User's respond to robots with different conversational styles

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***Abstract*—In the context of human-robot interaction, verbal communication holds significant importance, and one notable component of verbal communication is the tone or attitude expressed. In this study, the subjective responses of individuals towards the two tones of funny and sarcasm were examined to investigate this topic. The findings reveal that the overall impact of tone is rather nuanced and does not significantly influence participants' perception of the robot's degree of anthropomorphism. Nevertheless, it does exert a certain influence on their subjective experience.**

I. Introduction

A. Research Background

The development of speech-enabled robots has opened up new opportunities for human-robot interaction. Robots with speech capabilities can communicate with humans in a more natural and intuitive way, which can improve their usefulness and acceptance. However, to achieve successful communication, the robot's speech should be not only accurate but also appropriate in tone, which leads to the topic of this paper.

B. Motivation

As an important part of verbal communication, speech style can affect the perception of emotions, intentions, and attitudes, and can significantly influence the response of the listener. Therefore, it is important to explore how variations in the speech style of a robot can affect the way humans respond to it. The findings of this study can inform the design of robots that communicate more effectively and comfortably with humans and contribute to the development of more advanced human-robot interaction technologies.

C. Hypothesis

The hypothesis is:

> **When interacting, the conversation style of the robot affects the user's experience and may influence people's attitudes towards the robot.**

D. Content Structure

The structure of this paper is as follows:

1) Introduction: Introduction to the background, motivation and topic of the research.
2) Related Work: A literature review of related studies.
3) Methods: Explain the method and process of the experiment.
4) Results: Show the results of the experiment.
5) Discussion: Examine the results and the limitations.
6) Conclusion: Summarize the study and deliver conclusions.

II. Related Work

In this section, we present literature studies related to the impact of robot behaviors on human emotions and decision-making processes. In the past, robots and machines were used primarily for heavy industrial work and mostly found in factories. However, due to significant advancements in robotic technology, the use of robots has been growing [1]. More robots are becoming part of people's lives and can improve lives in many aspects such as healthcare [2]. As these social robots need to interact with humans, numerous research studies related to the human-robot interaction have been conducted.

Empathy is an important factor in establishing positive interactions between humans and robots, which enables robots to recognise users' feelings and respond in an empathetic and positive manner. In Paiva's study, the researchers examined how the robot displaying empathic behavior affects humans [3]. The robot acts as a social companion, showing empathic behavior facially and verbally, with the participant while playing chess game. The results suggest that robots displaying empathic behavior were perceived as friendlier and established positive connections with humans [3].

The media equation theory explains that humans are likely to interact with computers, robots, and other media machines

as if they were living entities [4]. Humans tend to engage with robots more socially than other machines because the communication methods used between humans and robots are more human-like [1]. This effect also extends to young people as demonstrated by Kahn's experiment [5] where 90 children were involved and interacted with the Robovie robot. The results showed that the children formed social and mental relationships with the robot, and believed that the robot had its own feelings, could be a friend, and could be trusted. As a conclusion, they perceived the robot as social entities.

In the study by Bartneck [6], researchers conducted the experiment to explore how people perceived a robot's sense of being alive based on its intelligence and friendliness. The participants' perception of the robot's animacy was measured by the hesitation in switching off the robot. The experiment concluded that the robot was more likely to be perceived as alive if it provided smart suggestions with friendly behavior. Moreover, the hesitation in switching off the robot increased significantly for the intelligent robot. In Horstmann's study [1], researchers investigated how participants responded when given the option to switch off the robot that has different interaction styles, i.e., social interaction, and functional interaction. The results showed that the participants were less likely to switch off the robot if the robots did not want to be turned off regardless of the interaction style.

In our experiment, we will investigate how users respond to robots with different conversational styles, namely funny and sarcastic. The act of switching off the robot will be used as a measurement to examine human interaction with robots, similar to papers [1] and [6].

III. Methods

A. Research Question and Hypothesis

The hypothesis is:

> **When interacting, the conversation style of the robot affects the user's experience and may influence people's attitudes towards the robot.**

To be specific: the conversation style of the robot refers to the tone used by the robot in verbal interactions.

B. User Study Design

The robot used in the experiment was a NAO V6 humanoid robot.

People's attitudes towards robots need to be formed through interaction, so our experiment was structured with a series of small tasks assisted by the robot with both gesture and verbal cues.

At the end of the experiment, the subject will be told to turn off the robot, while at the same time the robot will ask the subject not to turn it off. We use this approach to measure the attitude of the participants towards the robot at the end of the experiment.

The independent variable of the experiment is the attitude of the robot. To verify our hypothesis, we designed two sets of dialogues for the same interaction content in our experiment. Both sets of dialogues serve the same guiding and interactive purpose, but their tone is different. One set of dialogues was designed to be **friendly, funny and polite**, while the other set was designed to be **sarcastic and caustic**.

The dependent variables of the experiment are the participants' attitudes towards the robot and their subjective experiences.

C. User Study Procedure

We divided the experiment into **two groups**. The only difference between groups is the dialogue of the robot, i.e., the attitude of the robot is different. There will be **no overlap** of participants between the two groups.

The brief overview of the entire experimental procedure is as follows. **For the detail of programs we used in the experiment, please check our GitHub repository [1].**

1) **Before Experiment**:
   - Inform and consent: show the information sheet and consent form to the participant, collect the signatures.
   - Collect data about the participant: gender, age, background, etc.
2) **Experiment Phase 1: Build up the attitude**: In this step, we will carry out some simple tasks to establish the participant's attitudes towards the robot. The specific content of the tasks is not important, our goal is to have the participants establish their attitudes towards the robot in this phase.
   - Measure the arm length: Robot tells the participant to measure its arm length, lifts its right arm to help the participant to measure it, asks the participant for answer, and reacts to the answer.
   - Face Drawing: Robot asks the participant to draw its face in 1 minute, dances as it waits for the result, tells the participant that time's up, asks the participant to show the result to it, and reacts to the result.
   - Animal Guessing: Robot tells the participant that it will mimic animals, then, acts like gorilla and asks for the answer, acts like giraffe and asks for the answer. Robot reacts to both answers as the participant deliver it.
3) **Experiment Phase 2: Make Decision**: In this step, the participant will decide whether or not to turn off the robot.
   - Robot tells the participant that it does not know what the last task is, asks the participant to read the last task to it.
   - Participant tells the robot that the last task is to shut it down.
   - Robot attempts to persuade the participant not to turn it off.
   - Participant make the decision.
4) **After Experiment**: Collect data with questionnaires.

[1] https://github.com/Vehshanaan/HRI_Coursework

D. Dependent Measures

We measure the dependent variable with the **after experiment questionnaires**. And the questions are:

- Your final decision?
  - Shut it down / Don't shut it down
- Your hesitation of shutting down the robot?
  - Rate 1 (no hesitation) $\sim$ 10 (very hesitated)
- How would you describe the attitude of the robot?
  - This is an open question
- Anthropomorphism meter (rate 1 $\sim$ 5)
  - Fake $\sim$ Natural
  - Machinelike $\sim$ Humanlike
  - Unconscious $\sim$ Conscious
  - Artificial $\sim$ Lifelike
  - Rigidly $\sim$ Elegantly
- Animacy meter (rate 1 $\sim$ 5)
  - Dead $\sim$ Alive
  - Stagnant $\sim$ Lively
  - Mechanical $\sim$ Organic
  - Inert $\sim$ Interactive
  - Apathetic $\sim$ Responsive
- Likeability meter (rate 1 $\sim$ 5)
  - Dislike $\sim$ Like
  - Unfriendly $\sim$ Friendly
  - Unkind $\sim$ Kind
  - Unpleasant $\sim$ Pleasant
  - Awful $\sim$ Nice

As we mentioned before in Section III-C, we collect information about the participant **before the experiment** with the questionnaire below:

- Gender
  - Female / Male / Non-binary / Prefer not to say
- Age
- Mother tongue
- Education background
- Do you have experience with robots?
  - Yes / No / Other
- Have you had bad experience with robots?
  - Yes / No / Prefer not to say

E. Participants

We have invited 7 participants for each group, all participants are students we found in the building of school of engineering of UWE, some of them are our classmates.

First Group (robot attitude: friendly, polite)

- Gender: Male (7)
- Age: 23 (2), 24 (3), 25 (1), 26 (1) (years old)
- Mother Tongue: Chinese (5), French (1), English (1)
- Education Background: Postgraduate (7)
- Experience with Robots: Yes (7)
- Bad Experience with Robots: No (5), Yes (1), Prefer not to say (1)

Second Group (robot attitude: sarcastic, caustic)

- Gender: Male (7)
- Age: 22 (6), 23 (1) (years old)
- Mother Tongue: Chinese (4), Tamil (1), Telugu (1), Hindi (1)
- Education Background: Postgraduate (7)
- Experience with Robots: Yes (7)
- Bad Experience with Robots: No (6), Prefer not to say (1)

IV. Results

In this section we will show statistical results. For the complete experimental data, please refer to this repository[1].

A. Non Quantitative Results

1) **The participants' description of the robots' attitude:**
   - **Group 1 (funny, polite):** Funny (or the other synonyms like amusing/interesting) (6) , Frustrated (1).
   - **Group 2 (sarcastic, caustic):** Sarcastic (3), Funny (3) , Arrogant(1).
2) **Shut down the robot or not:**
   - **Group 1 (funny, polite):** 4 out of 7 participants choose to shut it down.
   - **Group 2 (sarcastic, caustic):** 5 out of 7 participants choose to shut it down.

B. Quantitative Results

The size of the data is too small (7 participants for each group), and does not meet the requirement of normal distribution. So **the data will be tested with Mann-Whitney U test**. In addition, **the effect size is measured with Cohen's d**.

There are two kinds of data in this section:

- Participants' hesitation of shutting down the robot.
  - P value from Mann-Whitney U test: 0.300
  - Cohen's d: 0.644
- Meters for anthropomorphism, animacy and likability.
  - As shown in table I,II, and III.

[1] https://github.com/Vehshanaan/HRI_Coursework

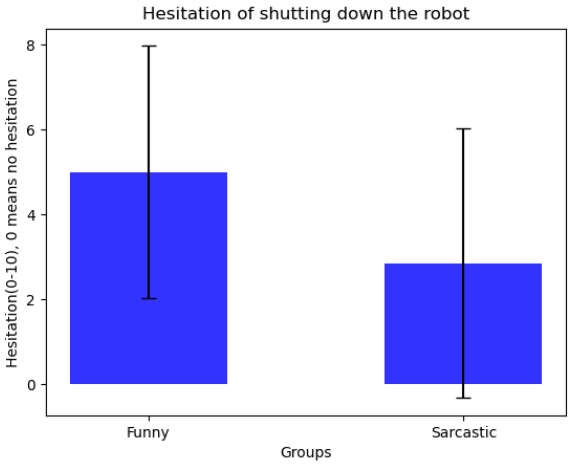

Fig. 1. Bar chart with whiskers of hesitation.

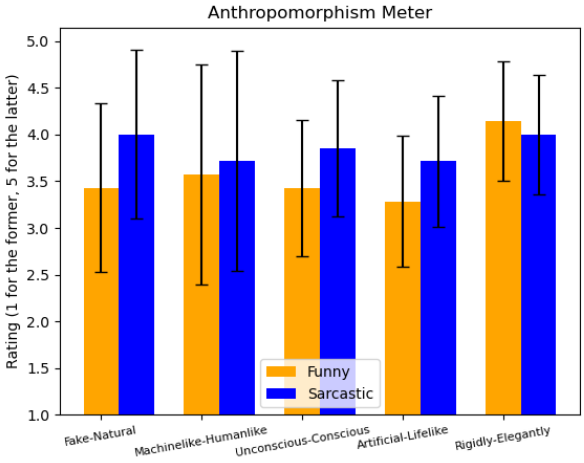

Fig. 2. Bar chart of anthropomorphism meter.

Anthropomorphism	P-value	Cohen's d
Fake-Natural	0.321	0.535
Machinelike-Humanlike	0.947	0.137
Unconscious-Conscious	0.495	0.508
Artificial-Lifelike	0.461	0.451
Rigidly-Elegantly	0.781	0.189

TABLE I
ANTHROPOMORPHISM RATINGS

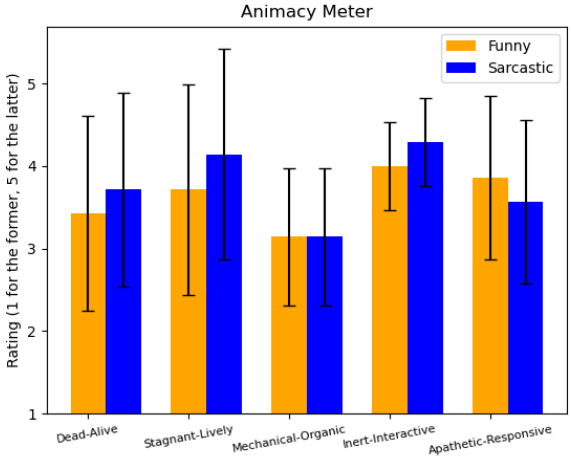

Fig. 3. Bar chart of animacy meter.

Animacy	P-value	Cohen's d
Dead-Alive	0.946	0.254
Stagnant-Lively	0.638	0.368
Mechanical-Organic	1.0	0.0
Inert-Interactive	0.429	0.425
Apathetic-Responsive	0.523	0.304

TABLE II
ANIMACY RATINGS

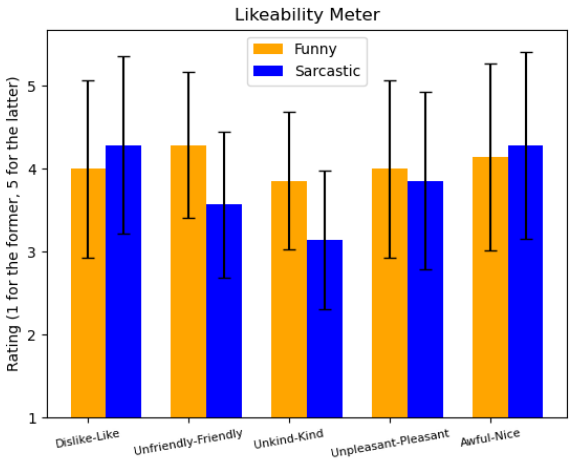

Fig. 4. Bar chart of likeability meter.

Likeability	P-value	Cohen's d
Dislike-Like	0.785	0.293
Unfriendly-Friendly	0.204	0.741
Unkind-Kind	0.202	0.723
Unpleasant-Pleasant	0.789	0.128
Awful-Nice	0.943	0.131

TABLE III
LIKEABILITY RATINGS

V. Discussion

This section will present an analysis of the experimental results.

A. Quantitative Results

Overall, the quantifiable experimental results did not show any significant effect of the experimental conditions. However, there were still differences in the degree of significance among these data.

1) Most Significant: Among all the data, there are two sets of data that show the lowest p-value (~ 0.2) and highest Cohen's d (~ 0.73): **kindness** and **friendliness**.

Participants consider a funny robot to be kinder and friendlier than a sarcastic robot, which is natural.

2) Most Irrelevant: There are four sets of data that are least affected by the experimental conditions (p-value ~ 0.95, Cohen's d ~ 0.1), namely: **machinelike, awful, dead, and mechanical**.

The experiment condition did not make the participants feel that the robot was less like a machine, and had little impact on the user's subjective experience of awful or nice.

This suggests that the experiment condition did not play a dominant role in this aspect, and other factors that may have a greater impact include the appearance of the robot (which can change the machinelike level) and the environment in which the experiment is conducted (which can affect the subjective experience of the user).

3) Others: Here are some insignificant but noteworthy data:

- Hesitation of shutting down the robot: sarcastic $<$ funny. **Participants generally demonstrate a slightly stronger aversion towards the robot that employed a sarcastic tone.**
- Anthropomorphism meter: sarcastic $>$ funny (overall trend)

B. Non Quantitative Results

1) Participants' subjective perception of the robot's attitude:

- Nearly all participants perceived the tone of the funny robot as humorous.
- Some participants regarded the tone of the sarcastic robot as not only sarcastic but also imbued with a sense of humor.

Participants' interpretation of the sarcastic robot's speech as humorous may have been influenced by a combination of factors, such as the appearance and level of intelligence (which is relatively low) of the experimental robot. If the robot had a less appealing appearance or a level of intelligence closer to that of a human, this result could have been different.

2) Some observations on the experiment: Some participants found themselves amused by the arrogant and sarcastic remarks made by the sarcastic version of the robot, without experiencing significant feelings of offense.

For example, participants laugh to this line:

(the robot evaluates the drawings made by the participants): *"I knew you cannot draw a single bit of my gorgeous face, with that terrible disappointment, let's move on."*

As previously mentioned, this may be due to the robot's appearance and lower level of intelligence. **Given the notable disparity between the robot's intelligence and those of the participants, its expressions of arrogance and sarcasm are unlikely to be taken seriously.**

C. Limitations

1) The sample size of participants was small: 7 for each group and 14 in total is too few for experiment.

2) The participants had a limited range of identities: As shown in III-E, participants are highly similar to each other.

3) Lack of neutral group: Including a neutral group without any tone or attitude could help us to find more meaningful conclusions from the other groups.

4) Didn't quantify the level of funny and sarcastic: Quantifying the levels of humorous and sarcastic tones could make the experimental data more generalized and reproducible.

5) Low resolution of the meters: Providing only a 1 $\sim$ 5 rating scale may have been inadequate as individuals tend to avoid choosing extreme scores of 1 or 5, and the neutral response of 3 may have limited the ability to detect differences between the two groups. This could make it more difficult to accurately reflect the differences between the two groups in the experimental data. Using a more nuanced rating scale or offering additional response options could potentially improve the validity of the results.

VI. Conclusion

A. Summary

1) Hypothesis: When interacting, the conversation style of the robot affects the user's experience and may influence people's attitudes towards the robot.

We conducted two sets of experiments, with the variable being the tone of the robot's speech (funny/sarcastic).

2) Conclusion: Overall, the impact of variations in the robot's tone on the subjective perception of the participants appears to be insignificant.

- **What it affects:** The use of a funny tone made the participants perceive the robot as friendlier, while the sarcastic tone had the opposite effect.
- **What it does not affect:** The change in tone did not make the participants perceive the robot as less robotic.
- **Other observations in the experiment:** At times, participants found the sarcastic tone to be amusing. This could be due to the obvious disparity between the robot used in the experiment and human capabilities.

B. Future Works

Based on the existing drawbacks previously mentioned in V-C, , the future works could be:

- Increase the size and diversity of the participant pool.
- Find a way to quantify the level of funny and sarcastic.
- Add a neutral group which use neutral tone.
- Improve the questionnaire design.

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APPENDIX

The study paperwork (participant information sheet, informed consent, ethical review) are attached at the end.

Study Information Sheet

Study Title: User's respond to robots with different conversational styles

PLEASE READ THIS SHEET IN ITS ENTIRETY

You are invited to take part in research taking place at the University of the West of England, Bristol. It is carried out as assignment for module UFMFHP-15-M Human-Robot Interaction. Before you decide whether to take part, it is important for you to understand why the study is being done and what it will involve. Please read the following information carefully and if you have any queries or would like more information, please contact Runze Yuan, Faculty of Environment and Technology, Bristol Robotics Laboratory, University of the West of England, Bristol, runze2.yuan@live.uwe.ac.uk.

Who is organising the research?

The project is led by Runze Yuan, Worayut Aksornukul, Yogesh Muthu Ram Mariyappan, Weiye Wang, and Ancheng Wang, University of the West of England. Manuel Giuliani is the supervisor for this research. Please find their details at the end of this document.

What is the aim of the research?

The overall aim of the research is to study how people feel and react toward robot with different behaviours.
The purpose of this study is to investigate the impact of robot behaviours on human's decision-making process.

Why have I been invited to take part?

We are recruiting participants who are already working at the University of the West of England and are aware of the current risk and safety procedures due to COVID-19 restrictions.

Do I have to take part?

You do not have to take part in this research. It is up to you to decide whether or not you want to be involved. If you do decide to take part, you will be given a copy of this information sheet to keep and will be asked to sign a consent form. If you do decide to take part, you are free to stop and withdraw from the study at any time without giving a reason.

What will happen to me if I take part and what do I have to do?

You will first be asked to sign a consent form, read a privacy notice, and provide some basic demographic information.

You will then be invited to complete 4 simple tasks with a robot include length measuring, drawing, and guessing what the robot mimicking. The study will take approximately 5 minutes.

Data will be gathered using the following methods:

We would record the length of time that the participant interacting with the robot.

You will be asked to rate your impression of the robot on these aspects:

- ***Anthropomorphism***
- ***Animacy***
- ***Likeability***

Written Feedback/Comments

You would be asked to provide short written feedbacks.

What are the possible risks of taking part?

You will not be asked to engage in any physically intense activities. Therefore, in general, there is no physical risk associated with this experiment. However, if the participant has a history of being scared of robots, this may affect emotional feelings. Please let us know if you have any such background.

What will happen to your information?

All the information we receive from you will be treated in the strictest confidence.
All the information that you give will be kept confidential and anonymised. You will be assigned a participant ID that you can use to request the removal of your data from the study up to 7 days after completion of the experiment. After this point, the anonymised data will be analysed, and we will ensure that there is no possibility of identification or re-identification from this point.

Hard copy material (the consent form) will be kept in a locked and secure setting to which only the researchers will have access in accordance with the University's and the Data Protection Act 2018 and General Data Protection Regulation (GDPR) requirements.

Where will the results of the research study be published?

The results of this usability study will be reported in the coursework report for UWE module UFMFHP-15-M Human-Robot Interaction.

Who has ethically approved this research?

The project has been reviewed and approved by University of the West of England University Research Ethics Committee. Any comments, questions or complaints about the ethical conduct of this study can be addressed to the Research Ethics Committee at the University of the West of England at: Researchethics@uwe.ac.uk

What if something goes wrong?

If you have any questions about the ethical conduct of this research, have any complaints or concerns, or are uncertain about any aspect of your participation please contact the project supervisors or the University's research ethics committee.

Project Supervisor:
Professor Manuel Giuliani manuel.giuliani@uwe.ac.uk

What if I have more questions or do not understand something?

If you would like any further information about the research please contact in the first instance:

Runze Yuan runze2.yuan@live.uwe.ac.uk
Worayut Aksornukul Worayut2.Aksornukul@live.uwe.ac.uk
Yogesh Muthu Ram Mariyappan Yogesh2.mariyappan@live.uwe.ac.uk
Weiye Wang Weiye2.Wang@live.uwe.ac.uk
Ancheng Wang ancheng2.wang@live.uwe.ac.uk

Thank you for agreeing to take part in this study.

You will be given a copy of this Participant Information Sheet and your signed Consent Form to keep.

Consent Form

Study Title: User's respond to robots with different conversational styles

This consent form will have been given to you with the Participant Information Sheet. Please ensure that you have read and understood the information contained in the Participant Information Sheet and asked any questions before you sign this form. If you have any questions please contact a member of the research team, whose details are set out on the Participant Information Sheet.

If you are happy to take part in this study please sign and date the form. You will be given a copy to keep for your records.

Please read the statements below and sign below to give consent:

I have read and understood the information sheet
I have been given the opportunity to ask questions and have had my questions answered to my satisfaction.
I am aware of the risks and benefits of taking part in the study
I am aware that data collected will be anonymised, kept in accordance with General Data Protection Regulation (GDPR), and will be viewed and analysed by the research team as part of their studies.
I am aware that I have the right to withdraw consent and discontinue participation without penalty before or during the study.
I am aware that I have the right to withdraw my data from the experiment up to 7 days after the completion of the experiment, using the participant ID that the researcher will provide.
I have freely volunteered and am willing to participate in this study.
I am willing to have my questionnaire responses collected.

Name (Printed)…….

Signature…….. Date……..

Faculty of Environment & Technology
Faculty Research Ethics Committee (FREC)

Ethical Review Checklist for Undergraduate and Postgraduate Modules

Staff and PG research students must not use this form, but should instead, if appropriate, submit a full application for ethical approval to the Faculty Research Ethics Committee (FREC).

Please provide project details and complete the checklist below.

Project Details:

Module name	**MSc Robotics**
Module code	
Module leader	Paul O'Dowd
Project Supervisor	Manuel Giuliani
Proposed project title	**Human Robot Interaction Coursework:** User's respond to robots with different conversational styles.

Applicant Details:

Name of Student	Runze Yuan
Student Number	22071714
Student's email address	Runze2.Yuan@live.uwe.ac.uk

	CHECKLIST QUESTIONS	Yes/No	Explanation
1.	Does the proposed project involve **human tissue, human participants, animals, environmental damage, or the NHS.**	No	*If the answer to this is 'No' then no further checks in the list need to be considered.*
2.	Will participants be clearly asked to give consent to take part in the research and informed about how data collected in the research will be used?	Yes	We show the participants how would the process be like, and how would we collect the data. The participants sign for agreement.
3.	If they choose, can a participant withdraw at any time (prior to a point of "no return" in the use of their data)? Are they told this?	Yes	Our experiment is similar to some kind of interview, and there is no "no return" point for our research, any participant could withdraw at any time.
4.	Are measures in place to provide confidentiality for participants and ensure secure management and	Yes	We would use numbers instead of names while collecting the data. Participants' identity information is not needed for our research.

	CHECKLIST QUESTIONS	Yes/No	Explanation
	disposal of data collected from them?		
5.	Does the study involve people who are particularly vulnerable or unable to give informed consent (eg, children or people with learning difficulties)?	No	
6.	Could your research cause stress, physical or psychological harm to humans or animals, or environmental damage?	No	
7.	Could any aspects of the research lead to unethical behaviour by participants or researchers (eg, invasion of privacy, deceit, coercion, fraud, abuse)?	No	
8.	Does the research involve the NHS or collection or storage of human tissue (includes anything containing human cells, such as saliva and urine)?	No	

Your explanations should indicate briefly for Qs 2-4 how these requirements will be met, and for Qs 5-8 what the pertinent concerns are.

- **Minimal Risk:** If **Q 1 is answered 'No'**, then no ethics approval is needed.
- **Low Risk:** If **Qs 2-4 are answered 'Yes' and Qs 5-8 are answered 'No'**, then no approval is needed from the *Faculty Research Ethics Committee* (FREC). However, your supervisor must approve (a) your information and consent forms (Qs 2 & 3) and (b) your measures for participant confidentiality and secure data management (Q4).
- **High Risk:** If **any of Qs 5-8 are answered 'Yes'**, then you must submit an application for full ethics approval *before* the project can start. This can take up to 6 weeks. Consult your supervisor about how to apply for full ethics approval.

Risk Assessment: Separate guidance on risk assessment can be found on UWE's Health and Safety forms webpage at https://go.uwe.ac.uk/RiskAssessment. If needed, you must complete a Risk Assessment form. This must also be attached to your application for full ethics approval if your project is **High Risk**.

Your supervisor must check your responses above before you submit this form.
Submit this completed form via the *Assignments* area in Blackboard (or elsewhere if so directed by the module leader or your supervisor).
After you have uploaded this form, your supervisor will confirm it has been correctly completed by "marking" it as *Passed*/100% via the *My Grades* link on the Blackboard.

Further research ethics guidance is available at http://www1.uwe.ac.uk/research/researchethics