |
| Dependent | 1.5 | 0-5 | 1 | 1-5 | 58 | -.91 | 24 | .36 |
| Efficient | 1 | 1-2 | 1 | 1-3 | 71 | -.09 | 24 | .93 |
| Familiar | 1 | 0-3 | 0.5 | 0-3 | 58.50 | -.85 | 24 | .39 |
| Friendly | 1 | 0-5 | 1 | 0-2 | 68.50 | -.23 | 24 | .82 |
| Hostile | 4 | 0-5 | 3 | 0-5 | 70 | -.12 | 24 | .91 |
| Human looking | 0 | 0-2 | 1 | 0-4 | 48 | -1.53 | 24 | .13 |
| Independent | 2 | 0-5 | 1 | 0-5 | 57 | -.90 | 24 | .37 |
| Loud | 0.5 | 0-5 | 2 | 0-5 | 52 | -1.19 | 24 | .23 |
| Loyal | 0.5 | 0-5 | 1 | 0-3 | 42.50 | -1.93 | 24 | .05 |
| Misleading | 4 | 0-5 | 4 | 0-5 | 64 | -.48 | 24 | .63 |
| Non-human looking | 0.5 | 0-2 | 1 | 0-5 | 45.50 | -1.64 | 24 | .10 |
| Phony | 3 | 0-5 | 4 | 0-5 | 52.50 | -1.17 | 24 | .24 |
| Pointless | 4 | 0-5 | 2 | 0-5 | 51 | -1.25 | 24 | .21 |
| Precise | 1 | 1-2 | 1 | 1-5 | 62 | -.77 | 24 | .44 |
| Predictable | 1 | 1-2 | 1 | 0-5 | 70 | -.14 | 24 | .89 |
| Reliable | 1 | 1 | 1 | 1-5 | 60 | -1.45 | 24 | .15 |
| Risky | 5 | 2-5 | 2.5 | 0-5 | 40.50 | -1.92 | 24 | .06 |
| Safe | 1 | 1-2 | 1 | 0-2 | 62 | -.76 | 24 | .45 |
| Sneaky | 4 | 0-5 | 4 | 0-5 | 69.50 | -.15 | 24 | .88 |
| Social | 0 | 3-5 | 1 | 0-3 | 57.50 | -.90 | 24 | .37 |
| Unfeeling | 0.5 | 0-5 | 1 | 0-5 | 71 | -.06 | 24 | .95 |
| Unpredictable | 5 | 3-5 | 3 | 1-5 | 28 | -2.73 | 24 | .006** |
| Unreliable | 5 | 4-5 | 4 | 1-5 | 30 | -2.65 | 24 | .008** |
| Unsocial | 0 | 0-5 | 0 | 0-5 | 71 | -.07 | 24 | .95 |

*Note*. 0 = don't know, 1= Not at all, 2 = to a limited extent, 3 = to a moderate extent, 4 = to a large extent, 5 = to a great extent.

*$p < .05$, **$p < .01$, ***$p < .001$

## APPENDIX BB

## DIFFERENCES IN DISTRIBUTION OF RANKED SCORES FOR TASKS FOR WHICH YOUNGER ADULTS PREFERRED TO TRUST A HUMAN/ROBOT FOR ASSISTANCE COMPARED TO NO PREFERENCE

| Task | *M* | *SD* | *Mdn* | *Range* | *Z* | *n* | *p* |
|---|---|---|---|---|---|---|---|
| ADL | | | | | | | |
| Bathing | 2.67 | .78 | 2.5 | 2-4 | -1.41 | 12 | .16 |
| Reaching for objects | 3.00 | .43 | 3 | 2-4 | 0.00 | 12 | 1 |
| Walking | 2.67 | .78 | 3 | 1-4 | -1.41 | 12 | .16 |
| IADL Cognitive | | | | | | | |
| Deciding what medication to take | 1.50 | .67 | 1 | 1-3 | -3.04 | 12 | <.01** |
| Medication reminding | 3.83 | .39 | 4 | 3-4 | -3.16 | 12 | <.01** |
| Monitoring home/warning about dangers | 3.75 | .45 | 4 | 3-4 | -3.00 | 12 | <.01** |
| IADL Psychomotor | | | | | | | |
| Cleaning the kitchen | 2.75 | .45 | 3 | 2-3 | -1.73 | 12 | .08 |
| Hand washing dishes | 2.33 | .78 | 2.5 | 1-3 | -2.27 | 12 | .02* |
| Opening and closing drawers | 2.83 | .58 | 3 | 1-3 | -1.00 | 12 | .16 |
| EADL | | | | | | | |
| Entertaining | 2.33 | .65 | 2 | 1-3 | -2.53 | 12 | .01* |
| Learning new skills | 1.75 | .87 | 1.5 | 1-3 | -2.76 | 12 | .01* |

*Note.* 1 = Only trust a human, 2 = Trust a human more, 3 = Trust either a human or a robot, 4 = Trust a robot more, 5 = Only trust a robot.

*$p < .05$, **$p < .01$, ***$p < .001$

**DIFFERENCES IN DISTRIBUTION OF RANKED SCORES FOR TASKS FOR WHICH HIGH TECH OLDER ADULTS PREFERRED TO TRUST A HUMAN/ROBOT FOR ASSISTANCE COMPARED TO NO PREFERENCE**

| Task | *M* | *SD* | *Mdn* | *Range* | *Z* | *n* | *p* |
|---|---|---|---|---|---|---|---|
| ADL | | | | | | | |
| Bathing | 2.33 | .78 | 2.5 | 1-3 | -2.27 | 12 | .02* |
| Reaching for objects | 3.17 | .84 | 3 | 2-4 | -.71 | 12 | .48 |
| Walking | 3.42 | .67 | 3 | 3-5 | -1.89 | 12 | .06 |
| IADL Cognitive | | | | | | | |
| Deciding what medication to take | 1.75 | .87 | 1.5 | 1-3 | -2.76 | 12 | <.01** |
| Medication reminding | 3.50 | .67 | 4 | 2-4 | -2.12 | 12 | .03* |
| Monitoring home/warning about dangers | 3.83 | .58 | 4 | 3-5 | -2.89 | 12 | <.01** |
| IADL Psychomotor | | | | | | | |
| Cleaning the kitchen | 2.75 | .62 | 3 | 2-4 | -1.34 | 12 | .18 |
| Hand washing dishes | 2.75 | 1.06 | 3 | 1-5 | -.79 | 12 | .43 |
| Opening and closing drawers | 3.08 | .67 | 3 | 2-5 | -.45 | 12 | .66 |
| EADL | | | | | | | |
| Entertaining | 2.50 | .80 | 2.5 | 1-4 | -1.89 | 12 | .06 |
| Learning new skills | 2.67 | .78 | 2.5 | 2-4 | -1.41 | 12 | .16 |

*Note.* 1 = Only trust a human, 2 = Trust a human more, 3 = Trust either a human or a robot, 4 = Trust a robot more, 5 = Only trust a robot.

*$p < .05$, **$p < .01$, ***$p < .001$

**DIFFERENCES IN DISTRIBUTION OF RANKED SCORES FOR TASKS FOR WHICH LOW TECH OLDER ADULTS PREFERRED TO TRUST A HUMAN/ROBOT FOR ASSISTANCE COMPARED TO NO PREFERENCE**

| Task | *M* | *SD* | *Mdn* | *Range* | *Z* | *n* | *p* |
|---|---|---|---|---|---|---|---|
| ADL | | | | | | | |
| Bathing | 1.75 | 1.06 | 1 | 1-4 | -2.71 | 12 | <.01** |
| Reaching for objects | 2.92 | .90 | 3 | 1-4 | -.33 | 12 | .74 |
| Walking | 2.75 | 1.14 | 3 | 1-4 | -.97 | 12 | .34 |
| IADL Cognitive | | | | | | | |
| Deciding what medication to take | 1.58 | .67 | 1.5 | 1-3 | -3.02 | 12 | <.01** |
| Medication reminding | 3 | .85 | 3 | 1-4 | .00 | 12 | 1 |
| Monitoring home/warning about dangers | 3.50 | 1.17 | 4 | 1-5 | -1.35 | 12 | .18 |
| IADL Psychomotor | | | | | | | |
| Cleaning the kitchen | 2.92 | .90 | 3 | 1-4 | -.33 | 12 | .74 |
| Hand washing dishes | 2.33 | .98 | 2.5 | 1-4 | -1.99 | 12 | .05 |
| Opening and closing drawers | 3.17 | .94 | 3 | 1-4 | -.63 | 12 | .53 |
| EADL | | | | | | | |
| Entertaining | 2.25 | 1.06 | 2.5 | 1-4 | -2.08 | 12 | .04* |
| Learning new skills | 2.25 | .75 | 2 | 1-3 | -2.46 | 12 | .01* |

*Note.* 1 = Only trust a human, 2 = Trust a human more, 3 = Trust either a human or a robot, 4 = Trust a robot more, 5 = Only trust a robot.

*$p < .05$, **$p < .01$, ***$p < .001$

## APPENDIX CC

## DIFFERENCES IN DISTRIBUTION OF RANKED SCORES FOR TRUST IN ASSISTANCE BETWEEN YOUNGER AND HIGH TECH OLDER ADULTS

| | Younger Adults | | High Tech Older Adults | | | | |
|---|---|---|---|---|---|---|---|
| Task | *Mdn* | *Range* | *Mdn* | *Range* | *U* | *n* | *p* |
| ADL | | | | | | | |
| Bathing | 2.5 | 2-4 | 2.5 | 1-3 | 60 | 24 | .45 |
| Reaching for objects | 3 | 2-4 | 3 | 2-4 | 66 | 24 | .67 |
| Walking | 3 | 1-4 | 3 | 3-5 | 37.5 | 24 | .02* |
| IADL Cognitive | | | | | | | |
| Deciding what medication to take | 1 | 1-3 | 1.5 | 1-3 | 61.5 | 24 | .50 |
| Medication reminding | 4 | 3-4 | 4 | 2-4 | 53 | 24 | .17 |
| Monitoring home/warning about dangers | 2 | 3-4 | 4 | 3-5 | 67.5 | 24 | .74 |
| IADL Psychomotor | | | | | | | |
| Cleaning the kitchen | 3 | 2-3 | 3 | 2-4 | 70.5 | 24 | .92 |
| Hand washing dishes | 2.5 | 1-3 | 3 | 1-5 | 58 | 24 | .39 |
| Opening and closing drawers | 3 | 1-3 | 3 | 2-5 | 66 | 24 | .55 |
| EADL | | | | | | | |
| Entertaining | 2 | 1-3 | 2.5 | 1-4 | 64 | 24 | .61 |
| Learning new skills | 1.5 | 1-3 | 2.5 | 2-4 | 33 | 24 | .02* |

*Note.* 1 = Only trust a human, 2 = Trust a human more, 3 = Trust either a human or a robot, 4 = Trust a robot more, 5 = Only trust a robot.

*$p < .05$, **$p < .01$, ***$p < .001$

**DIFFERENCES IN DISTRIBUTION OF RANKED SCORES FOR TRUST IN ASSISTANCE BETWEEN HIGH AND LOW TECH OLDER ADULTS**

| | High Tech Older Adults | | Low Tech Older Adults | | | | |
|---|---|---|---|---|---|---|---|
| Task | *Mdn* | *Range* | *Mdn* | *Range* | *U* | *n* | *p* |
| ADL | | | | | | | |
| Bathing | 2.5 | 1-3 | 1 | 1-4 | 45 | 24 | .10 |
| Reaching for objects | 3 | 2-4 | 3 | 1-4 | 65 | 24 | .66 |
| Walking | 3 | 3-5 | 3 | 1-4 | 52.5 | 24 | .20 |
| IADL Cognitive | | | | | | | |
| Deciding what medication to take | 1.5 | 1-3 | 1.5 | 1-3 | 66 | 24 | .71 |
| Medication reminding | 4 | 2-4 | 3 | 1-4 | 47 | 24 | .11 |
| Monitoring home/warning about dangers | 4 | 3-5 | 4 | 1-5 | 62.5 | 24 | .55 |
| IADL Psychomotor | | | | | | | |
| Cleaning the kitchen | 3 | 2-4 | 3 | 1-4 | 60.5 | 24 | .46 |
| Hand washing dishes | 3 | 1-5 | 2.5 | 1-4 | 58.5 | 24 | .41 |
| Opening and closing drawers | 3 | 2-5 | 3 | 1-4 | 58.5 | 24 | .37 |
| EADL | | | | | | | |
| Entertaining | 2.5 | 1-4 | 2.5 | 1-4 | 63 | 24 | .58 |
| Learning new skills | 2.5 | 2-4 | 2 | 1-3 | 55 | 24 | .29 |

*Note.* 1 = Only trust a human, 2 = Trust a human more, 3 = Trust either a human or a robot, 4 = Trust a robot more, 5 = Only trust a robot.

*$p < .05$, **$p < .01$, ***$p < .001$

## APPENDIX DD

## DIFFERENCES IN DISTRIBUTION OF RANKED SCORES FOR RATINGS BETWEEN YOUNGER AND HIGH TECH OLDER ADULTS FOR TRUST FOR TASKS

| | Younger Adults | | High Tech Older Adults | | | | |
|---|---|---|---|---|---|---|---|
| Task | *Mdn* | *Range* | *Mdn* | *Range* | *U* | *n* | *p* |
| ADL | | | | | | | |
| Bathing | 2.5 | 1-5 | 4 | 1-4 | 45.5 | 24 | .11 |
| Reaching for objects | 4.5 | 4-5 | 5 | 2-5 | 72 | 24 | 1 |
| Walking | 4 | 2-5 | 5 | 3-5 | 47.5 | 24 | .13 |
| IADL Cognitive | | | | | | | |
| Deciding what medication to take | 2 | 1-4 | 2 | 1-5 | 60.5 | 24 | .48 |
| Medication reminding | 4.5 | 4-5 | 4 | 1-5 | 63 | 24 | .56 |
| Monitoring home/warning about dangers | 4 | 4-5 | 5 | 4-5 | 30 | 24 | .01* |
| IADL Psychomotor | | | | | | | |
| Cleaning the kitchen | 4 | 3-5 | 4.5 | 2-5 | 71 | 24 | .95 |
| Hand washing dishes | 4 | 2-4 | 3 | 1-5 | 63 | 24 | .59 |
| Opening and closing drawers | 5 | 4-5 | 4.5 | 4-5 | 66 | 24 | .76 |
| EADL | | | | | | | |
| Entertaining | 4 | 2-5 | 4 | 1-5 | 71 | 24 | .95 |
| Learning new skills | 4 | 3-5 | 4 | 3-5 | 45 | 24 | .09 |
| Getting information on the weather or news | 5 | 4-5 | 4 | 4-5 | 54 | 24 | .23 |
| Total Across Tasks | 4 | 1-5 | 4 | 1-5 | 63 | 24 | .55 |

*Note.* 1 = Strongly disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, 5 = Strongly agree.
* $p < .05$

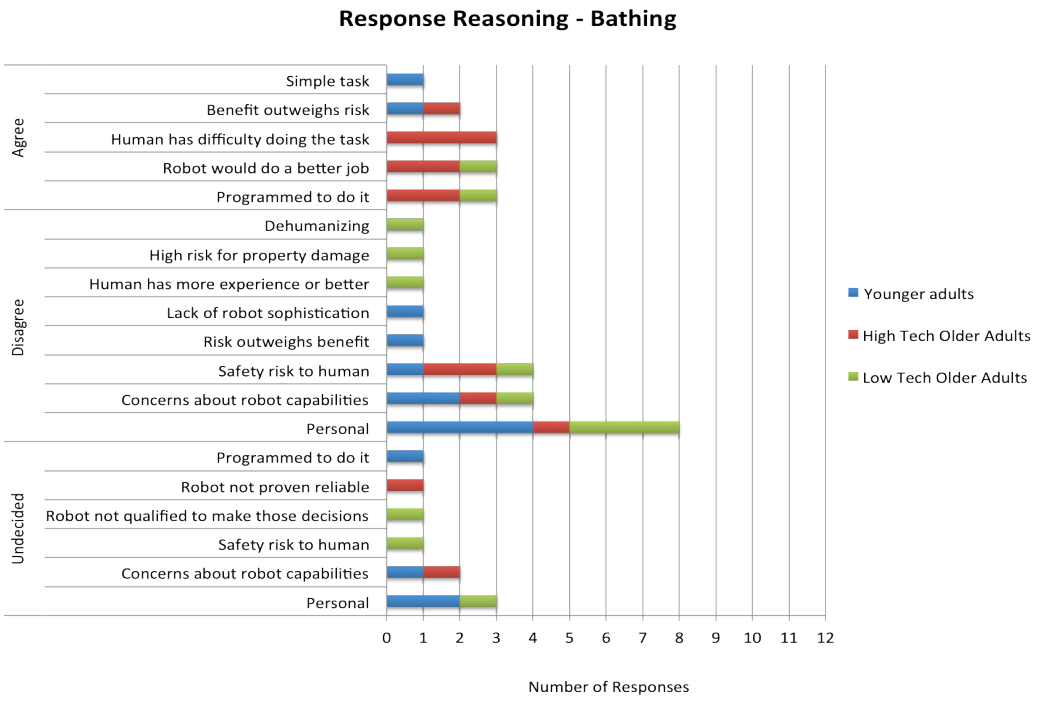
**DIFFERENCES IN DISTRIBUTION OF RANKED SCORES FOR RATINGS BETWEEN HIGH AND LOW TECH OLDER ADULTS FOR TRUST FOR TASKS**

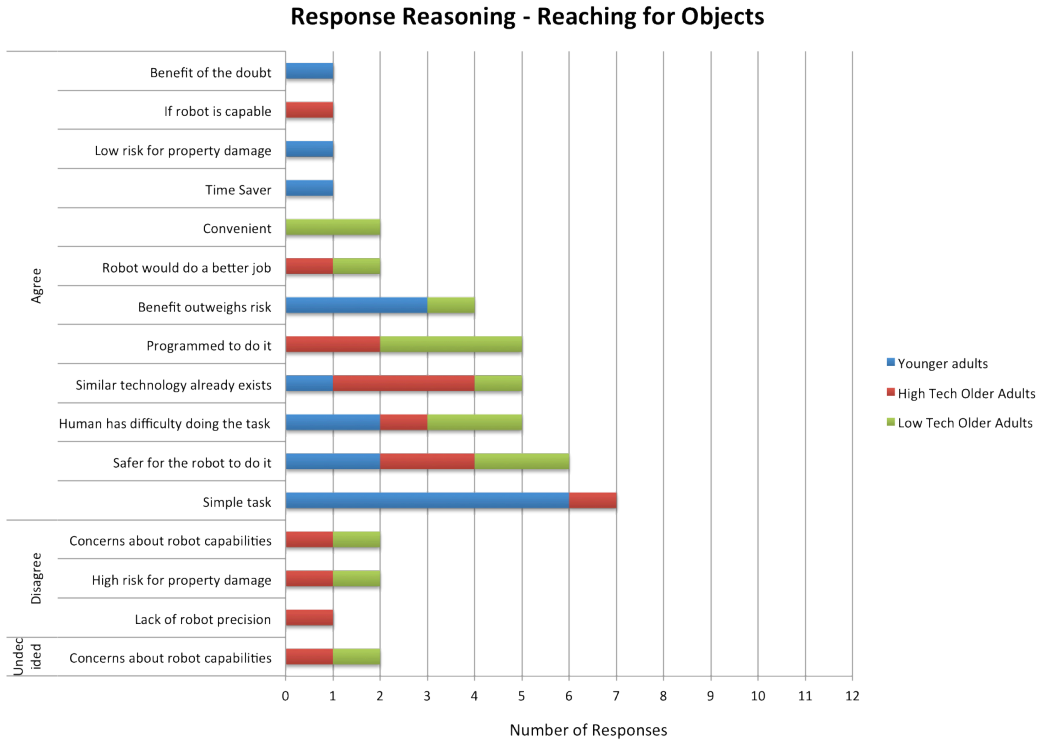
| | High Tech Older Adults | | Low Tech Older Adults | | | | |
|---|---|---|---|---|---|---|---|
| Task | *Mdn* | *Range* | *Mdn* | *Range* | *U* | *n* | *p* |
| ADL | | | | | | | |
| Bathing | 4 | 1-4 | 2.5 | 1-5 | 55 | 24 | .31 |
| Reaching for objects | 5 | 2-5 | 4 | 1-5 | 53.5 | 24 | .25 |
| Walking | 5 | 3-5 | 4 | 1-5 | 50 | 24 | .17 |
| IADL Cognitive | | | | | | | |
| Deciding what medication to take | 2 | 1-5 | 2 | 1-3 | 69.5 | 24 | .88 |
| Medication reminding | 4 | 1-5 | 5 | 2-5 | 60.5 | 24 | 46 |
| Monitoring home/warning about dangers | 5 | 4-5 | 4 | 1-5 | 32 | 24 | .01* |
| IADL Psychomotor | | | | | | | |
| Cleaning the kitchen | 4.5 | 2-5 | 4 | 1-5 | 62 | 24 | .53 |
| Hand washing dishes | 3 | 1-5 | 2.5 | 1-5 | 62.5 | 24 | .58 |
| Opening and closing drawers | 4.5 | 4-5 | 4 | 3-5 | 54 | 24 | .25 |
| EADL | | | | | | | |
| Entertaining | 4 | 1-5 | 4 | 1-5 | 52 | 24 | .22 |
| Learning new skills | 4 | 3-5 | 4 | 2-5 | 49 | 24 | .16 |
| Getting information on the weather or news | 4 | 4-5 | 4 | 1-5 | 36.50 | 24 | .03* |
| Total Across Tasks | 4 | 1-5 | 4 | 1-5 | 48.50 | 24 | .14 |

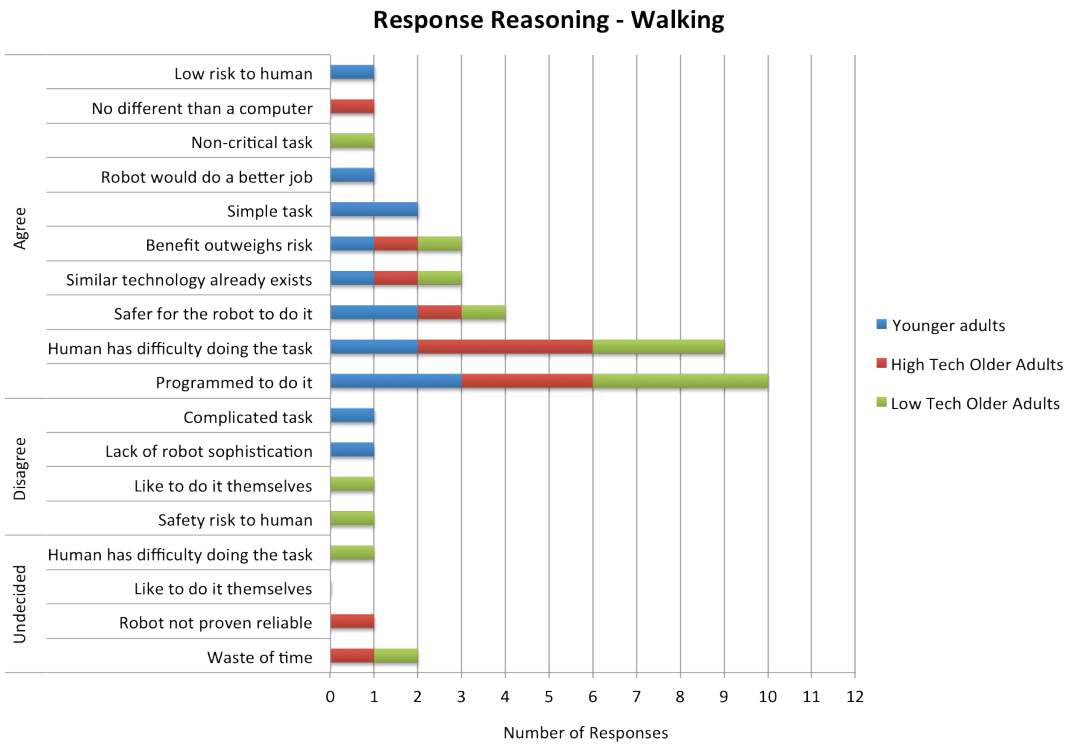
*Note.* 1 = Strongly disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, 5 = Strongly agree.
* $p < .05$

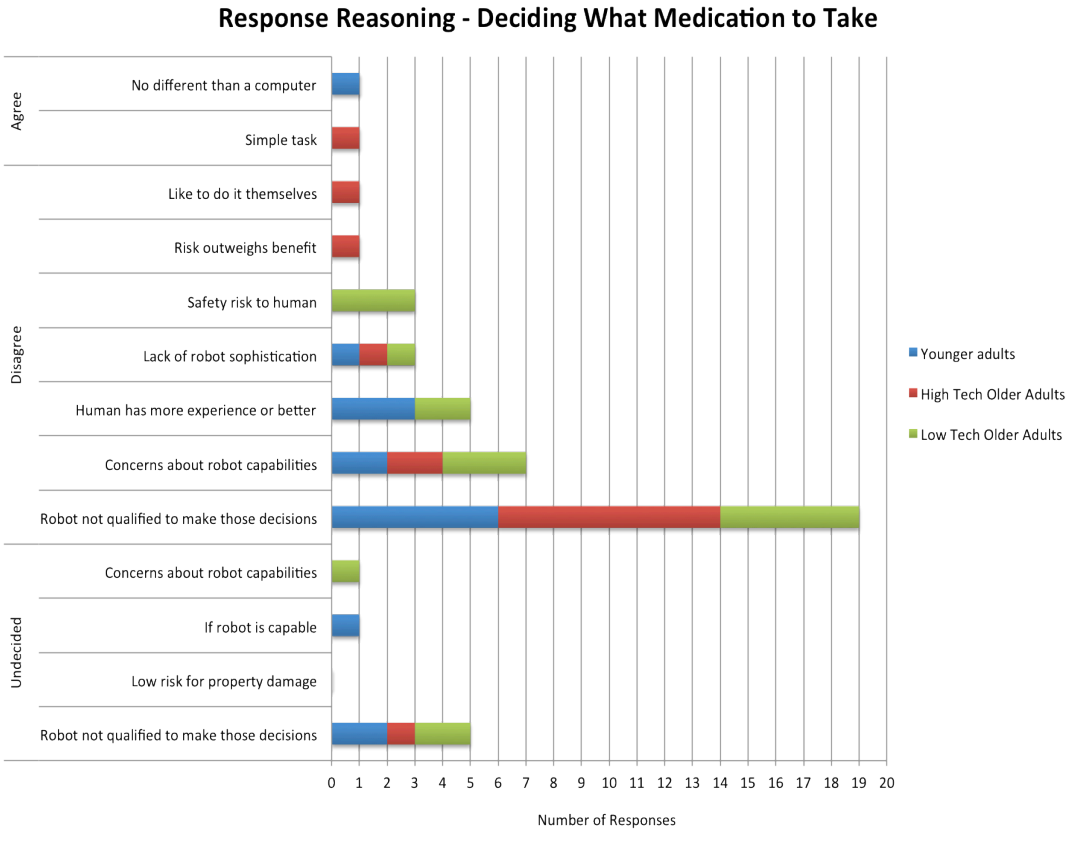
# APPENDIX EE

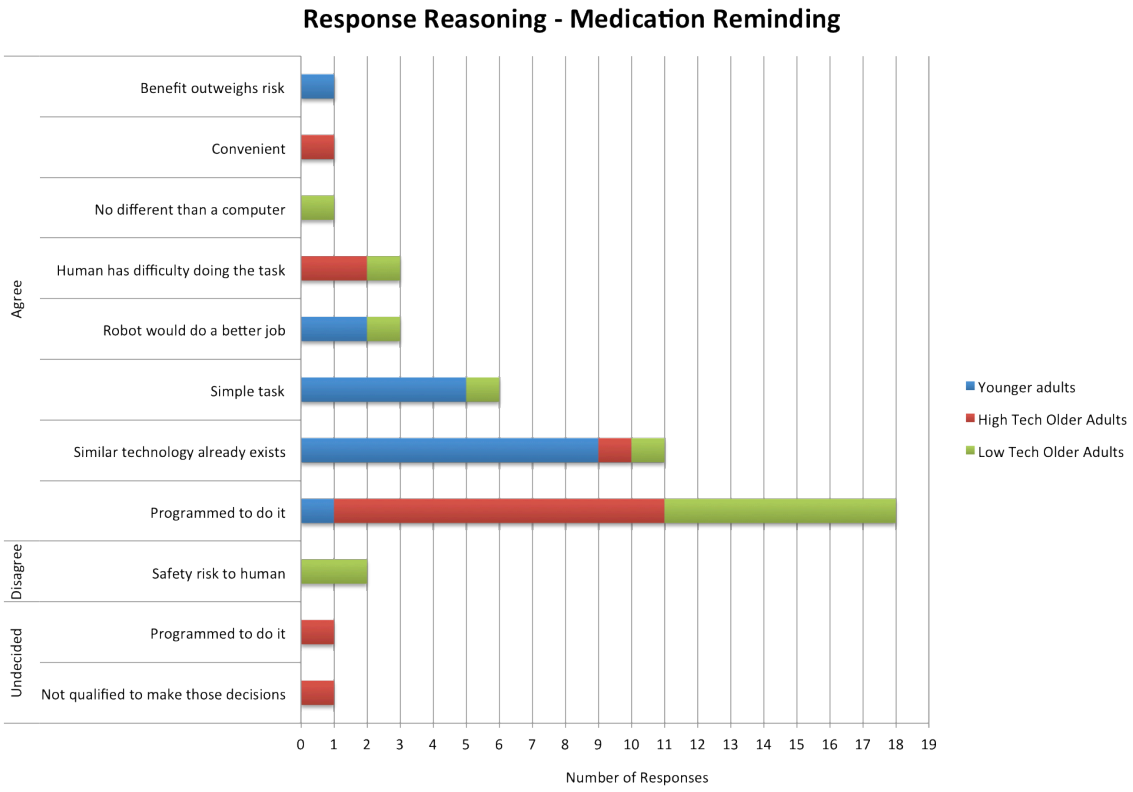
# RESPONSE REASONINGS FOR TRUST IN TASKS INTERVIEWS

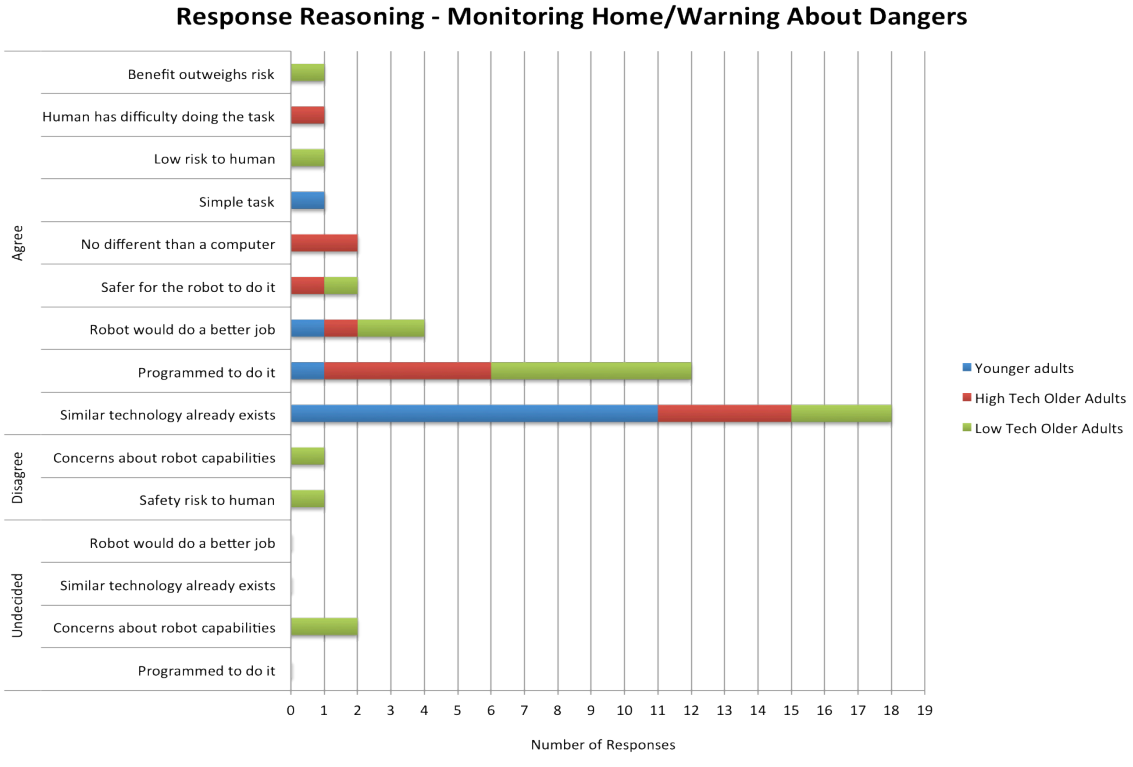


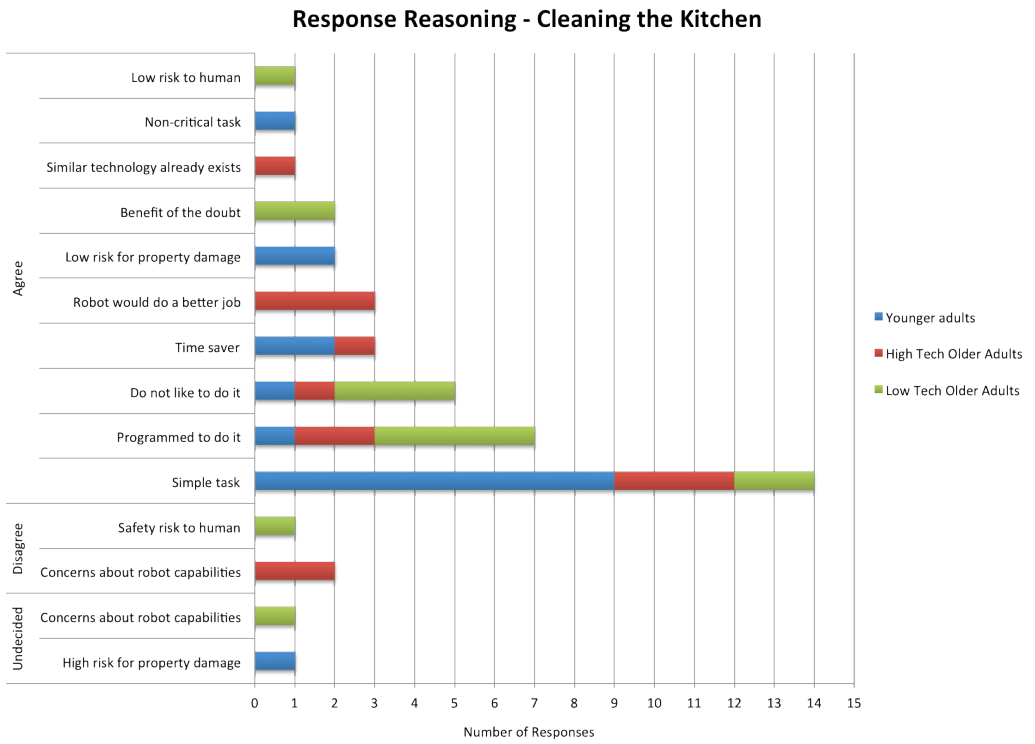



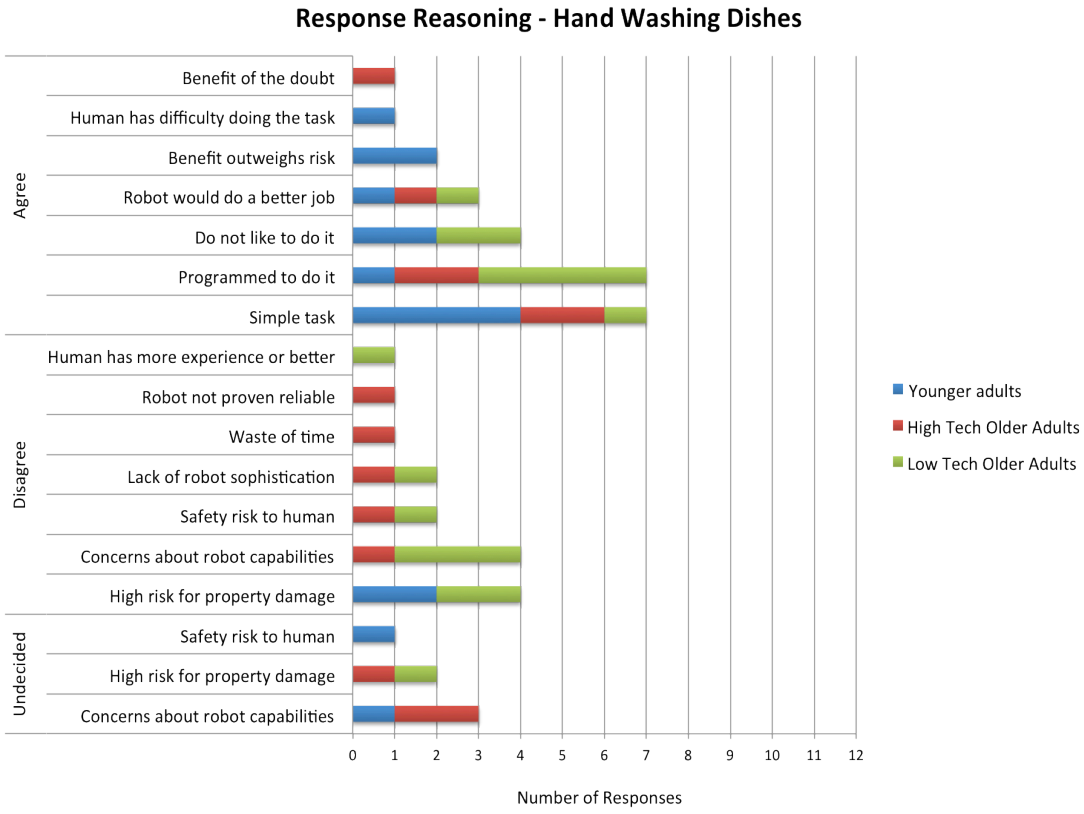

Response Reasoning - Walking
Agree
Low risk to human
No different than a computer
Non-critical task
Robot would do a better job
Simple task
Benefit outweighs risk
Similar technology already exists
Safer for the robot to do it
Human has difficulty doing the task
Programmed to do it
Disagree
Complicated task
Lack of robot sophistication
Like to do it themselves
Safety risk to human
Undecided
Human has difficulty doing the task
Like to do it themselves
Robot not proven reliable
Waste of time
0 1 2 3 4 5 6 7 8 9 10 11 12
Number of Responses
Younger adults
High Tech Older Adults
Low Tech Older Adults

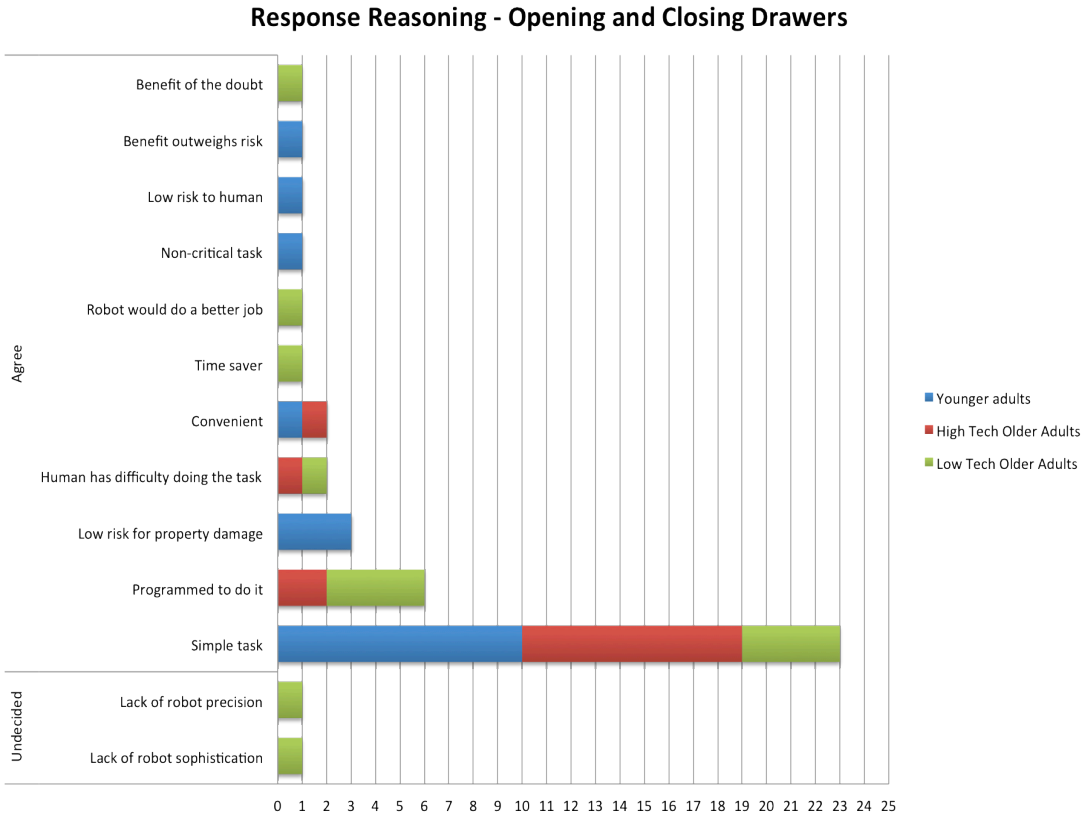

Response Reasoning - Deciding What Medication to Take
Agree
No different than a computer
Simple task
Disagree
Like to do it themselves
Risk outweighs benefit
Safety risk to human
Lack of robot sophistication
Human has more experience or better
Concerns about robot capabilities
Robot not qualified to make those decisions
Undecided
Concerns about robot capabilities
If robot is capable
Low risk for property damage
Robot not qualified to make those decisions
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Number of Responses
Younger adults
High Tech Older Adults
Low Tech Older Adults

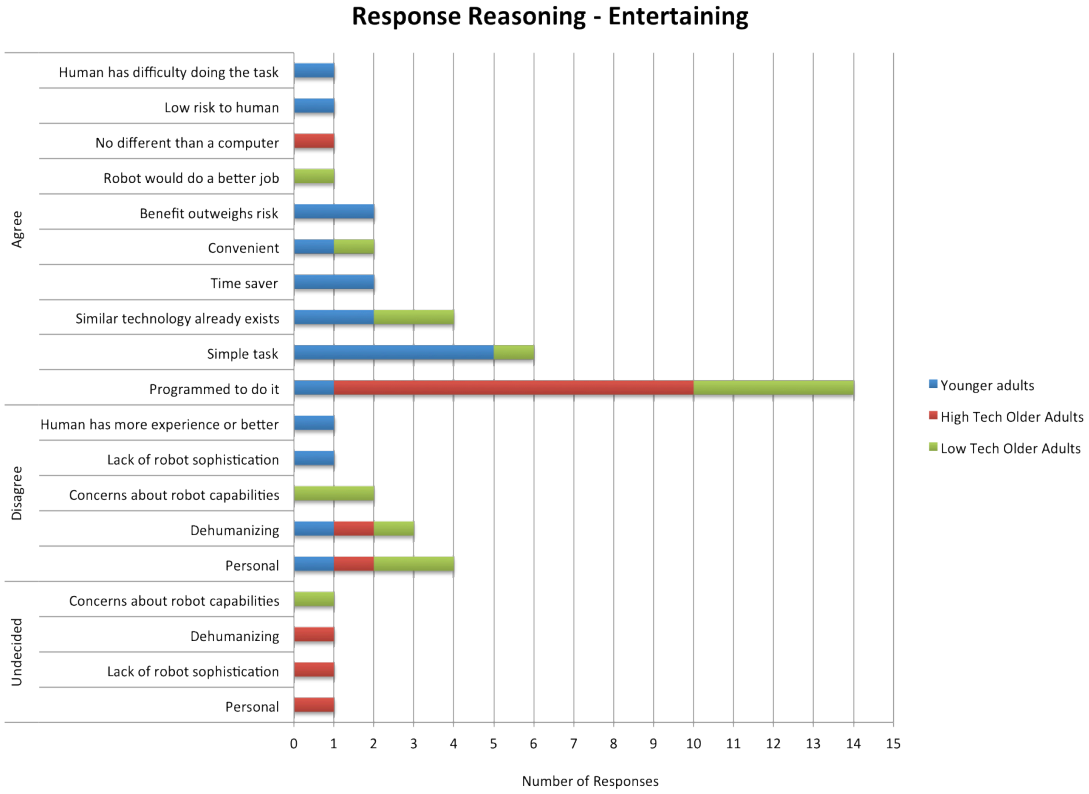

Response Reasoning - Medication Reminding
Agree
Benefit outweighs risk
Convenient
No different than a computer
Human has difficulty doing the task
Robot would do a better job
Simple task
Similar technology already exists
Programmed to do it
Disagree
Safety risk to human
Undecided
Programmed to do it
Not qualified to make those decisions
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Number of Responses
Younger adults
High Tech Older Adults
Low Tech Older Adults


Response Reasoning - Monitoring Home/Warning About Dangers
Agree
Benefit outweighs risk
Human has difficulty doing the task
Low risk to human
Simple task
No different than a computer
Safer for the robot to do it
Robot would do a better job
Programmed to do it
Similar technology already exists
Disagree
Concerns about robot capabilities
Safety risk to human
Undecided
Robot would do a better job
Similar technology already exists
Concerns about robot capabilities
Programmed to do it
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Number of Responses
Younger adults
High Tech Older Adults
Low Tech Older Adults

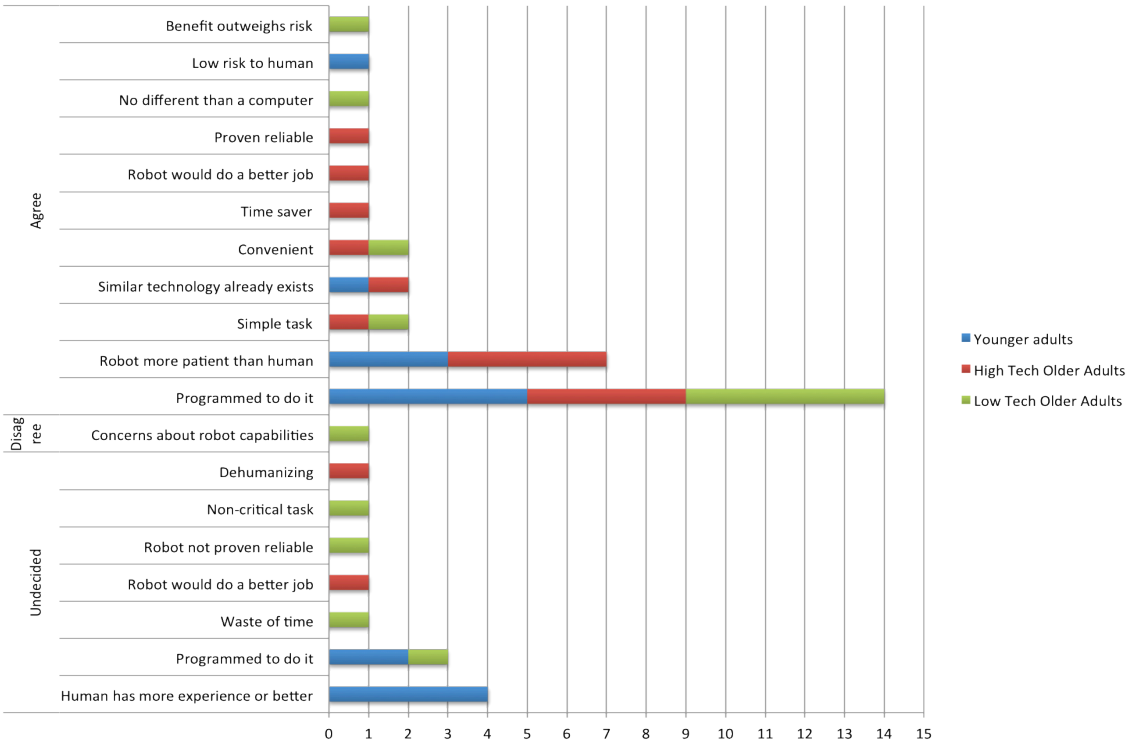

Response Reasoning - Cleaning the Kitchen
Agree
Disagree
Undecided
Low risk to human
Non-critical task
Similar technology already exists
Benefit of the doubt
Low risk for property damage
Robot would do a better job
Time saver
Do not like to do it
Programmed to do it
Simple task
Safety risk to human
Concerns about robot capabilities
Concerns about robot capabilities
High risk for property damage
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Number of Responses
Younger adults
High Tech Older Adults
Low Tech Older Adults


Response Reasoning - Hand Washing Dishes
Agree
Disagree
Undecided
Benefit of the doubt
Human has difficulty doing the task
Benefit outweighs risk
Robot would do a better job
Do not like to do it
Programmed to do it
Simple task
Human has more experience or better
Robot not proven reliable
Waste of time
Lack of robot sophistication
Safety risk to human
Concerns about robot capabilities
High risk for property damage
Safety risk to human
High risk for property damage
Concerns about robot capabilities
0 1 2 3 4 5 6 7 8 9 10 11 12
Number of Responses
Younger adults
High Tech Older Adults
Low Tech Older Adults

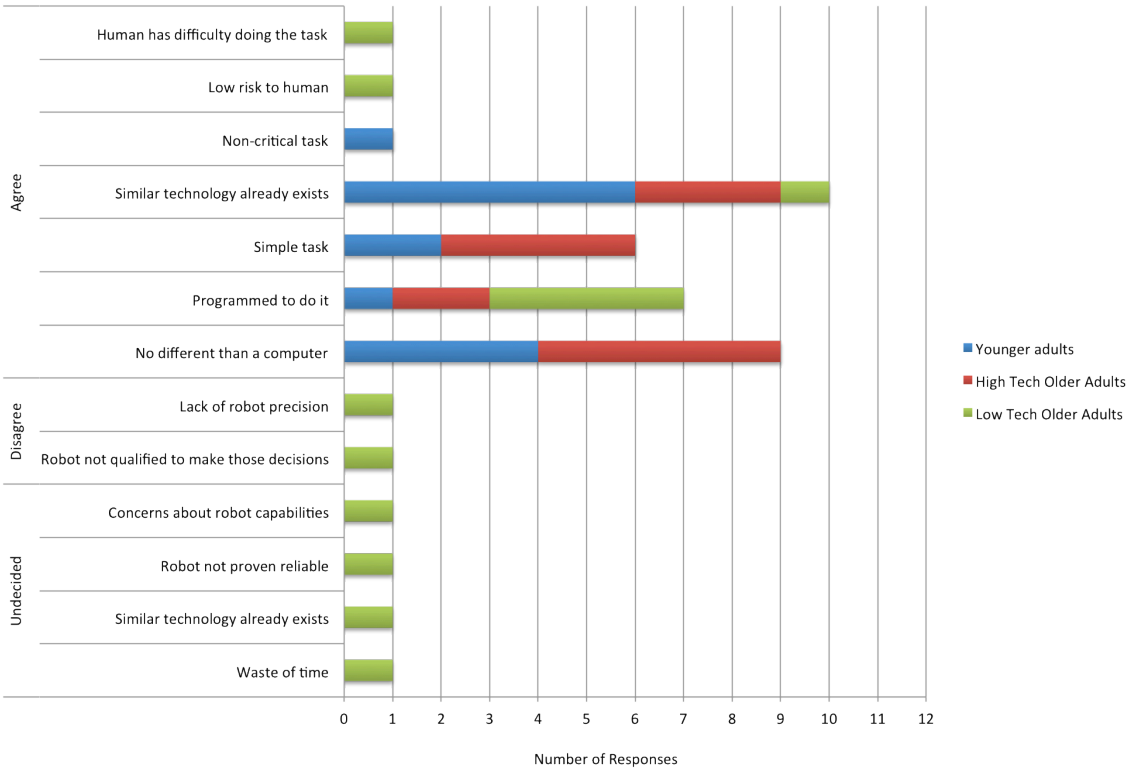

Response Reasoning - Opening and Closing Drawers
Agree
Benefit of the doubt
Benefit outweighs risk
Low risk to human
Non-critical task
Robot would do a better job
Time saver
Convenient
Human has difficulty doing the task
Low risk for property damage
Programmed to do it
Simple task
Undecided
Lack of robot precision
Lack of robot sophistication
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Younger adults
High Tech Older Adults
Low Tech Older Adults


Response Reasoning - Entertaining
Agree
Human has difficulty doing the task
Low risk to human
No different than a computer
Robot would do a better job
Benefit outweighs risk
Convenient
Time saver
Similar technology already exists
Simple task
Programmed to do it
Disagree
Human has more experience or better
Lack of robot sophistication
Concerns about robot capabilities
Dehumanizing
Personal
Undecided
Concerns about robot capabilities
Dehumanizing
Lack of robot sophistication
Personal
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Number of Responses
Younger adults
High Tech Older Adults
Low Tech Older Adults

## Response Reasoning - Learning New Skills




## Response Reasoning - Getting Information on the Weather/News



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