Supplemental Document for Balancing User Control and Perceived Robot Social Agency through the Design of End-User Robot Programming Interfaces

Alex Wuqi Zhang
University of Chicago, Dept. of Computer Science
Chicago, USA
alexwuqizhang@uchicago.edu

Rafael Queiroz
University of Chicago, Dept. of Computer Science
Chicago, USA
rqueiroz@uchicago.edu

Sarah Sebo
University of Chicago, Dept. of Computer Science
Chicago, USA
sarahsebo@uchicago.edu

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1 Low Granularity EUP Interface Sample

Your First Name

John Doe

Movement Speed

This controls how fast your robot moves around.

Slow   Normal   Fast

Talking Speed

This controls how fast your robot speaks.

Slow   Normal   Fast

Stopping Distance

This controls how far away your robot stops when moving towards something, e.g. when it's moving towards you.

Close   Normal   Far

Robal Vocal Persona

This controls what persona you want your robot to have when talking to you.

Boy	Girl	Business Man	Business Woman
Old Man	Old Woman	Surfer Dude	Surfer Girl
Butler	Yoga Woman	Robot	

Explainability of Robot Behavior

This controls how much your robot explains what it's doing as it's completing an action.

None   Minimal   Full

Ambient Movement

This controls whether the robot stands still while talking or sometimes sways from side to side.

Stand still   Sway side to side

Current Events

This specifies the topic that you want to hear about when your robot updates you with the latest news.

Sports   Science   Weather

Submit

Figure 1: This is a depiction of the Low Granularity EUP Interface, populated with sample customizations.

2 High Granularity EUP Interface Sample

Enter your first name: [John Doe]

Welcome Home Sequence

Robot moves towards [me ▾] at a [moderate ▾] pace.
Optionally, robot explains what it's doing in the following way:
Sample: I'm heading towards you!

Robot stops moving when it is [1.0 ▾] m away from [me ▾] .

Robot greets me in the following way:
Sample: Good evening, Rachel!

Robot takes my bag.

Robot drops my bag.

Robot asks to take my bag in the following way:
Sample: Would you like me to take your bag?

Robot tells me it cleaned apartment and directs me to couch in the following way:

Robot talks using a [robot ▾] persona while speaking at a [moderate ▾] pace.
Robot moves towards [me ▾] at a [moderate ▾] pace.
Optionally, robot explains what it's doing in the following way:
Sample: I'm heading towards you!
Robot stops moving when it is [1.0 ▾] m away from [me ▾] .
Robot greets me in the following way:
Sample: Good evening, Rachel!
Robot asks to take my bag in the following way:
Sample: Would you like me to take your bag?
Robot takes my bag.
Robot moves towards [bag drop ▾] at a [moderate ▾] pace.
Optionally, robot explains what it's doing in the following way:
Sample: I'm heading towards the bag drop!
Robot drops my bag.

Unpack Your Day Sequence

Robot moves towards [me ▾] at a [moderate ▾] pace.
Optionally, robot explains what it's doing in the following way:
Sample: I'm heading towards you!

Robot stops moving when it is [1.0 ▾] m away from [me ▾] .

If I had a [good ▾] day, robot will ask further about it in the following way:
Sample: What's something interesting you did tod...

Robot asks about my day in the following way:
Sample: How was your day?

Robot asks me if I want to hear about its day in the following way:
Sample: Do you want to hear about my day?

Robot tells me about its day in the following way:
Sample: I became friends with the neighbor's puppy

Robot talks using a [robot ▾] persona while speaking at a [moderate ▾] pace.
Robot moves towards [me ▾] at a [moderate ▾] pace.
Optionally, robot explains what it's doing in the following way:
Sample: I'm heading towards you!
Robot stops moving when it is [1.0 ▾] m away from [me ▾] .
Robot asks about my day in the following way:
Sample: How was your day?
If I had a [good ▾] day, robot will ask further about it in the following way:
Sample: What's something interesting you did tod...
If I had a [bad ▾] day, robot will ask further about it in the following way:
Sample: What's something interesting you did tod...
Robot tells me about its day in the following way:
Sample: I became friends with the neighbor's puppy

Snack Sequence

Robot moves towards [me ▾] at a [moderate ▾] pace.
Optionally, robot explains what it's doing in the following way:
Sample: I'm heading towards you!

Robot stops moving when it is [1.0 ▾] m away from [me ▾] .

Robot asks if I want a chips or rice krispies snacks in the following way:
Sample: Would you like chips or rice krispies?

Robot picks up snack.
Optionally, robot explains what it's doing in the following way:
Sample: I'm picking up your snack.

Robot gives me snack.

Robot says this to me as it gives me the snack:
Sample: Here's your snack, enjoy!

Robot talks using a [robot ▾] persona while speaking at a [moderate ▾] pace.
Robot asks if I want a chips or rice krispies snacks in the following way:
Sample: Would you like chips or rice krispies?
Robot moves towards [snack bar ▾] at a [moderate ▾] pace.
Optionally, robot explains what it's doing in the following way:
Sample: I'm heading towards you!
Robot stops moving when it is [1.0 ▾] m away from [snack bar ▾] .
Robot picks up snack.
Optionally, robot explains what it's doing in the following way:
Sample: I'm picking up your snack.
Robot moves towards [me ▾] at a [moderate ▾] pace.
Optionally, robot explains what it's doing in the following way:
Sample: I'm heading towards you!
Robot stops moving when it is [1.0 ▾] m away from [me ▾] .
Robot gives me snack.

Entertainment Sequence

Sports
Science
Weather

Robot talks using a [robot ▾] persona while speaking at a [moderate ▾] pace.
Robot gives information about [science ▾]
Specific area of science: [Sample: Biology]
Scientist: [Sample: Albert Einstein]
Any particular topic?
Sample: What is a black hole?
while [standing still ▾]
Optionally, robot explains what it's doing in the following way:
Sample: I'm about to update you on the latest ne...

[Submit]

Figure 2: This is a depiction of the High Granularity EUP Interface, populated with sample customizations.

3 User Customization Distributions for All Features

Table 1: Choice Distributions Across All Features in Low Granularity (LG) and High Granularity (HG) Interfaces

Feature	Option	LG Count	LG %	HG Count	HG %
Robot Vocal Persona	Teenager Girl	6	16.67%	13	8.12%
	Business Girl	6	16.67%	15	9.38%
	Old Woman	5	13.89%	0	0.00%
	Butler Man	4	11.11%	24	15.00%
	Robot	4	11.11%	83	51.88%
	Old Man	3	8.33%	0	0.00%
	Surfer Dude	3	8.33%	8	5.00%
	Meditation Woman	2	5.56%	10	6.25%
	Surfer Girl	1	2.78%	2	1.25%
	Business Man	1	2.78%	4	2.50%
	Teenager Boy	1	2.78%	1	0.62%
	Total	36	100%	160	100%
Stopping Distance (m)	0.6	4	11.11%	28	23.33%
	0.8	10	27.78%	18	15.00%
	1.0	16	44.44%	55	45.83%
	1.2	5	13.89%	10	8.33%
	1.4	1	2.78%	9	7.50%
	Total	36	100%	120	100%
Movement Speed (m/s)	0.5	15	41.67%	20	16.67%
	0.4	14	38.89%	17	14.17%
	0.3	6	16.67%	77	64.17%
	0.2	1	2.78%	6	5.00%
	0.1	0	0.00%	0	0.00%
	Total	36	100%	120	100%
Talking Speed	Very Slow	0	0.00%	0	0.00%
	Slow	3	8.33%	11	6.88%
	Moderate	15	41.67%	121	75.62%
	Fast	16	44.44%	26	16.25%
	Very Fast	2	5.56%	2	1.25%
	Total	36	100%	160	100%
Explainability Level	Minimum Explainability	N/A	N/A	15	41.67%
	Full Explainability	N/A	N/A	13	36.11%
	No Explainability	N/A	N/A	8	22.22%
	Total	N/A	N/A	36	100%

Note: The Explainability Level changes were only applicable to the LG Interface.

4 Changes Made Between Interaction 1 and Interaction 2

Table 2: Changes Made from Interaction 1 to Interaction 2 Across All Features

Feature	Interface	Participants Changed	Percentage
Vocal Profile	LG Interface	14/18	77.78%
	HG Interface	15/80	18.75%
Stopping Distance	LG Interface	11/18	61.11%
	HG Interface	26/60	43.33%
Movement Speed	LG Interface	12/18	66.67%
	HG Interface	29/60	48.33%
Talking Speed	LG Interface	12/18	66.67%
	HG Interface	27/80	33.75%
Explainability Level	LG Interface	11/18	61.11%
	HG Interface	N/A	N/A

Table 3: Detailed Changes in LG Interface

Feature	Change Description	Count
Stopping Distance	Decreased by 0.6 m	1
	Decreased by 0.4 m	3
	Decreased by 0.2 m	3
	Increased by 0.2 m	3
	Increased by 0.4 m	1
Movement Speed	Increased by 0.1 m/s	8
	Increased by 0.2 m/s	3
	Increased by 0.3 m/s	1
Talking Speed	Decreased by 2 steps	2
	Decreased by 1 step	7
	Increased by 1 step	2
	Increased by 2 steps	1
Explainability Level	Changed from fullXAI to minXAI	2
	Changed from minXAI to fullXAI	5
	Changed from minXAI to noXAI	4

Table 4: Detailed Changes in HG Interface

Feature	Change Description	Count
Stopping Distance	Decreased by 0.6 m	2
	Decreased by 0.4 m	6
	Decreased by 0.2 m	3
	Increased by 0.2 m	2
	Increased by 0.4 m	8
	Increased by 0.6 m	5
Movement Speed	Decreased by 0.1 m/s	4
	Increased by 0.1 m/s	13
	Increased by 0.2 m/s	12
Talking Speed	1 step slower	8
	1 step faster	17
	2 steps faster	2

5 GPT-4 Prompting Guidance

In order to ensure that the robot stayed on topic and in character throughout the interaction, we used conversation guidance (see section 5.1) and character guidance prompts (see sections 5.2 and 5.3).

5.1 Conversation Guidance Prompts

Table 5: Conversation Guidance Prompts for GPT-4

Prompt Type	Prompt Text
first_hello	You are the user's robot assistant. Greet the user by their name and welcome them home from a long day at work. Make sure to introduce yourself as the robot assistant, your name is Stretch. Do not say anything extra. Must not ask the user any questions.
take_bag	Ask if you can take their bag for them, for example: "May I take your bag for you please". Like offering a hint, tell them they can put the bag in your hand at the end of your robot arm. Must not greet user again. Must offer to take their bag and not say anything else.
sit_couch	Tell the user you cleaned up the apartment and did some household chores. Explicitly and directly tell the user to go sit down and rest at the comfortable couch on their right while you put their bag away.
greet_user	Use a direct question to ask the user how their day went. End with "How was your day?"
respond_greeting	If they said their day was good or neutral, ask them if they did anything interesting today. If their day was bad, offer some sympathy and ask "do you want to talk about it?" Don't ask or suggest anything else off topic. End with a direct question.
your_day	If the user talks about their day, respond appropriately without using a question here. If the user does not want to talk about their day, don't ask anymore, also do not ask them to talk about anything else. After that, must ask the user "do you want to hear something interesting about my day?".
snack_sequence	If the user says yes, tell them something interesting about your day. If the user says no, then just say okay. Must end with offering a snack, ask them if they want potato chips or if they rather have rice crispy treats.
fetching_snack	If they gave you their preference, tell the user their snack of choice is coming right up. If they say anything else, tell them to give you a moment to fetch a snack for them. Must end with telling them your snack is coming right up.
handing_snack	Tell the user that their snack of choice is here and tell them to enjoy the snack.
entertainment	Perform a talk show style news breakdown about {topic} and must only include details about {details}. Start off by saying something like "while you enjoy your snack, I'm going to give you a quick runthrough of the latest news in {topic}. I hope you enjoy it." Address the user by their name. Make sure to perform it with your assigned personality. Must have between 150 to 200 words.

5.2 Vocal Profile Customizations

Table 6: Vocal Profile Customizations for GPT-4

Profile Name	Description
surfer_dude	Young man that is super laid back and likes to surf, very chill, and uses a lot of slang.
surfer_girl	Young woman that is super laid back and likes to surf, very chill, and uses a lot of slang.
business_man	Mature, formal man that is straight to the point and uses formal language as if he is in a board meeting.
business_girl	Mature, formal woman that is straight to the point and uses formal language as if she is in a board meeting.
teenager_boy	Young 12-year-old boy that is happy, immature, friendly, and uses a lot of "like", "um", and "uhs".
teenager_girl	Young 12-year-old girl that is happy, immature, friendly, and uses a lot of "like", "um", and "uhs".
old_man	Old man that is very wise, uses a lot of wisdom, and is jolly like Santa.
old_woman	Old woman that is very motherly, worries a lot about you, and is very caring.
meditation_woman	Young woman that has inner peace, mindfulness, and a deep connection with her surroundings, often radiating calmness and serenity.
butler_man	50-year-old servant man that is very formal, attentive to your needs, and very polite.
robot	You are a mechanical robot with gears, oil, and parts.

5.3 System Customization Prompt

Table 7: System Customization Prompt for GPT-4

Customization Type	Prompt Text
system_customization	You are a robot assistant. Your words have to embrace the personality of a {vocal_profile}. Don't ever explicitly mention that you are this.

6 Post-Experiment Questionnaire

6.1 Adherence to User Preference

How well do these statements describe the robot during your interaction with it?

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
The robot's behavior (e.g., movement speed, speech, voice, etc) closely aligns with my preference in how I want the robot to behave.	○	○	○	○	○	○	○
I was able to easily modify the robot's behavior (e.g. movement speed, speech, voice, etc) to better match my preferences.	○	○	○	○	○	○	○
The robot adapted its behavior (e.g. movement speed, speech, voice, etc) to better match my preferences.	○	○	○	○	○	○	○
How satisfied were you with the level of control you had over the robot's behavior (e.g. movement speed, speech, voice, etc)?	○	○	○	○	○	○	○

Figure 3: Questionnaire Items for Preference Adherence.

6.2 Non-deterministic Autonomy

Please select how you best feel about each statement.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
The robot can adapt its behavior in real-time, reacting to external stimuli with unscripted, autonomous actions that are not pre-determined or pre-programmed by me.	○	○	○	○	○	○	○

Figure 4: Questionnaire Items for Perceived Autonomy.

6.3 Perceived Agency

How well do these statements describe the robot during your interaction with it?

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
The robot acts with purpose	○	○	○	○	○	○	○
The robot's has goals	○	○	○	○	○	○	○
The robot can create new goals	○	○	○	○	○	○	○
The robot can communicate with people	○	○	○	○	○	○	○
The robot treats others as if they had a mind	○	○	○	○	○	○	○
The robot wanted to perform these actions	○	○	○	○	○	○	○
The robot can show emotions to other people	○	○	○	○	○	○	○
The robot can change their behavior based on how people treat them	○	○	○	○	○	○	○
The robot can adapt to different situations	○	○	○	○	○	○	○
The robot would do well in other environments	○	○	○	○	○	○	○
The robot can perform many different types of tasks	○	○	○	○	○	○	○

Figure 5: Questionnaire Items for Perceived Agency.

Drag the slider to indicate from 1 (terrible) to 5 (great) how well you think the robot will do in each scenario.

Figure 6: Scenario Questions for Perceived Agency.

6.4   Social Presence

Please select how you best feel about each statement.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
During the interaction with the social robot, I noticed it	○	○	○	○	○	○	○
The social presence of robots is obvious to me	○	○	○	○	○	○	○
I think social robots receive my attention in interactions	○	○	○	○	○	○	○
I think that when interacting with robots, we co-exist in the space in the present moment	○	○	○	○	○	○	○
It helped me in the process of interacting with the social robots	○	○	○	○	○	○	○
I was able to work with social robots to complete a job	○	○	○	○	○	○	○
The behaviour of a social robot is based on my behaviour	○	○	○	○	○	○	○
The behaviour of a social robot during an interaction is closely related to my behaviour	○	○	○	○	○	○	○
I do not think the social robot understands my expressions when I interact with it	○	○	○	○	○	○	○
I think social robots are able understand my thoughts correctly	○	○	○	○	○	○	○
I think I am able to communicate with social robots through language	○	○	○	○	○	○	○
I think the social robots in our interactions affected how I felt	○	○	○	○	○	○	○
The attitude of the robot during the interaction influenced my feelings	○	○	○	○	○	○	○
I felt the atmosphere between us during the interaction	○	○	○	○	○	○	○
It is easy for me to become distracted from interacting with the robot when other things are going on	○	○	○	○	○	○	○
Social robots are easily distracted when interacting	○	○	○	○	○	○	○
I keep an eye on the social robot as I interact with it	○	○	○	○	○	○	○

Figure 7: Questionnaire Items for Social Precense.

6.5   Social Intelligence

Please select how you best feel about each statement.

This robot is...
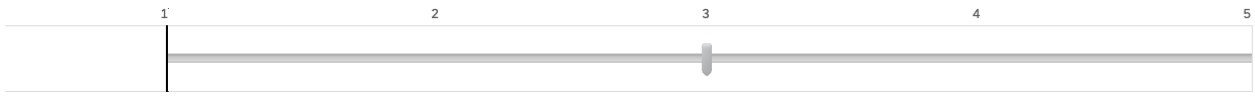
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
notices human presence	○	○	○	○	○
enjoys meeting people	○	○	○	○	○
notices when people do things	○	○	○	○	○
adapts effectively to different things people do	○	○	○	○	○
anticipates people's behavior	○	○	○	○	○
tries to be helpful	○	○	○	○	○
is trustworthy	○	○	○	○	○
cares about others	○	○	○	○	○
recognizes human emotions	○	○	○	○	○
responds appropriately to human emotion	○	○	○	○	○
anticipates others' emotions	○	○	○	○	○
tries to hurt people	○	○	○	○	○
can figure out what people think	○	○	○	○	○
adapts its behavior based upon what people around it know	○	○	○	○	○
thinks it is better than everyone else	○	○	○	○	○
anticipates others' beliefs	○	○	○	○	○
is impolite	○	○	○	○	○
is socially competent	○	○	○	○	○

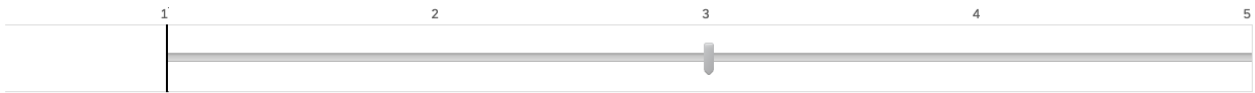Figure 8: Questionnaire Items for Social Intelligence.

6.6 Perceived Intelligence (Godspeed)

Q115

On a scale of 1 (**incompetent**) to 5 (**competent**), please rate the robot based on your interaction with it.
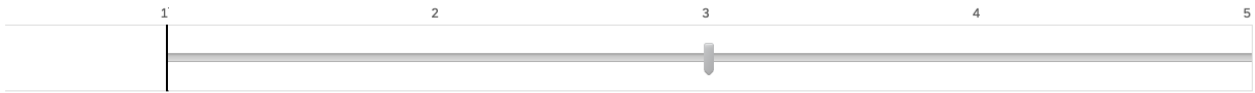
| 1 | 2 | 3 | 4 | 5 |

Q116

On a scale of 1 (**ignorant**) to 5 (**knowledgeable**), please rate the robot based on your interaction with it.
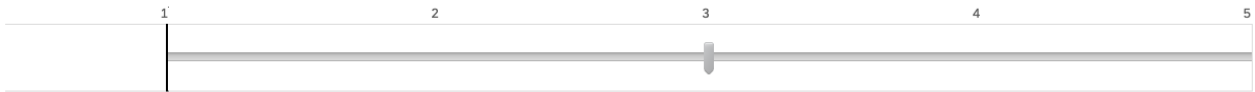
| 1 | 2 | 3 | 4 | 5 |

Q117

On a scale of 1 (**irresponsible**) to 5 (**responsible**), please rate the robot based on your interaction with it.
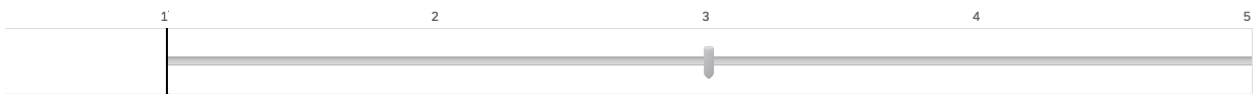
| 1 | 2 | 3 | 4 | 5 |

Q118

On a scale of 1 (**unintelligent**) to 5 (**intelligent**), please rate the robot based on your interaction with it.

| 1 | 2 | 3 | 4 | 5 |

Q119

On a scale of 1 (**foolish**) to 5 (**sensible**), please rate the robot based on your interaction with it.

| 1 | 2 | 3 | 4 | 5 |

Figure 9: Questionnaire Items for Perceived Intelligence.

6.7 Overall Interaction Experience

Please select how you best feel about the overall robot system in the context of your interactions with it today. Note: the system refers to the robot and any computer interfaces you may have used to interact with it (e.g., communicate to the robot what your name is)

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I enjoyed using this system.	○	○	○	○	○	○	○
I want this system in my home.	○	○	○	○	○	○	○
My interaction with the system was engaging.	○	○	○	○	○	○	○
My interaction with the system felt stagnant.	○	○	○	○	○	○	○

Figure 10: Questionnaire Items for Overall Participant Enjoyment.

6.8 Short Answer Questions

Q124

Please briefly describe your impressions of the system as a whole. You're encouraged to note down specific things in the experience that stood out to you. Note: the system refers to the robot and any computer interfaces you may have used to interact with it (e.g., communicate to the robot what your name is)

Q148

Based on the interaction you just had with the robot, what aspect(s) of the robot's behavior would you want to change?

Q149

Do you feel confident in being able to make the change(s) with the computer interface you used before entering the room with the robot?

Figure 11: Short Answer Questions.