Uncanny, Artificial, but Curious: A Mixed Methods Study on Responses to Sex Robots

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***Abstract*— This study employs both qualitative and quantitative approaches to explore perceptions of sex robots. Utilizing grounded theory, a thematic analysis revealed three primary themes: uncanny, artificial, and curious. Following this, an exploratory factor analysis was conducted to evaluate the dimensionality of these themes. Regression analyses were then performed to examine the influence of individual differences on these dimensions. The findings indicated that females perceived sexbots as more uncanny, older individuals perceived sexbots as more artificial, Americans were more curious about sexbots than the British, and males were more curious about sexbots, particularly the female sexbots.**

I. INTRODUCTION

As technological advancements continue to accelerate, the integration of robots into various aspects of human life has become increasingly prevalent. One of the more controversial and intriguing developments in this field is the emergence of sex robots, or "sexbots." These robots, designed to mimic human appearance and interactions, raise numerous questions about human-robot relationships, societal impacts, and the psychological responses they elicit [1]. Understanding these responses is crucial for navigating the ethical, social, and psychological implications of integrating sexbots into society. We seek to explore the nuanced perceptions of sexbots, utilizing both qualitative and quantitative methodologies to provide a comprehensive analysis.

II. RESEARCH QUESTIONS

Exploring the central psychological themes in people's perceptions of sexbots is crucial for understanding the emotional and cognitive responses they provoke [2]. This insight is essential for informing the design and development of sexbots, shaping ethical guidelines, and contributing to the academic literature on human-robot interaction. By identifying these themes, we aim to provide a comprehensive understanding of how sexbots impact individuals psychologically.

> **RQ1**: What are the central psychological themes in people's perceptions of sexbots?

Individual differences, such as age, gender, and country of origin, significantly influence how people perceive robots [3]. Investigating these variations is crucial for predicting potential psychological and social effects, addressing concerns and misconceptions, and developing personalized and inclusive sexbot designs. This study seeks to identify the factors driving diverse responses to sexbots.

> **RQ2**: How do individual differences influence perceptions of sexbots?

III. QUALITATIVE APPROACH

Given the sparse research, we employed a mixed methods approach, starting with a qualitative analysis of responses to three open-ended survey questions. This helped us identify key psychological themes in sexbot perceptions, which informed our subsequent quantitative analysis.

A. Data

The data for the qualitative study were sourced from Study 3 of the Psychological Responses to Robots (PRR) dataset [4]. This publicly available dataset encompassed participant responses to a diverse array of stimuli representing robots across 28 domains, including industry, military, education, and hospitality. Our research focused exclusively on the subset related to sexbots. Data collection occurred in the United States via online participant panels in October 2019.

Participants responded to three open-ended questions about their actual or hypothetical interactions with sexbots. They were asked to articulate any emotions or feelings they experienced or anticipated, the thoughts or cognitions they had or might have, and the actions or behaviors they engaged in or could foresee engaging in during such interactions.

A total of 62 participants, with an average age of 41.75 (*SD*=12.66), provided responses concerning sexbots. Among these participants, 37 identified as female and 24 as male, with one opting not to disclose their gender. Notably, only one participant reported having previous experience with sexbots, indicating that the study's findings predominantly reflect the anticipated emotions, thoughts, and behaviors rather than actual experiences.

B. Coding Process

The 186 text entries (62 participants × 3 questions) were imported into NVivo for qualitative analysis. Figure 1 shows a word cloud illustrating the simple frequency of words. While the word cloud offers a quick overview of common terms, it does not account for synonyms, negations (e.g., "not"), or sarcasm (i.e., implying the opposite). Thus, word frequency alone does not necessarily indicate the importance or relevance of a term, making the word cloud less effective for thematic analysis in our study.

To further investigate the data, we systematically coded each text entry using the grounded theory approach [5]. The first step in grounded theory is open coding, where we read the text without a preconceived coding scheme, focusing

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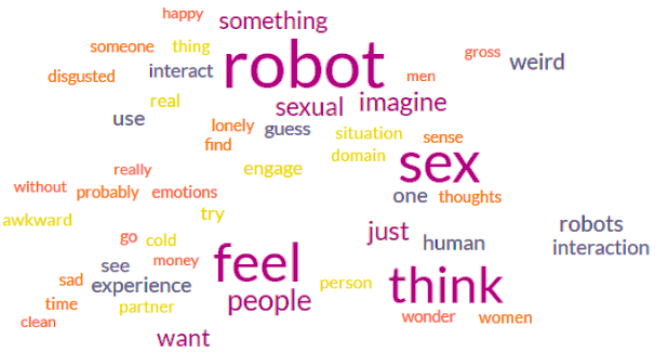

Fig. 1. Word cloud

Theme	Codes (Frequency Count)
Uncanny	Weird (16), disgusted (14), creepy (11), awkward (9), gross (6), unnatural (5), odd (5)
Artificial	Emotionless (12), cold (8), fake (8), impersonal (5)
Curious	Curious (9), want to try (5)
Others	Privacy concerns (9), sad (8), sex doll (7), lonely (6), happy (5)

TABLE I
THREE MAIN THEMES

on various possible interpretations and key points in each entry. The codes could be the participants' original words or synonyms identified in previous codes. Through open coding, we organically created codes to tag each entry, resulting in multiple codes per entry. This analysis yielded a total of 385 codes.

We then carefully examined the 385 codes generated during open coding. Most codes had a low frequency count, which is typical in the early stages of an exploratory study. Grounded theory emphasizes breadth to capture the wide scope of participants' emotions, feelings, cognitions, thoughts, and potential behaviors. For this paper, however, we chose to further investigate only codes with a frequency count of five or higher, narrowing the list to 18 codes. After this, we proceeded to the second step in grounded theory analysis.

The second step is axial coding, where we began relating the codes to each other. During this phase, some interrelated codes started to converge, and we merged them into broader codes while constantly comparing between codes and themes. For example, we developed three main themes, "uncanny", "artificial", and "curious," along with an additional theme labeled "Others" (Table I).

The third step, selective coding, involved merging codes into a broader topic. Continuing from the example in the second step, the codes "uncanny", "artificial", and "curious" converged to suggest that participants generally perceive sexbots with curiosity due to their uncanny and artificial nature, aspects that are not fully understood through common sense alone. This theme of curiosity then became the focal point of our overall qualitative analysis.

In grounded theory, this structure of "uncanny," "artificial," and "curious" can be labeled as "a theory of imagined human-sexbot interactions" by anticipated users who have not yet experienced it. We consider this finding preliminary, as further analysis, constant comparison in axial coding, and re-grouping of themes could refine the latent phenomenon through selective coding. However, the identified codes and themes offer a broad structure to guide our quantitative exploration of the topic.

IV. QUANTITATIVE APPROACH

Based on the qualitative findings, a quantitative analysis was conducted to develop a scale to quantify the three themes and examine how they are influenced by individual differences, including country of origin, age, and gender.

A. Data

The dataset for the qualitative study was sourced from Study 4 of the PRR dataset [4], collected in the United Kingdom and the United States between March and April 2021. Unlike the original study, where participants encountered robots from various domains randomly, our focus was exclusively on sexbots. Participants were randomly presented with an explicit image of a life-sized AI-driven sexbot, either male or female, along with descriptions, and were asked to respond to questions about their perceptions. A total of 103 participants—49 from the UK and 54 from the US—contributed responses; 55 identified as female, and 48 as male. The average age of participants was 46.85 years (SD=17.09).

B. Exploratory Factor Analysis

First, we conducted an exploratory factor analysis (EFA) to assess the dimensionality and ensure the validity of the dependent variables—uncanny, artificial, and curious. From the original study's 149 questions, eleven items were selected to measure these three dimensions using a 7-point scale, ranging from 1 (strongly disagree) to 7 (strongly agree).

The Kaiser-Meyer-Olkin measure of sampling adequacy was robust at .86, suggesting that the patterns of correlation among items were sufficiently compact for factor analysis to yield distinct and reliable factors. Bartlett's test of sphericity confirmed this with a significant result, $X^2(78)=754.16$, $p<.001$, indicating that item correlations were sufficiently large. Both eigenvalues and the scree plot pointed to a three-factor solution. Table II details the factor loadings and communalities, which were all adequately high. Cronbach's alpha confirmed the reliability of all three dimensions.

C. Regression Analysis

After confirming the dimensionality and reliability of the scale, we conducted a series of multiple regression analyses to examine the predictors—nationality, age, gender, and robot gender—of people's responses to sexbots (uncanny, artificial, curious). Table III displays the zero-order correlations and descriptive statistics for the study variables.

Before proceeding with the regression analysis, we screened the data for outliers, linearity, independence of

Dimension	Item	Factor 1	Factor 2	Factor 3	Communalities
Uncanny (α=.88)	76. This robot is abnormal.		.70		.58
	78. This robot makes me feel unpleasant.		.88		.74
	91. This robot is disgusting.		.86		.78
	92. This robot is gross.		.74		.54
Artificial (α=.65)	23. This robot does not feel or respond like humans.			.59	.38
	28. This robot is merely an object.			.70	.46
	36. This robot is emotionless.			.56	.32
Curious (α=.94)	39. I would be interested in this robot.	.83			.80
	99. I would want to learn more about this robot.	.85			.74
	123. I would like to play with this robot.	.93			.86
	146. I would experiment with or test this robot to see what it can do.	.92			.82
	Eigenvalue	5.40	1.54	1.21	
	% of Variance (Cumulative)	49.08	63.09	74.05	

Note. Extraction method: Principal axis factoring. Oblique rotation method: Promax.

TABLE II

EXPLORATORY FACTOR ANALYSIS: PATTERN FACTOR LOADINGS AND COMMUNALITIES

Variable	1	2	3	4	5	6	7	M	SD
1. Nationality[a]	1							0.53	0.50
2. Age	.11	1						46.85	17.09
3. Gender[b]	-.05	.15	1					0.47	0.50
4. Robot Gender[b]	-.20*	-.04	.02	1				0.45	0.50
5. Uncanny	-.12	-.13	-.31**	-.04	1			3.65	1.55
6. Artificial	-.06	.24*	.03	.04	.38**	1		4.95	1.16
7. Curious	.18	-.08	.40**	-.04	-.59**	-.30**	1	3.75	1.87

$^{*}p < .05$, $^{**}p < .01$. [a]UK=0, US=1. [b]Female=0, Male=1.

TABLE III

ZERO-ORDER CORRELATIONS OF STUDY VARIABLES (N=102)

observations, normality, and multicollinearity. The maximum Cook's distance was .10, well below the cut-off of 1, indicating the absence of significant outliers. A scatterplot matrix confirmed linear relationships among continuous variables. The Durbin-Watson statistics, ranging from 1.89 to 2.04, showed no significant autocorrelation in the residuals. Standardized residuals varied from -2.29 to 2.79, supporting normality, as further evidenced by P-P plots confirming the normal distribution of standardized residuals. The Variance Inflation Factor (VIF) index ranged from 1.05 to 2.76, revealing no concerns of multicollinearity. All necessary statistical assumptions for multiple regression were thus satisfied.

Tables IV, V, and VI present the results of the regression analysis, detailing unstandardized coefficients, standard errors, standardized regression coefficients, their confidence intervals, and p-values. Additionally, the interaction effect of participant gender and robot gender was included in the model to investigate whether responses vary between same-gendered and opposite-gendered robots. Significant findings were as follows:

Uncanny. Female participants (M=4.09, SD=1.53) were more likely to perceive sexbots as uncanny compared to males (M=3.14, SD=1.43).

Artificial. Older participants were more likely to perceive sexbots as artificial. Although the regression model was not significant due to the limited sample size and small effect size, the zero-order correlation was significant, $r(100)$=.24.

Curious. Americans (M=4.07, SD=1.93) were more likely to show curiosity toward sexbots compared to British participants (M=3.41, SD=1.77). Older participants were less likely to be curious than younger participants. The main effect of gender indicated that overall, males (M=4.56, SD=1.66) were more curious than females (M=3.05, SD=1.66). The interaction effect (Figure 2) showed that male participants were significantly more curious about female sexbots than male sexbots, $t(45)$=2.13, p=.04. By contrast, female participants did not show a significant difference in their curiosity toward male vs. female sexbots, $t(42.59)$=-1.00, p=.33.

V. DISCUSSION

Research on sexbots, though still emerging, is advancing rapidly. This study represents one of the first applications of a mixed methods approach to comprehensively assess perceptions of sexbots. By integrating qualitative insights from thematic analysis with quantitative data from exploratory factor and regression analyses, our research provides a nuanced understanding of the complex factors that influence how different demographics perceive sexbots.

Predictor	*B*	*SE*	β	95% CI		*p*
				LL	UL	
Nationality	-.42	.30	-.14	-1.02	.18	.17
Age	-.01	.01	-.06	-.02	.01	.54
Gender	-1.36	.40	-.44	-2.16	-.56	.001
Robot Gender	-.63	.40	-.20	-1.43	.17	.12
Gender×Robot Gender	.94	.59	.25	-.23	2.11	.12

$F(5, 96)=6.94$, $p=.01$, $R=.38$, $R^2=.14$, adjusted $R^2=.10$

TABLE IV

REGRESSION ANALYSIS: UNCANNY

Predictor	*B*	*SE*	β	95% CI		*p*
				LL	UL	
Nationality	-.19	.23	-.08	-.66	.28	.42
Age	.02	.01	.25	.003	.03	.015
Gender	.05	.31	.02	-.57	.67	.88
Robot Gender	.17	.32	.07	-.45	.80	.59
Gender×Robot Gender	-.19	.46	-.07	-1.11	.72	.68

$F(5, 96)=1.37$, $p=.24$, $R=.26$, $R^2=.07$, adjusted $R^2=.02$

TABLE V

REGRESSION ANALYSIS: ARTIFICIAL

Predictor	*B*	*SE*	β	95% CI		*p*
				LL	UL	
Nationality	.78	.33	.21	.12	1.45	.02
Age	-.02	.01	-.18	-.04	-.001	.04
Gender	2.34	.45	.62	1.45	3.22	.001
Robot Gender	.60	.45	.16	-.29	1.49	.18
Gender×Robot Gender	-1.48	.66	-.33	-2.78	-.17	.03

$F(5, 96)=7.41$, $p<.001$, $R=.52$, $R^2=.27$, adjusted $R^2=.23$

TABLE VI

REGRESSION ANALYSIS: CURIOUS

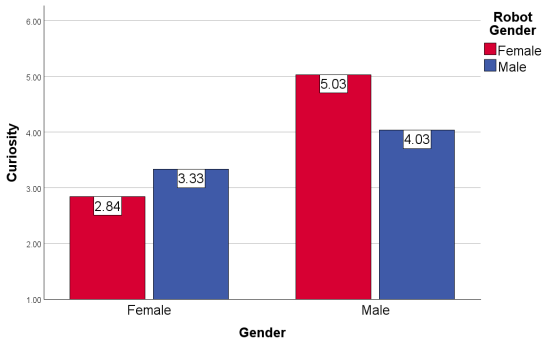

Fig. 2. Curiosity towards same- vs. opposite-gender sexbots

Our findings extend the original PRR study [4], which broadly categorized participant responses as positive or negative, by investigating more specific dimensions pertinent to sexbots. Our results also highlight the relevance of the "uncanny valley" effect in this domain [6] and affirm gender differences noted in recent research [7], [8].

These insights enrich the literature on human-robot interaction, providing a deeper understanding of psychological responses to sexbots. Highlighting individual differences, this study informs developers, policymakers, and academics about the ethical and social considerations necessary for responsibly integrating sexbots into society.

Future research should consider participants' sexual orientations to more accurately gauge reactions to sexbots [9]. This inclusion could refine our findings, especially as different orientations may react differently to the same-sex or cross-sex pairings of sexbots and participants.

Further investigation should also explore deeper into dimensions initially grouped under "Others" in our analysis, such as privacy concerns. Perceived stigma, along with feelings of shame and embarrassment, are intricately linked to privacy concerns and could critically influence individuals' willingness to engage with sexbots [6].

Moreover, while our study concentrated on physical intimacy, future research should investigate the potential roles of emotional intimacy and companionship that may develop in interactions with sexbots [8], [10].

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