Negotiating with a robot: Analysis of Regulatory Focus Behavior

Arturo Cruz-Maya and Adriana Tapus
Autonomous Systems and Robotics Laboratory, U2IS
ENSTA ParisTech, Université Paris-Saclay
828 bd des Maréchaux, 91762 Palaiseau cedex France
{firstname.lastname}@ensta-paristech.fr

***Abstract*— Companion robots are more and more taking the role of caregivers for elderly people. Elderly people sometimes take the advice given by their family members or caregivers as a criticism. In this context, persuasive communication skills could be helpful. A social psychology theory called Regulatory Focus states that people have one of two inclinations when taking decisions: Promotion or Prevention Focus. Also, based on these inclinations, people can be influenced by the way the message is sent, including the speed of the speech and the amplitude of body gestures. In this paper, we analyze the influence of Regulatory Focus on a negotiation scenario, using 3 conditions: (1) a robot with a promotion behavior, (2) a robot with a prevention behavior, and (3) a robot with a neutral behavior. Our results support the results found in the psychology literature related to Regulatory Focus, suggesting that Promotion participants were more influenced by the robot showing a Promotion based behavior. Moreover, Prevention participants were more relaxed on the condition with the robot showing a Prevention based behavior, and accepted the biggest concession between the initial and final offer.**

I. INTRODUCTION

Our society is growing older. The number of caregivers for older adults is expected to decrease from currently 10-12 per older adult to just 2-3 persons in 2050. Companion robots will be more and more needed so as to complement the caregivers. Elderly people sometimes take the advice given by their family members or caregivers as a criticism, when for example are asked to take their medication, or are reminded to make a phone call. In this context, persuasive communication skills could be helpful.

Some research works have been done in the field of Human-Robot Interaction (HRI) with the purpose of finding a good manner on how robots should give advice to their users. In [17], the authors analyzed robot advice and strategies based on human-human interactions. Furthermore, the authors in [18] made use of hedges (to soften what was said) and discourse markers, such as "kind of" and "basically". It was found that when the robot used these features, it seemed more considerate, likable, and less controlling. Another study designed for motivating the elderly during physical exercises with a coach robot, found evidence that support the use of relational discourse in increasing intrinsic motivation [9]. A study in Human-Robot Negotiation using a telepresence robot, proposes the use of handshaking before the negotiating phase, which resulted in increased cooperation between negotiators [4].

Moreover, in the context of negotiation between humans and robots, guilt and agency have been investigated, but the results suggest that these factors have no influence on the overall concession in the negotiation task [16].

In this context, and part of the EU Horizon2020 ENRICHME project, we propose the use of different robot's behaviors for HRI, based on the Regulatory Focus Theory, to increase user's performance. Nevertheless, before starting working with the final target population, the elderly, we would like to analyze the stress generated on the users with a younger age group (average age of 27.7 years).

A. Regulatory Focus and Regulatory Fit

Regulatory Focus is a theory from social psychology proposed by Crowe and Higgins [7]. The Regulatory Focus theory proposes the existence of two types of self regulatory states that influence the motivation to perform a task. These states are: Chronic Promotion Focus and Chronic Prevention Focus. Individuals with a higher level of Promotion Focus are more likely to take risks in order to maximize their gains and individuals with higher level of Prevention Focus are more cautious when taking decisions and they focus on not having losses.

Higgins [12] also proposes Regulatory Fit, a theory linked to the Regulatory Focus, which can be viewed as follows: if an individual receives a message with the same frame as their own regulatory state (promotion or prevention), they are more likely to do what the message says, by increasing the motivational orientation of the person. In [6], the authors discuss the use of Regulatory Fit so as to increase the effectiveness in changing attitudes and behavior.

An increase of persuasiveness can be achieved by non-verbal cues such as body gestures and the speed of the speech. Making a lot of movements, leaning forward, and speaking faster, are more persuasive cues for individuals with Chronic Promotion State. Instead, making precision gestures and speaking more slowly, are more persuasive cues for individuals with Chronic Prevention State [5].

B. Regulatory Focus and Negotiation in HRI

As stated by Higgins [12], fit has significant implications for improving the quality of life in interpersonal conflicts and the negotiation process needs to be fair and equitable. In Human-Robot Interaction, if the robot expresses a behavior matching the regulatory focus state of the users, the users could increase their satisfaction with the negotiation and

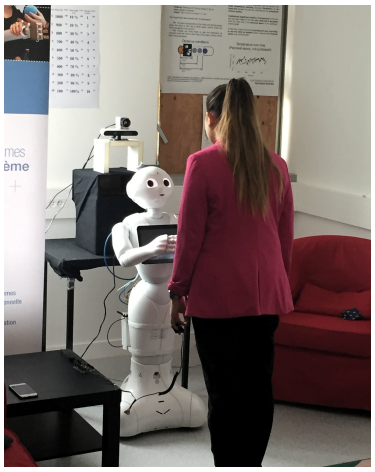

Fig. 1: Negotiation scenario with a Pepper Robot

commitment to the agreement, which could imply less stress on them.

To the best of our knowledge, Regulatory Focus and Regulatory Fit have not been studied before in a negotiation scenario in HRI. Personal robots could use the behaviors from human-human interaction proposed in the field of social psychology, with the purpose to be more persuasive on their roles in Human-Robot Interaction. A way of testing their persuasion style, a negotiation game could be used. Regulatory Focus in the context of negotiation has been studied in human-human interaction. In [11], the authors found that promotion focused negotiators achieved more advantageous distributive outcomes than did prevention focused negotiators. Other study [2], shows that when negotiation focuses on price, buyers adopt a prevention focus strategy and sellers adopt a promotion strategy.

In this paper, we present an analysis of three different robot behaviors: robot control condition, robot Promotion based behavior, and robot Prevention based behavior. The behavior of the robot was presented to the user in a negotiation scenario (see Fig. 1). Also, participants were divided in groups based on their Regulatory States: in Promotion and Prevention groups, respectively.

This paper is organized as follows: Section 2 describes the experimental design setup; Section 3 shows the results obtained; and finally Section 4 concludes the paper.

II. EXPERIMENTAL DESIGN SETUP

A. Hypothesis

Based on the Regulatory Focus and Regulatory Fit theories, described in section I-B, we propose the following hypotheses:

- H1) Participants with Chronic Promotion Focus, interacting with a robot in a Negotiation scenario, will give more concessions when the robot shows a Promotion based behavior, than when the robot shows a Prevention based behavior.
- H2) Participants with Chronic Prevention Focus, interacting with a robot in a Negotiation scenario, will give more concessions when the robot shows a Prevention based behavior, than when the robot shows a Promotion based behavior.
- H3) Participants matching their Chronic Regulatory Focus with the robot behavior, will be less stressed than the participants not matching their Chronic Regulatory Focus with the robot behavior.

B. Negotiation game Scenario

The negotiation game used in this work, was first proposed in the field of psychology in [8], and modified and used in HRI by [16]. In this game, participants were instructed to play the role of a seller, selling a mobile phone to a robot. The negotiation included three features to negotiate: price, warranty, and services. Also there were ten levels of these features, where the first level was the most convenient for the sellers, and the last level was the most convenient for the robot. Participants were told that each feature had associated an amount of points that they could gain as sellers if they succeeded selling the phone. The first level contained the highest price, the lowest warranty, and the lowest services, with 100 points associated to each feature. The last level contained the lowest price, the highest warranty, and the lowest services, with 10 points associated to each feature. This information was also posted on the wall behind the robot, so users could see it at any moment.

The game started with the robot (buyer) saying its offer in terms of the levels of the three features, then the participant (seller) accepted or refused the offer. The interaction was done by using voice commands. In this step, the robot recognized the commands of ”yes” and ”no”. If the user said ”no”, the robot asked for the level of each feature, here the robot recognized the commands of ”level one”, ”level two”, and so on until ”level ten”.

The robot (buyer) followed a predetermined pattern of offers, in order to present the same pattern to all the participants and avoid inconsistences on the offers. The pattern followed by the robot was proposed in [8] in order to represent a cooperative-competitive strategy in the same pattern.

If the offer of the participant was better than the next offer in the pattern followed by the robot, then the robot accepted the offer of the participant and the negotiation finished. In the opposite case, the robot started a new round and this was repeated by a maximum of seven rounds. Participants were told that after some rounds, if they did not agree with the robot, it would say ”good bye” and they could not sell the phone.

C. Robot Platform

The robot used in this work was the Pepper robot designed by Softbank robotics, which has the capabilities of face detection and tracking, voice recognition, and movement of the body and head to track the user. These capabilities are provided by the NaoQI framework. We disabled the tracking with the body of the robot and let working only the movement of the face. Also, we used the naoqi ROS driver to communicate the different modules used in the experiment.

D. Robot Speech

Each time the robot refused an offer, it took a random phrase from the list presented below:

- I consider that a better agreement should be (offer)
- Perhaps a better idea would be (offer)
- I am looking for a better package, I would like (offer).
- I'm afraid I could not agree to that, I propose (offer)
- I was hoping for something around (offer)
- I would not expect to pay more than (offer)
- I am afraid your offer does not go far enough, I propose (offer)

When the robot accepted the offer of the participant, it said "I think we have reached an agreement here". And in the case the robot finished the round seven, it said "We did not agree, I'm leaving, good bye".

To our understanding of the Regulatory Focus Theory, the used phrases do not represent any "promotion" or "prevention" strategy, since they are not stating the reward in the message.

E. Robot Speech Recognition

We used the module "ALSpeechRecognition" of the Naoqi Framework using the English language and the dictionary of the recognized words was the following: dictionary = ["yes", "no", "level one", "level two", "level three", "level four", "level five", "level six", "level seven", "level eight", "level nine"]. The speech recognition was paused each time the robot talked, in order to avoid self voice recognition of the robot. The recognized words were saved in the memory using the module "ALMemory", subscribing to the event "WordRecognized". Each time the robot recognized a word, we compared to the words on the dictionary and if its associated probability valued surpassed a threshold of 30%, then the message was sent to the robot to execute the corresponding behavior.

F. Conditions

42 participants (37 men, 5 women) were recruited to take part in this experiment, 5 of them were discarded, 4 participants because of false speech recognition by the robot, finishing the experiment unexpectedly, and the other participant because of an important instruction missed by the experimenter.

There were 3 conditions: (1) the control condition, (2) the robot promotion based behavior condition, and (3) the robot prevention based behavior condition. The robot behaviors were designed accordingly to the theory of Regulatory Focus [5].

Participants of both Promotion and Prevention Regulatory Focus, were randomly assigned on each condition. In the control condition participated 7 promotion participants and 4 prevention participants. In the Promotion robot condition participated 6 promotion participants and 5 prevention participants. And finally, in the Prevention robot condition participated 10 promotion participants and 5 prevention participants.

1) Control Condition: In the control condition, the robot only moved its head, tracking the face of the participants. The speed of its voice was the default speed.

2) Promotion Based Robot Behavior Condition: In the Promotion Behavior condition, the robot beside moving its head, showed moving outward gestures, and it was leaning forward towards the participant. The speed of its voice was set to 115% of the default speed.

The postures of the Promotion based robot behavior are shown in Fig. 2. For each one of the two phrases, the robot chose randomly one posture.

The postures were designed using the Choregraphe Software and were run using the Module "ALAnimationPlayer". All of them started from the "Stand" posture of the module "ALRobotPosture".

The design of the movements of the robot was done using the Motion timeline of Choregraphe. An example of the angles and time used on this work is showed below, running from Timeline 1 to Timeline 3.

Behavior (a) (see Fig. 2).

Timeline 1, Frame 18: [RElbow: 76,4°, RElbowYaw: 74,4°, RHand: 0,56°, RShoulderPitch: 89,8°, RShoulderRoll: -11,0°, RWristYaw: 32,4°].

Timeline 2; Frame 12-40: [RElbow: 76,4°, RElbowYaw: 74,4°, RHand: 0,86°, RShoulderPitch: 35,5°, RShoulderRoll: -37,1°, RWristYaw: 73,8°].

Timeline 3, Frame 18: [RElbow: 76,4°, RElbowYaw: 74,4°, RHand: 0,56°, RShoulderPitch: 89,8°, RShoulderRoll: -11,0°, RWristYaw: 32,4°].

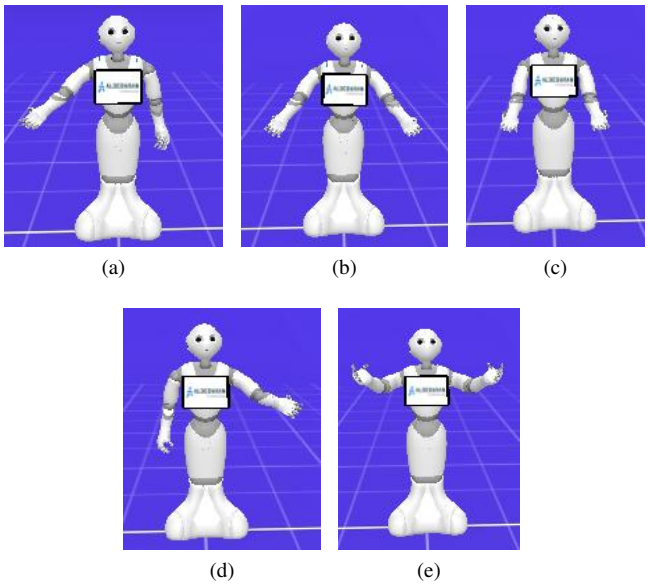

Fig. 2: Postures of the Promotion based robot condition

3) Prevention Based Robot Behavior Condition: In the Prevention Behavior condition, the robot beside moving its head, showed pushing down gestures. The speed of its voice was set to 85% of the default speed.

The postures of the Prevention based robot behavior are

shown in Fig. 3. For each one of two phrases, the robot showed randomly one posture.

G. Regulatory Focus Questionnaire - Proverb Form

A Pre-experiment questionnaire was applied to the participants in order to obtain their Chronic Regulatory State. This questionnaire is called: Regulatory Focus Questionnaire - Proverb Form (RFQ-PF 18 items), originally developed in French [10]. For our experiment, we used a translated version of the proverbs, using their English version. Only one proverb, for which we did not find an equivalent one, was substituted.

Unlike other questionnaires of Regulatory Focus, this one does not depend only on the personal history of the individual, like the Regulatory Focus Questionnaire [13]. Also, it is not related to academic questions such as the General Regulatory Focus Measure [15]. Instead, using proverbs allows to evaluate the chronic regulatory state in a discrete and subtle manner.

H. Measures

In order to validate our hypotheses, we used the average level of the offer of the participants, taking the initial offer, the final offer, and the difference between them (improvement of the offer), also the rounds taken on the negotiation, and the success or not in selling the phone, this last measure can be seen also as the success of the robot in buying the phone at a cheap price and/or advantageous warranty and service. All the trials were taken into consideration, even the ones where there was no agreement, because we consider a measure of robot persuasiveness as successful if the robot "sell the phone".

Also, we measured some physiological signals: respiration rate, heart rate, blinking rate, and skin conductance of the participants. All of them were measured with the purpose

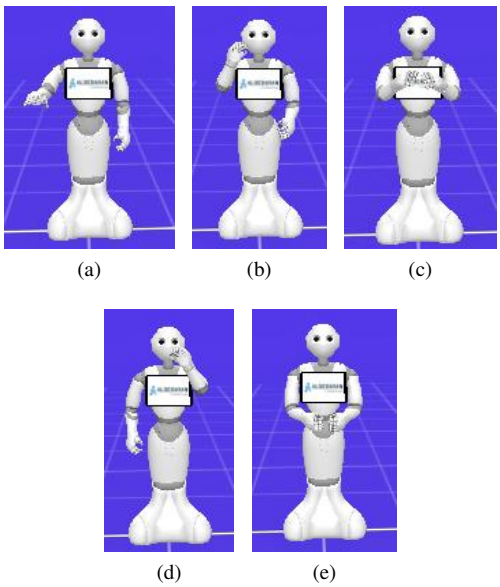

Fig. 3: Postures of the Prevention based robot condition

Fig. 4: Negotiation scenario with a Pepper Robot

to detect stress and anxiety on the participants. Some of these measures were recorded using external sensors (the GSR sensor or the Thermal camera). The respiration rate, heart rate, and blinking were recorded using an external Asus Xtion RGB-D camera. We used the Asus Xtion RGB-D camera, instead of the one included on the Pepper robot, to facilitate the detection of the Faces for its post analysis.

The faces and facial features were detected using the Dlib toolkit [14] (see Fig. 4). We used the Grove - GSR Sensor to measure the skin conductance [1]. The method used to extract the blinking rate is presented in [1]. For comparison of the measures registered with the sensors, we used a linear regression on the filtered data, using the difference between the beginning and the end of the regression of the signal. The only exception was the blinking, which was measured using the total number of blinks detected.

Furthermore, the participants completed the Godspeed Questionnaire [3] (sections for Likability, Perceived Intelligence, and Perceived Safety).

III. RESULTS AND DISCUSSION

We found statistical differences between the groups of participants when the robot behavior matched their Chronic Regulatory State and the groups of participants when it did not matched. The results of the measures of the negotiation game are shown in Table I.

The groups of participants and conditions are described below:

- Condition 1: Control Condition
- Condition 2: Robot Promotion Condition
- Condition 3: Robot Prevention Condition
- Group A: Condition 1 - Promotion Participants
- Group B: Condition 1 - Prevention Participants
- Group C: Condition 2 - Promotion Participants
- Group D: Condition 2 - Prevention Participants
- Group E: Condition 3 - Promotion Participants
- Group F: Condition 3 - Prevention Participants

We started our analysis with an one-way ANOVA, using the different groups of the experiment as factors. We did

[1] http://wiki.seeed.cc/Grove-GSR_Sensor/

TABLE I: Mean and Std Deviation of the measures on the negotiation game

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Group	Sucess	rounds	init. offer	final offer	improv. offer
	Mean - Std Dev	Mean - Std Dev	Mean - Std Dev	Mean - Std Dev	Mean - Std Dev
A	0.28 - 0.48	6.00 - 1.73	3.28 - 1.59	6.19 - 0.66	2.90 - 1.15
B	0.25 - 0.50	6.25 - 1.50	3.83 - 1.13	5.83 - 0.88	1.50 - 0.79
C	**1.00 - 0.00**	4.83 - 0.75	3.61 - 1.92	**6.72 - 0.25**	3.11 - 1.81
D	0.40 - 0.54	5.80 - 1.30	3.53 - 1.67	5.66 - 1.45	2.13 - 1.21
E	0.70 - 0.48	4.80 - 1.98	4.19 - 2.03	6.43 - 1.52	2.23 - 1.73
F	0.20 - 0.44	6.20 - 1.78	**1.73 - 1.64**	5.93 - 0.98	**4.20 - 2.03**

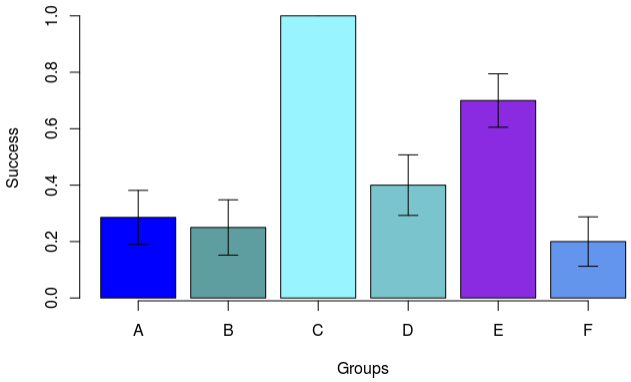

Fig. 5: Robot success selling the phone by Group

not found any statistical difference among the groups. As this could be due to the small size of the groups, we proceeded with pairwise comparisons between the groups and the factors of interest. In the following subsections, we discuss the results of the measures, linking them with each formulated hypothesis.

A. *Hypothesis 1*

Participants with Chronic Promotion Focus effectively gave more concessions to the robot when it presented a Promotion based behavior (Group C). It can be seen in Table I, the scale goes from 0 to 1, where 1 means 100%, Group C was the only group where the robot achieved 100% of success on the negotiation. These results are shown in Fig. 5. The t-test between the Control Condition and the Promotion condition (Group A an Group C) shows a $p = 0.007$. Also, there are significant differences between groups B, D, and F with p values of 0.0148, 0.0353, and 0.0062, respectively.

Participants from Group C sold the phone to the robot, which was good for them, but also, they did at the expense of selling it at a good price for the robot (mean final offer of 6.72), they did the highest offer of all groups.

There is no significant difference on the rounds of the negotiation. Nevertheless, the Promotion people did less rounds than the Prevention people in all conditions. This can be due to the differences on the inner strategy of Promotion and Prevention people, where the tendency of Promotion people to take risks can lead them to make higher offers.

Moreover, we found evidence that support the Regulatory Focus and Regulatory Fit theories for Promotion Focus individuals, and that is possible to increase the persuasiveness of a robot in a negotiation game. This could be useful for personal robots, requiring such capabilities when negotiating with their users in everyday life.

B. *Hypothesis 2*

Participants with Chronic Prevention Focus did not give more concessions to the robot on the negotiation game when it presented a Prevention behavior (Group F).

It is possible that due to the strategy of prevention individuals, they did not make high offers to the robot, because they could had been trying to minimize their losses. This idea is reinforced by the results on the initial offer of the group (1.73), the lowest offer of all groups, significantly different than the group E (t-test $p = 0.016$). The robot showing a Prevention behavior matched their own Prevention Focus, which could result in an increase on their motivation and strategy.

Moreover, this group increased their offer as no other group (see Table I), it is shown in Fig. 6. The t-test analyzing this group against the groups B, D, and E, presents p values of 0.015, 0.045, and 0.029, respectively. The explanation, accordingly with the Regulatory Fit theory could be that, the matching of the behavior of the robot with the user regulatory state, generated more satisfaction on the participants, which is linked with the Hypothesis 3 and the stress of the participants.

C. *Hypothesis 3*

This hypothesis was half supported: only participants with Chronic Prevention Focus showed differences on the conditions.

There was only one significant difference between the groups using the measures obtained with the GSR sensor, heart rate, respiration rate, and blinking. The results of these physiological signals are presented in Table II. Example of these physiological signals are shown in Fig. 7. Nevertheless, we found some correlations presented on the groups of Prevention Focus individuals.

The measure related with the stress level on the participants that gave significant differences was the heart rate. Participants with Chronic Prevention on the condition with the robot showing a Promotion based behavior (Group D), were the ones who showed the highest heart rate. While participants with Chronic Prevention on the condition with

TABLE II: Mean and Std Deviation of the measures of the physiological signals of the different groups

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Group	Heart rate	Resp. rate	Blinking	GSR
	Mean - Std Dev	Mean - Std Dev	Mean - Std Dev	Mean - Std Dev
A	-0.75 - 4.97	0.88 - 2.41	96.16 - 35.89	-51.16 - 96.60
B	4.38 - 9.40	1.26 - 0.58	98.33 - 57.70	-29.54 - 19.79
C	-0.69 - 4.06	1.36 - 2.64	63.00 - 16.38	-36.98 - 45.20
D	**5.19 - 9.72**	0.40 - 2.71	127.60 - 50.55	-10.86- 19.28
E	0.23 - 9.48	1.41 - 2.66	94.87 - 64.60	-13.66 - 38.24
F	**-5.23 - 6.02**	-0.37 - 2.36	152.00 - 143.75	-19.23 - 47.05

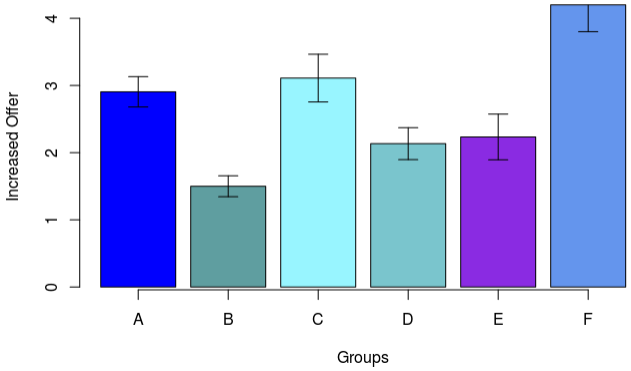


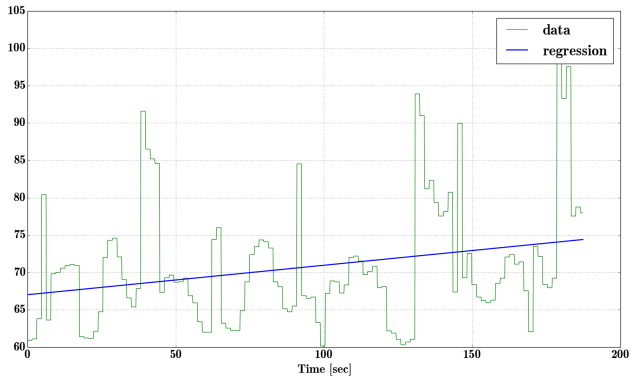
Fig. 6: Increased offer by Group

the robot showing a Prevention based behavior (Group F) showed the lowest heart rate. The group D presented a significant difference, applying a t-test, against the groups A (Control condition) and F (Prevention robot) with p values of 0.0451 and 0.0074, respectively. This could mean, that participants with Prevention Focus interacting with the robot that did not match their Regulatory Focus, experienced more stress than participants interacting with the robot that matched their Regulatory Focus.

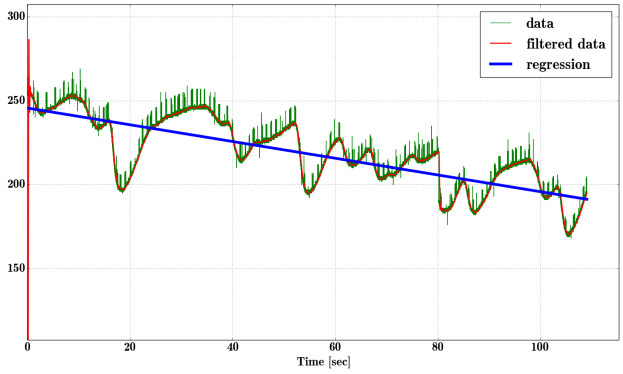
The correlations found on Prevention participants are associated with the GSR data. The results of the Pearson Test are shown in Table III. In the control condition, participants with Chronic Prevention state (Group B) presented a positive correlation between the respiration rate and the skin conductance (GSR), which could be related with an increase on the stress. In the Robot Promotion condition, participants with Chronic Prevention state (Group D) presented a positive correlation between the Prevention score and the GSR, which means that while more dissociated the Regulatory state of the participants and the behavior of the robot, higher the stress on the participants. In the Robot Prevention condition, participants with Chronic Prevention state (Group F) presented a positive correlation between the rounds of the negotiation and the GSR, this could mean just that, with more time expended on the negotiation, more stress on the participants.

D. Godspeed Questionnaire

The Godspeed questionnaire, showed that the less likable behavior of the robot was the one of the control condition



(a)



(b)

Fig. 7: (a) Increase on Heart rate of one participant of Group D. (b) decrease on skin conductance (GSR) of one participant of Group F.

TABLE III: Correlations found on the physiological signals

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Resp. rate and GSR - Pearson Test				
Group	Correlation	P-value	t	df
B	0.9991	0.02698	23.584	1.0000
Prevention score and GSR - Pearson Test				
Group	Correlation	P-value	t	df
D	0.9406	0.0171	4.8029	3.0000
Rounds and GSR - Pearson Test				
Group	Correlation	P-value	t	df
F	0.9452	0.0152	5.0168	3.0000

for the Chronic Prevention participants (Group B). The robot of the group F was rated as the less intelligent of all groups. Finally, there were no differences on the safety perception of the robot between the conditions.

IV. CONCLUSION AND FUTURE WORK

In this work, we presented a study on robot behaviors based on the Regulatory Focus and Regulatory Fit theories, in a negotiation game scenario. Our results support these theories, and open new the possibilities in Human-Robot Interaction, in particular in social robotics, to design robot behaviors, that can be of great impact in situations where the robot need to persuade their users in a certain tasks.

The results were easily identifiable for participants with Chronic Promotion Focus (their own inner strategy is to take risks in order to maximize gains). However, it was not the case for participants with Chronic Prevention Focus (their own inner strategy is to minimize losses). The opposite was obtained when analyzing the physiological signals: the significant differences were only found on Prevention participants.

Moreover, we observed that in the condition with the robot with Promotion based behavior, participants responded faster than in the other conditions. This effect could had been generated, because of the voice rate of the robot, which was the fastest of the three conditions.

In addition, it is possible that the instructions given to the participants played a role on the experiment, activating more the Promotion Focus on the participants, because they were expressed in terms of gaining the more amount of points when selling the phone to the robot.

In future developments, we plan designing an adaptive behavior based on the theories used in this work, in order to minimize the stress caused to the users, while increasing the persuasiveness of the robot.

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