What are European Union Public Attitudes towards Robots?

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ABSTRACT

This paper presents a very brief overview of public attitudes towards robots from different geographical regions of the world but focuses on one such study in one particular geographic area, the European Union (EU) of 27 countries. By far, the Eurobarameter Survey on Public Attitudes towards Robots, released online in 2012, is the largest study of public attitudes towards robots. It focused exclusively on descriptive statistics which are mathematical procedures used to organize, summarize and simplify data. The statistical procedures used in this paper to perform a secondary data analysis of the data from the Eurobarameter Survey on Attitudes towards robots focused on inferential statistics which focus on inference and statistical comparisons. Secondary data analyses are often used when large data sets are posted online for public, professional, and educational use. A one-way repeated-measures analysis of variance (ANOVA), and separate two-way independent-measures analysis of variance (ANOVA) were used to analyze participant responses on relevant survey questions. The results supported our hypotheses that there are significant differences in EU public attitudes by gender and age group.

Keywords: Gamification, Educational Technology, Serious Games, Sensation Seeking, Statistical Significance

1. INTRODUCTION

People around the world have different attitudes towards robots that are based on personal experiences, on what is covered in the media, on their country's economic and technical development, on their country's national funding priorities and on the historical and religious context of their country's culture [1]. Although public attitudes towards robots have not been studied in all geographical regions of the world, they have been studied in many. The largest study to date both in the number of participants and in number of countries participating has been the European Union's 2012 Eurobarameter Survey on Public Attitudes towards Robots [2]. Other countries which have examined attitudes towards robots include Japan [1], the United States [3], the United Kingdom (UK) [4] , Canada [5], France [6], the Middle East [7], Taiwan [8,] South Korea [9], Australia [10], New Zealand [11], Sweden [12] the Netherlands [13], Ireland [14], Malaysia [15], Mexico [16] and, China [17].

2. LITERATURE REVIEW

Japan has more robots than any other country [1]. It also has the highest percentage of industrial robots in the world [18]. The first modern Japanese robot, Gakutensoku, was created in 1927 and could smile, flutter his eyes, and write [19]. Japan's relationship with robots can be traced back to the 12th century writer Konjaku Monogatari who described a mechanical doll that could automatically pour water into paddy fields during dry periods of the year [19]. Japanese affection for all things robotic contrasts sharply with the West's fear of automatons [20]. Kitano [18] suggested that Westerners are slightly uncomfortable with humanoid robots while the Japanese display no such inhibitions. Known as the "Robot Kingdom,"Japan has a government-backed plan to create new markets for the RT (Robot-Technology) Industry [21]. By 2025, the Ministry of Economy, Trade and Industry of Japan (METI) estimates that the robot industry could become as large as a 6.2 trillion yen market [21].

Many studies have focused on negative attitudes towards robots [4], [22], [23], [24], [25]. Some studies have focused on gender differences in attitudes towards robots [3], [5], [26], [27]. Schermerhorn, Scheutz, and Crowell [26] reported findings indicating that males tend to think of robots as more human-like while females saw the robot as more machine-like. Also, males demonstrated more socially desirable responding than females to the robot's survey [26]. Kuo, Rabindran, Broadbent, Lee, Kerse, Stafford and MacDonald found that males had a more positive attitude towards robots in health care [27]. Other studies have focused on age- group attitudes towards robots [28], [29], [30]. Dinet and Robin reported age group differences in their study [28]. Younger respondents (children) rated significantly more positive attitudes towards robots than other age groups (teenagers, young adults, and seniors) [28]. Still, other studies have focused on cross-cultural attitudes towards robots [6], [31], [32], [33]. Bartneck, Nomura, Kanda, Suzuki, and Kato administered the Negative Attitudes towards Robots Scale (NARS) to Dutch, Chinese, German, Mexican American, and Japanese participants and reported that American participants were least negative towards robots, while the Mexican participants were most negative [31]. The authors also reported that, against expectations, Japanese participants did not have a particularly positive attitude towards robots [31]. Wang, Pei-Luen, Evers, Robinson, and Hinds found that participants with a Chinese versus a U.S. cultural background changed their decisions more when collaborating with robots that communicated implicitly versus explicitly [32]. They also found that Chinese participants were more negative in their attitude towards robots and relied less on the robot's advice [32].

The Eurobarameter Survey on Public Attitudes towards robots was completed in 2012 and published online in 2012. It contained responses and descriptive statistics on more than

25,000 participants from the 27 countries comprising the European Union (EU). Descriptive statistics were used to organize, summarize and simplify data. Examples of descriptive statistics include tables, percentages, bar graphs, and pie charts. The target ages of participants were from age 15 and up. The total number of questions on the survey was nine but items 5 and 8 were subdivided into five and four questions respectively [2]. According to the Eurobarameter Survey on Public Attitudes towards Robots, more than two-thirds (70%) of EU citizens have a positive view of robots [34]. However, there is widespread concern that robots could steal people's jobs [21]. The Eurobarameter Survey on Public Attitudes towards Robots indicated a North-South divide in attitudes towards robots with EU citizens in northern countries expressing far more positive views than those in southern countries [34].

The key descriptive statistical findings of the Eurobarameter Survey on Public Attitudes towards Robots are indicated in the Executive Summary of the survey report [2] and are presented briefly below: (1) a quarter of EU citizens are 'very interested' in scientific discoveries and technological developments and half are moderately interested; (2) the image that EU citizens have of a robot is more likely to be that of an instrument-like machine than that of a human-like machine; (3) Few EU citizens have experience using robots; (4) The majority of EU citizens has a positive view of robots; (5) EU citizens have well-defined specific attitudes about robots. They express the utilitarian view that while robots can be useful they can also steal people's jobs and require careful management; (6) EU citizens have well-defined views about the application areas for robots and the areas in which the use of robots should be banned; (7) EU participants identified space exploration and manufacturing for widespread use of robots. They reported widespread opposition when it comes to the care of people and education; (8) EU citizens are relatively comfortable with the idea of a robot assisting them at work but totally uncomfortable with the idea of a robot caring for children or elderly parents; and (10) EU citizens do not expect robots to do housework in the near future.

Although the Eurobarameter Survey by the European Union on Public Attitudes toward Robots is the most extensive study by country on public attitudes towards robots, the response data presented in that study and the report generated on it have focused on only descriptive statistics (which organize, summarize and simplify data) and not on inferential statistics (which use inference and make statistical comparisons). This paper, therefore, will focus mainly on inferential statistical analysis of some of the relevant survey responses. The European Union released the data set online in 2012 and it is currently posted on the study's website [2].

3. RESEARCH METHOD

Participants

The total number of individuals participating in the study was 26,751 (45.9% male and 54.1% female), as shown in Figure 1. The sample was a convenience sample and not a probability sample.

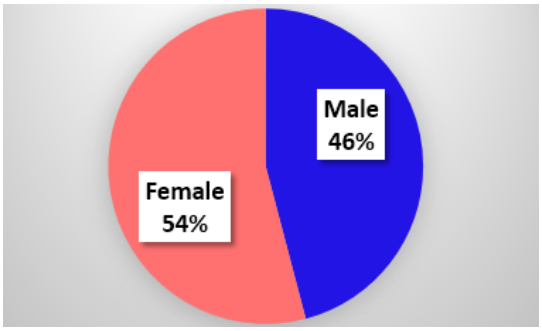

Figure 1- Participants' gender classification.

The age groups of the participants are displayed below in Table 1 and Figure 2. The percentage of participants from each of the 27 EU countries raged from 3.7 % to 3.9% except for Luxembourg, East Germany, West Germany, Cyprus, and Poland where the percentage was 1.9%. Finally, Northern Ireland was the country with the smallest percentage of participants at 1.2%. The sample did not appear to be stratified by age group within each country.

Table 1. Frequency and Percentage of Participants by Age Group

Age Group	Frequency	Percentage
15-24	*2980*	*11.1*
25-34	*3845*	*14.4*
35-44	*4494*	*16.8*
45-54	*4797*	*17.9*
55-64	*4589*	*17.2*
65+	*6046*	*22.6*
Total	26751	100

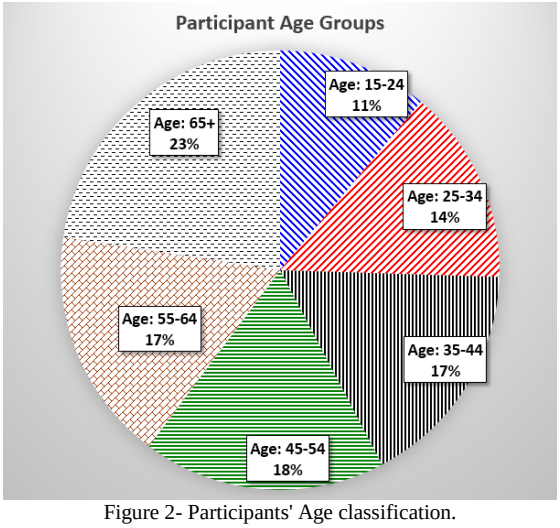

Figure 2- Participants' Age classification.

Participants

There were nine Eurobarameter Public Attitudes towards Robots Survey Questions with multiple items on questions 5 and 8. These questions are summarized below in Table 2. The purpose of the study was to gauge public opinion

towards robots by measuring public perceptions, acceptance levels, worries, and reservations among EU citizens aged 15 and over in the 27 member states [7]. The survey was carried out by TNS Opinion & Social Network between 25 February and March 2012. I recoded (changed) the Likert scale on all of the original survey questions except Questions 3, 6, and 7 (excluded from the analysis) to facilitate quantitative inferential statistical analysis and to exclude don't know (DK), not applicable (NA) or other vague answers.

Table 2. Eurobaraneter Survey Questions

No.	**Question Text**	**Question Scale**
Q 1	Please tell me whether you are interested, moderately interested, or not at all interested in scientific discoveries and technological developments	Likert Scale recoded: 1 (Not at all interested) to 3 (very interested)
Q 2	I'm going to show you two pictures. For each of them, please tell me to what extent it Corresponds with the idea you have of robots.*	Likert Scale recoded: 1 (Very badly) to 4 (Very well) for each picture
Q 3	Have you ever used, or are you currently using such robots at home or at work (e.g. a robotic vacuum cleaner at home or an industrial robot at work)?	Excluded: Since only 12% of EU participants had used robots at home or at work this result was not analyzed with inferential statistics
Q 4	Generally speaking, do you have a very positive, fairly positive, fairly negative or very negative view of robots?	Likert Scale recoded: 1 (Very negative) to 5 (Very positive)
Q 5	Please tell me to what extent you agree or disagree with each of the following statements about robots.	
Q 5.1	Robots are a good thing for Society because they help people	Likert Scale recoded: 1 (Totally disagree) to 5 (Totally agree)
Q 5.2	Robots steal people's jobs	
Q 5.3	Robots are necessary as they can do jobs that are too hard or too dangerous for people	
Q 5.4	Robots are a form of technology that requires careful management	
Q 5.5	Widespread use of robots can boost job opportunities in the European Union	
Q 6	In which areas do you think that robots should be used as a priority? (Max. 3 answers)	Excluded: Participants chose 3 of 14 word answers which precluded quantitative analysis.
Q 7	And on the other hand, in which areas do you think that the use of robots should be banned? (Max. 2 answers)	Excluded: Participants chose 3 of 14 word answers which precluded quantitative analysis.
Q 8	Here is a list that could be done by robots. For each of them, please tell me using a scale from 1 to 10 how you would personally feel about it. On this scale, '1' means that you would feel "totally uncomfortable" and '10' means that you would feel 'totally comfortable" with the situation	
Q 8.1	Having a medical operation performed on you by a robot	Likert Scale recoded: 1 (Totally uncomfortable) to 10 (Totally Comfortable)
Q 8.2	Having your dog walked by a robot	
Q 8.3	Having a robot assist you at work (e.g., in manufacturing)	
Q 8.4	Having your children or elderly parents minded by a robot	
Q 9	In your opinion, in Europe, when will it become commonplace for robots to do house work?	Likert Scale recode: 1 (in 5 years' time) to 4 (more than 20 years' time)

****: In survey question 2 (Q 2) above, a robot was defined as an autonomous, mobile machine which can assist humans in everyday tasks e.g. as a kind of co-worker helping on the factory floor or as a robot cleaner, or in activities which may be dangerous for humans, like search and rescue disasters. Robots can come in many shapes and sizes, including human-like. Traditional kitchen appliances, such as a blender or a coffee maker, are not robots.***

Procedures

The Eurobarameter Public Survey of Attitudes towards Robots was individually administered at home in a face-to-face interview with participants in their native language. The survey was carried out by TNS Opinion & Social Network between 25 February and March 2012.

Research Design

The research design of The Eurobarameter Public Survey of Attitudes towards Robots was survey methodology.

Research Hypotheses

There were no formal research hypotheses generated by the designers of the Eurobarameter Public Survey of Attitudes towards Robots. However, for the secondary inferential

statistical analysis by the authors of this paper, the research hypotheses were as follows.

Hypotheses	
H 1:	There will be significant differences by gender and age group on question 1 of the survey.
H 2:	There will be a significant difference in which picture of two robots EU participants choose as corresponding with the idea they have as of robots on question 2 of the survey.
H 3:	There will be significant differences by gender and age group on question 4 of the survey.
H 4:	There will be significant differences by gender and age group on each of the five questions comprising question 5 of the survey.
H 5:	There will be significant differences by gender and age group on each of the four questions comprising question 8 of the survey.
H 6:	There will be significant differences by gender and age group on question 9 of the survey.

Statistical Analyses

The statistical analyses utilized in our secondary statistical analysis of the Eurobarameter Public Survey towards Robots were a one-way repeated-measures analysis of variance (ANOVA), separate two-way independent-measures analyses of Variance (ANOVAs), and one two-way independent-measures multivariate analysis of variance (MANOVA).

4. RESULTS

Survey Question 1

On survey question 1 a two-way analysis of variance (ANOVA) was used to determine significant differences by gender and age group and there were statistically significant difference by gender, $F (1, 25474.805) = 1122.95$, $p < .001$, $\omega^2 = .041$, and age group, $F (5, 25450.850) = 124.38$, $p < .001$, $\omega^2 = .022$. There was no statistically significant interaction between gender and age group, $F (5, 26568) = 1.26$, $p = .28$. The Brown-Forsythe F was used to determine significant differences by gender and age group as the homogeneity of variance assumption was violated. Male participants scored significantly higher (M = 2.16, SD =.68) indicating greater interest than female participants (M = 1.88, SD = .65) on survey question 1 Please tell me whether you are very interested, moderately interested, or not at all interested in scientific discoveries and technological developments. The 15-24 age group scored significantly higher (M = 2.13, SD = .65) than the 45-54 age group (M = 2.03 SD = .66), the 55-64 age group (M = 1.98, SD = .68), and the 65+ age group (M = 1.84, SD = .72) on survey question 1 Please tell me whether you are very interested, moderately interested, or not at all interested in scientific discoveries and technological developments. The 25-34 age group score significantly higher (M = 2.08, SD = .66) than the 45-54 age group (M = 2.03, SD = .66), the 55-64 age group (M = 1.98, SD = .68), and the 65+ age group (M = 1.84, SD = .72) on survey question 1 Please tell me whether you are very interested, moderately interested, or not at all interested in scientific discoveries and technological developments. The 35-44 age group scored significantly higher (M = 2.09, SD =.64) than the 45-54 age group (M = 2.03, SD = .66), the 55-64 age group (M = 1.98, SD = .68), and the 65+ age group (M = 1.84, SD = .72) on survey question 1 Please tell me whether you are very interested, moderately interested, or not at all interested in scientific discoveries and technological developments. The 45-54 age group scored significantly higher (M = 2.03, SD = .66) than the 55-64 age group (M = 1.98, SD = .68) and the 65+ age group (M = 1.84, SD = .72) on survey question 1 Please tell me whether you are very interested, moderately interested, or not at all interested in scientific discoveries and technological developments. The 55-64 age group scored significantly higher (M = 1.98, SD = .68) than the 65+ age group (M = 1.84, SD = .72) on survey question 1 Please tell me whether you are very interested, moderately interested, or not at all interested in scientific discoveries and technological developments.

Survey Question 2

On survey question 2, a one-way repeated-measures analysis of variance (ANOVA) revealed that EU participants identified picture 1 of an instrument-like robot doing a factory floor activity as corresponding significantly more (M = 3.16, SD = .81) than picture 2 (M = 2.87, SD = .93) of the human-like robot helping out in the home with the idea they have of robots, $F (1, 25912) = 2216.646$ $p < .001$, $\eta p^2 = .079$.

Survey Question 3

Since only 12% of EU participants had used robots at home or at work this result was not analyzed with inferential statistics.

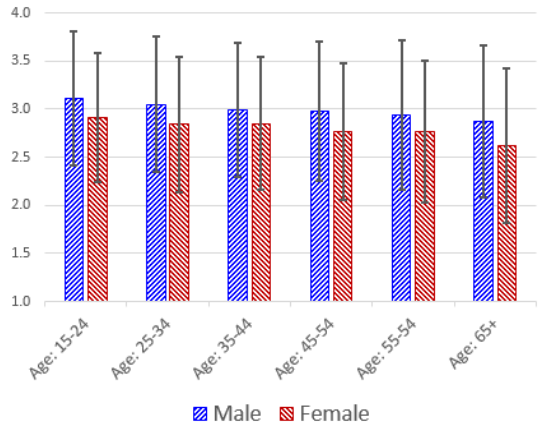

Figure 3- Participants' Responses to Survey Question 4.

Survey Question 4

On survey question 4, a two-way independent-measures analysis of variance (ANOVA) was used to determine significant differences by gender and age group. Although there were significant differences by gender and age group, there was a statistically significant interaction between gender and age group, $F (5, 25111) = 2.96$, $p = .011$, $\eta p^2 = .001$ and so only the results of the significant interaction

were interpreted. Male participants scored significantly higher (more positive) than female participants in all six age groups on survey question 4 Generally speaking, do you have a very positive, fairly positive, fairly negative or very negative view of robots? As indicated below in Table 3 and Figure 3.

Table 3. Means and Standard Deviations by Gender and Age Group

Age	Males	Females
15-24	(M = 3.11, SD = .70)**	(M = 2.91, SD = .67)
25-34	(M = 3.05, SD = .70)**	(M = 2.84, SD = .71)
35-44	(M = 2.99, SD = .70)**	(M = 2.85, SD = .69)
45-54	(M = 2.98, SD = .72)**	(M = 2.77, SD = .71)
55-64	(M = 2.94, SD = .78)**	(M = 2.77, SD = .74)
65+	(M = 2.87, SD = .79)**	(M = 2.62, SD = .80)

Survey Question 5

On survey question 5.1 a two-way independent-measures analysis of variance (ANOVA) was used to determine significant differences by gender and age group and there were statistically significant differences by gender, F (1, 22740.239) = 192.39, p < .001, ηp^2 = .008, and age group, F (5, 22008.670) = 3.50, p = .004, ηp^2 = .001. There was no statistically significant interaction between gender and age group, F (5, 22923) = .97, p = .43. The Brown-Forsythe F was used to determine significant differences by gender and age group as the homogeneity of variance assumption was violated. Male participants scored significantly higher (M = 3.16, SD = .78) than female participants (M = 3.02, SD = .78) on the question 5.1 Robots are a good thing for society because they help people. The 15-24 age group scored significantly higher (M = 3.14, SD = .77) than the 45-54 age group (M = 3.08, SD = .80) and the 65+ age group (M = 3.09, SD = .78) on the question 5.1 Robots are a good thing for society because they help people

On survey question 5.2 a two-way independent-measures analysis of variance (ANOVA) was used to determine significant differences by gender and age group and there were statistically significant differences by gender, F (1, 22306.227) = 103.56, p < .001, ηp^2 = .004, and age group, F (5, 22034.617) = 6.41, p < .001, ηp^2 = .001. There was no statistically significant interaction between gender and age group, F (5, 22923) = .39, p = .85. The Brown-Forsythe F was used to determine significant differences by gender and age group as the homogeneity of variance assumption was violated. Male participants scored significantly lower (M = 2.94, SD = .96) than female participants (M = 3.06, SD = .89) on the question 5.2 Robots steal peoples' jobs. The 65+ age group scored significantly higher (M = 3.06, SD = .93) than the 25-34 age group (M = 2.96, SD = .93), the 35-44 age group (M = 2.97, SD = .92), the 45-54 age group (M = 3.01, SD = .93), and the 55-64 age group (M = 2.99, SD = .94) on the question 5.2 Robots steal peoples' jobs.

On survey question 5.3 a two-way independent-measures analysis of variance (ANOVA) was used to determine significant differences by gender and age group and there were statistically significant differences by gender, F (1, 22886.498) = 165.95, p < .001, ηp^2 = .007, and age group, F (5, 22089.658) = 3.02, p = .01, ηp^2 = .001. There was no statistically significant interaction between gender and age group, F (5, 22923) = 1.21, p = .30. The Brown-Forsythe F was used to determine significant differences by gender and age group as the homogeneity of variance assumption was violated. Male participants scored significantly higher (M = 3.48, SD = .71) than female participants (M = 3.35, SD = .74) on question 5.3 Robots are necessary as they can do jobs that are too hard or too dangerous for people. The 15-24 age group (M = 3.44, SD = .71) and the 55-64 age group (M = 3.43, SD = .73) scored significantly higher than the 65+ age group (M = 3.38, SD = .77) on question 5.3 Robots are necessary as they can do jobs that are too hard or too dangerous for people.

On survey question 5.4 a two-way independent-measures analysis of variance (ANOVA) was used to determine significant differences by gender and age group and there were no statistically significant differences by gender, F (1, 22923) = 3.09, p = .08, or age group, F (5, 22923) = 1.42, p = .21. There was also no statistically significant interaction between gender and age group, F (5, 22923) = 1.53, p = .18 on question 5.4 Robots are a form of technology that requires careful management.

On survey question 5.5 a two-way independent-measures analysis of variance (ANOVA) was used to determine significant differences by gender and age group and there were statistically significant differences by gender, F (1, 22472.065) = 78.25, p < .001, ηp^2 = .003, and age group, F (5, 22923) = 4.42, p < .001, ηp^2 = .001. There was no statistically significant interaction between gender and age group, F (5, 22923) = 1.04, p = .39. The Brown-Forsythe F was used to determine significant differences by gender as the homogeneity of variance assumption was violated. Male participants scored significantly higher (M = 2.46, SD = .96) than female participants (M = 2.36, SD = .90) on question 5.5 Widespread use of robots can boost job opportunities in the European Union. The 15-24 age group scored significantly higher (M = 2.47, SD = .91) than the 45-54 age group (M = 2.39, SD = .94), the 55-64 age group (M = 2.38, SD = .95) and the 65+ age group (M = 2.38, SD = .93) on question 5.5 Widespread use of robots can boost job opportunities in the European Union.

Survey Question 6

Participants chose 3 of 14 word answers which precluded quantitative analysis.

Survey Question 7

Participants chose 3 of 14 word answers which precluded quantitative analysis.

Survey Question 8

On survey question 8 a two-way multivariate analysis of variance (MANOVA) was used to determine significant differences by gender and age group. Although there were significant differences by gender and age group, there was a statistically significant interaction between gender and age, F (20,96624) = 4.14, p < .001, ηp^2 = .001 and so only the results of the significant interaction were interpreted. Male participants scored significantly higher than female participants in all age groups on survey question 8.1 "How

would you personally feel about having a medical operation performed on you by a robot?" as indicated below in Table 4 and Figure 4.

Table 4. Means and Standard Deviations by Gender and Age Group

Age	Males	Females
15-24	(M = 3.86, SD = 3.00)**	(M = 2.96, SD = 2.63)
25-34	(M = 4.22, SD = 3.05)**	(M = 3.32, SD = 2.77)
35-44	(M = 4.24, SD = 3.05)**	(M = 3.57, SD = 2.90)
45-54	(M = 4.09, SD = 3.08)**	(M = 3.49, SD = 2.88)
55-64	(M = 4.30, SD = 3.21)**	(M = 3.47, SD = 2.97)
65+	(M = 4.17, SD = 3.19)**	(M = 3.20, SD = 2.85)

**** Significant at the .001 level**

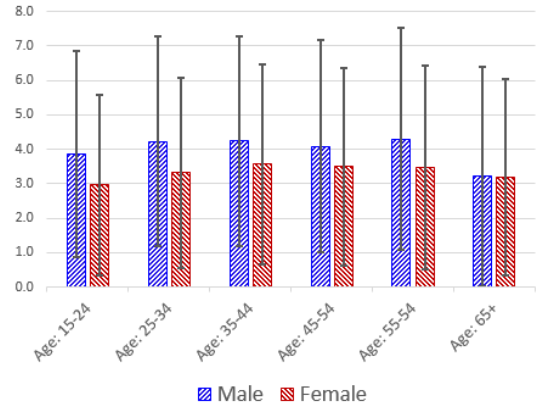

Figure 4- Participants' Responses to Survey Question 8.1.

Male participants scored significantly higher than female participants only in the first five age groups on survey question 8.2 "How would you personally feel about having your dog walked by a robot?" as indicated below in Table 5 and Figure 5.

Table 5. Means and Standard Deviations by Gender and Age Group

Age	Males	Females
15-24	(M = 4.35, SD = 3.21)**	(M = 3.57, SD = 2.92)
25-34	(M = 3.82, SD = 3.07)**	(M = 3.18, SD = 2.79)
35-44	(M = 3.51, SD = 2.99)**	(M = 2.98, SD = 2.71)
45-54	(M = 3.25, SD = 2.89)**	(M = 2.85, SD = 2.63)
55-64	(M = 2.90, SD = 2.73)*	(M = 2.70, SD = 2.62)
65+	(M = 2.59, SD = 2.53)	(M = 2.46, SD = 2.41)

***: Significant at the .05 level;**
****: Significant at the .001 level.**

Male participants scored significantly higher than female participants in all age groups on survey question 8.3 "How would you personally feel about having a robot assist you at work (e.g., in manufacturing)?" as indicated below in Table 6 and Figure 6.

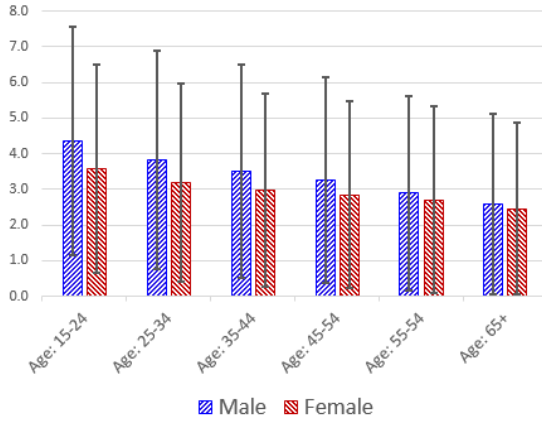

Figure 5- Participants' Responses to Survey Question 8.2.

Table 6. Means and Standard Deviations by Gender and Age Group

Age	Males	Females
15-24	(M = 7.06, SD = 2.82)**	(M = 6.38, SD = 2.81)
25-34	(M = 6.81, SD = 2.92)**	(M = 6.20, SD = 3.00)
35-44	(M = 6.62, SD = 3.05)**	(M = 6.19, SD = 3.05)
45-54	(M = 6.64, SD = 3.03)**	(M = 5.95, SD = 3.10)
55-64	(M = 6.51, SD = 3.10)**	(M = 5.94, SD = 3.10)
65+	(M = 6.33, SD = 3.08)**	(M = 5.48, SD = 3.13)

****: Significant at the .001 level.**

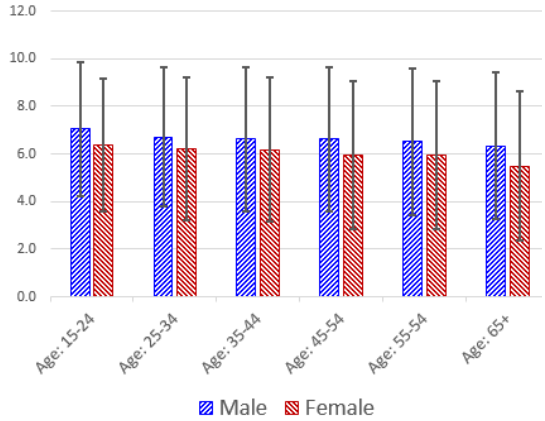

Figure 6- Participants' Responses to Survey Question 8.3.

Male Participants scored significantly higher than female participant in all age groups on survey question 8.4 "How would you personally feel about having your children or elderly parents minded by a robot?" as indicated in Table 7 and Figure 7.

Table 7. Means and Standard Deviations by Gender and Age Group

Age	Males	Females
15-24	(M = 2.66, SD = 2.38)**	(M = 2.10, SD = 2.04)
25-34	(M = 2.36, SD = 2.23)**	(M = 1.87, SD = 1.81)
35-44	(M = 2.19, SD = 2.08)**	(M = 1.89, SD = 1.84)
45-54	(M = 2.14, SD = 2.05)**	(M = 1.91, SD = 1.87)
55-64	(M = 2.11, SD = 2.07)**	(M = 1.90, SD = 1.94)
65+	(M = 2.02, SD = 1.98)**	(M = 1.84, SD = 1.84)

****: Significant at the .001 level.**

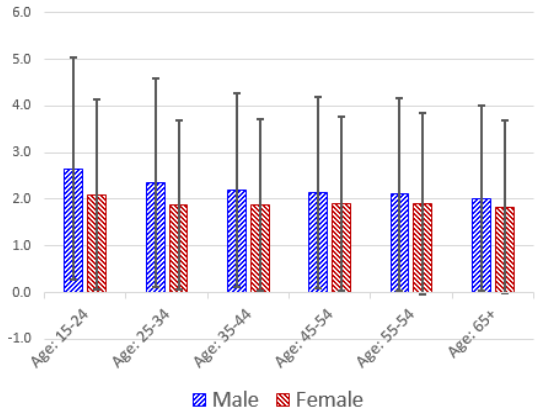

Figure 7- Participants' Responses to Survey Question 8.4.

Survey Question 9

On survey question 9 a two-way independent-measures analysis of variance (ANOVA) was used to determine significant differences by gender and age group and there were statistically significant differences by gender, F (1, 22934) = 29.81, p < .001, ηp^2 = .001, and age group, F (5, 22179.558) = 17.13, p < .001, ηp^2 = .004. There was no statistically significant interaction between gender and age group, F (5, 22924) = 1.08, p = .54. The Brown-Forsythe F was used to determine significant differences by age group as the homogeneity of variance assumption was violated. Female participants scored significantly higher (M = 2.78, SD =1 .15) than male participants (M = 2.69, SD = 1.15) on the question 9, "In your opinion, in Europe, when will it become commonplace for robots to do house work?". The 15-24 age group scored significantly lower (M = 2.63, SD = 1.12) than the 45-54 age group (M = 2.74, SD = 1.17), the 55-64 age group (M = 2.83, SD = 1.13), and the 65+ age group (M = 2.81, SD = 1.15) on question 9, "In your opinion, in Europe, when will it become commonplace for robots to do house work?". The 25-34 age group scored significantly lower (M = 2.67, SD = 1.15) than the 55-64 age group (M = 2.83, SD = 1.13) and the 65+ age group (M = 2.81, SD = 1.15) on question 9, "In your opinion, in Europe, when will it become commonplace for robots to do house work?". The 35-44 age group scored significantly lower (M = 2.69, SD = 1.17) than the 55-64 age group (M = 2.83, SD = 1.13) and the 65+ age group (M = 2.81, SD = 1.15) on question 9, "In your opinion, in Europe, when will it become commonplace for robots to do house work?". The 45-54 age group scored significantly lower (M = 2.74, SD = 1.16) than the 55-64 age group (M = 2.83, SD = 1.13) on question 9, "In your opinion, in Europe, when will it become commonplace for robots to do house work?"

5. DISCUSSION

As anticipated H1 was supported by the results and there were significant differences by gender and age group on survey question 1: Please tell me whether you are very interested, moderately interested, or not at all interested in scientific discoveries and technological developments.

As anticipated H2 was supported by the results and there was a significant difference between which of two robot pictures of EU participants chose as corresponding with the idea they have of robots on question 2 of the survey: I'm going to show you two pictures. For each of them, please tell me to what extent it corresponds with the idea you have of robots.

H3 was supported but there was a significant interaction between gender and age group so only the significant interaction was reported for survey question 4: Generally speaking, do you have a very positive, fairly positive, fairly negative or very negative view of robots?

For H4 survey questions 5.1, 5.2, and 5.3 were supported by the results and there were significant differences by gender and age on all three survey questions mentioned in Table 2 above. H4 survey question 5.4 was not supported by the results and there were no significant differences by gender and age group on that survey question: Robots are a form of technology that requires careful management. H4 survey question 5.5 was supported by the results and there were significant differences by gender and age group on that survey question: Widespread use of robots can boost job opportunities in the European Union.

For H5 survey questions 8.1, 8.2, 8.3, and 8 .4 mentioned in Table 2 above, there were significant differences by gender and age group but there were significant interactions between gender and age group on all 4 survey questions so only the significant interaction results were reported.

H6 was supported by the results and there were significant differences by gender and age group on survey question 9: In your opinion, in Europe, when will it become commonplace for robots to do house work?

Results of this study are consistent with previous studies mentioned in the literature review above which found that there were differences by gender [3], [5], [26], [27] and age group [28], [29], [30] in attitudes towards robots.

One of the limitations of the original study is that the sample was a convenience sample instead of a probability sample. A convenience sample is a non-probability sample that includes whatever participants are available. A probability sample is a sample selected in such a way that the likelihood of any individual being selected can be specified.

Another limitation of the original study was that the participants selected to participate in the study were not stratified by age, i.e. the percentage of each age group selected were not equal as indicated in Table 1.

One of the strengths of this study was the large sample size utilized. Another was that participants from all 27 EU countries were included in the study.

6. CONCLUSIONS AND FUTURE WORK

This study demonstrated that gender and age group influence public attitudes towards robots in the European Union. A similar study should examine public attitudes towards robots in the United States by individual states. Given the present vitriolic extreme political polarization in the U.S. it would be interesting to investigate public attitudes towards robots by geographical region in the U.S. as well.

A future direction for research would be to look at public attitudes towards robots for countries not mentioned in this paper. Another direction would be to identify other variables that may influence public attitudes towards robots such as level of education, socioeconomic status, and political affiliation.

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