Influence of user's personality on task execution when reminded by a robot

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Abstract. One of the main purposes of companion robots is to use them to remind their users about the tasks they have to do. The interaction requires robots to adapt to the person with respect to their preferences. The performance of the human when a robot reminds them to do a certain task is of great importance. Findings in social psychology show that personality influences the way that humans interact. In this work, we conducted an experiment of task reminders in an office-like environment with a robot reminding tasks to a person while the person is doing other office-activities, with the goal of searching for positive influences of the robot on user's personality. Nine different conditions were studied with the robot varying its behavior and appearance. Results show that the user's personality has an influence on his/her time to perform a task while being reminded by a robot to perform such task, showing that people with high conscientiousness are more promoted by the robot to finish the task earlier than people with low conscientiousness, and also that introverted people are more motivated by the robot to finish the task earlier than extroverted people.

1 INTRODUCTION

In recent years, the number of projects around the world aimed at developing companion robots has increased considerably. Developing companion robots for health care for the elderly is a challenge and a need [6] [4] [14]. Social robots used in therapy for children with autism have been an active field of research in the past years [16][3]. Companion robots were also used in education, work environments, and public spaces [11].

Having robots helping us with our daily activities lead to the need of endowing them with social capabilities in order to adapt their behavior to the environment and tasks. Nevertheless, how to achieve this adaptation remains a challenge. Some important features for social robotics are the synthesis and recognition of emotions in order to be more appealing to humans and to be perceived as more useful and expressive [10].

Moreover, in order to provide a customized interaction, the robots can be endowed with various personality traits according to the different types of tasks to be performed [8] [17].

Works in social psychology have shown that people with different kinds of personality have different preferences to interact. According to [18] extroverts allow closer interactions than introverts, but this can be influenced depending on the person's height [2]. Likewise, a study on smiling faces have proved that a smile has an impact on the behavior of people watching the smiling face [15]. Also, the personality trait of conscientiousness has shown to be linked to the performance of people when receiving orders [9].

To the best of our knowledge, no previous work explores the effects of distance, height, and smile of a robot while reminding a task to a person in order to improve their performance based on his/her personality. Therefore, in this work, we investigate the mentioned effects in relation with two traits of personality (conscientiousness and extroversion). The scenario is an office-like environment where the robot provides reminders of a schedule to the participant while the participant is busy with another task.

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.

2 EXPERIMENTAL DESIGN SETUP

2.1 Hypothesis

Personality is an important factor in human social interaction, and has a long-term consistent effect on the generated human multimodal behavior. The authors in [13] defined personality as the coherent and collective pattern of emotion, cognition, behavior, and goals over time and space. Therefore, it is important to consider the relationship between personality, goals, and performance in human-robot interaction.

According to the definition of introverts and extroverts, we can expect more observable social behavior of the extroverts, and also that they will prefer a closer interaction than introverts [18]. In human-human interaction people prefer to interact with a person with small height [2], and also the smile has an influence on the person's behavior [15]. The authors in [1] showed that the most consistent personality predictor for task performance is conscientiousness. Some adjectives that are usually used to describe people with high conscientiousness are responsible, organized, and achievement oriented.

Based on the above statements and the literature, we elaborated the following hypotheses:

- H1. High conscientiousness people perform better in time when reminded by a robot than low conscientiousness people.
- H2. Close interaction (at the limit of interpersonal distance [7]) will be preferred by extroverted people and far interaction (1.5 times the limit of interpersonal distance) will be preferred by the introverted people in the task reminder.

Fig. 1: Office-like scenario with the Meka M-1 robot

– H3. Participants will prefer to interact with a small robot rather than with a tall robot.
– H4. Participants will be motivated to finish a task earlier when the robot shows a smile on its face.

2.2 Office-like Scenario Description

The scenario used to test and validate our hypotheses is an office-like environment, shown in Figure 1, where the user is asked to reply to as many e-mails as he/she can in a series of 10 emails. The total allotted time is 6 minutes (maximum bound). Two e-mails are labeled as urgent: one is a reminder of a meeting, and the other is a request for an activity report that should consist of 30 to 100 words. The others 8 emails are related to personal or work relations, where the user can reply with short answers. At the same time, a schedule to follow is given to the user, but the user is free to choose if he/she wants to follow the schedule or not. The schedule marks a break between minutes 2 to 4 after the beginning of the activity, and an important meeting between minutes 4 to 6 (time to go to the meeting). One minute before the specified time of the activities and at the exact time of these, the robot approaches the user to remind him/her of the activities.

2.3 Robot Behavior

The Meka M-1, is a wheeled humanoid robot that has been designed to work in human-centered environments. At the moment of the reminder, the robot goes in front of the participant and reminds him/her the activity on the schedule. After that, it waits for the response of the participant.

In order to avoid speech recognition system limits (in the case of non native English speakers), the user answers by showing a card that is recognized by the robot. There are 4 cards with meanings of: 1. “Thank you”, 2. “Remind me later”, 3. “I already did it”, and 4. “Don’t remind me again”. If the user shows the cards 3 or 4, the robot will not remind that activity again.

The reminders of the robot were designed in consideration of the criteria for good reminders [12], and their verbal content is presented as follows:

– Taking a break: ”Hello, remember to take a break from your computer”.

Table 1: Robot factors varying for each condition

Condition	Code	Height	Distance	Smile
1	—	NA	NA	NA
2	TCN	Tall	Close	Off
3	TCE	Tall	Close	On
4	TFN	Tall	Far	Off
5	TFE	Tall	Far	On
6	SCN	Small	Close	Off
7	SCE	Small	Close	On
8	SFN	Small	Far	Off
9	SFE	Small	Far	On

– Going to a meeting: "I would like to remind you about the meeting with your boss in few minutes. It will take place in the Meeting room".

In order to avoid repetitions, two different phrases with similar meaning have been developed for each reminder.

2.4 Pre-experiment Questionnaire

We recruited 16 participants for this experiment (4 Female, 12 Male) from ENSTA ParisTech university campus. Participants ages ranged from 21 to 32, all with technical background.

Participants were asked to fill out the Big Five inventory prior to participation so as to determine their position on the extroversion-introversion and conscientiousness spectrums [5]. This questionnaire contains 44 items each with 5-point Likert scale that ask the participant to rate their agreement or disagreement with statements about their own personality and activities. The score of the test gives values between 1 to 5. People with a score $<= 3$ on a personality trait was considered in the low category of the examined personality trait. For our study, we looked only at the extroversion and conscientiousness traits.

For the conscientiousness trait, we selected 4 participants with low conscientiousness, 4 participants with high conscientiousness, in both groups there were 2 participants scoring low on extroversion and 2 participants scoring high on extroversion. For the extroversion group we selected 4 participants with low extroversion (introverted), and 4 participants with high extroversion (extroverted), all of them with a score bigger than 3 on conscientiousness.

2.5 Conditions

The study followed a 2x9 within-participants study design, with participant personality traits (extroversion/introversion and high/low conscientiousness, traits separately examined) and robot behavior as factors.The participants were divided in 4 groups according to the two traits of personality: conscientiousness

Table 2: Post-Experiment Questionnaire

Q12 You felt pressured by the robot reminding you the tasks to do: not at all/ a lot
Q14 The robot was: Strongly disagree / Strongly agree
Q14.a Social - Q14.b Attentive - Q14.c Stressful - Q14.d Helpful
Q15 The robot was expressive: Strongly disagree / Strongly agree
Q18 DId you think the robot was acting intelligently? not at all / a lot
Q19 What characteristics made the robot more efficient in the reminding task:
Q19.a Speech - Q19.b Height - Q19.c Proxemics - Q19.d Facial expressions

and Extroversion. The comparison on personality was done between High conscientiousness and Low conscientiousness individuals, and between Extroverted and Introverted individuals, having eight individuals in each personality trait. The first robot condition was realized without the robot, and thus no reminders were provided. The next eight robot conditions were done with the combination of the 3 parameters (independent variables) to test: height of the robot, distance between the user and the robot at the moment of the reminder, and the smiling of the robot. The conditions were applied in the same order to all the participants, but the risk of learning the task was minimized by using different e-mails to reply on each condition. The conditions are listed in Table 1, where the values of the different variables of the robot are shown.

The 3 parameters (height/proxemics/smile) defining robot's behavior are:

1. Distance. Close: 1.2 m, which is the limit of the interpersonal distance according to [7]. Far: 1.8 m, (1.5 x minimum interpersonal distance)
2. Height. Small: 1 m. Approx. height of a person sitting. Tall: 1.8 m. Approx. height of a person standing up .
3. Smile. Smile off: Robot without facial expression. Smile on: The face of the robot shows a smile drawn by the Meka LED matrix.

2.6 Post-experiment Questionnaire

A post-experiment 5-points Likert scale questionnaire (33 items) was conducted after each condition. This questionnaire was done with the purpose of analyzing the perception of the participants towards the robot and search for relations between the variables of the study and the perceived influence on the task. Other questions are related to the perceived usefulness of the robot in the reminder task, perceived personality of the robot, and stress caused by the robot. The questions of the most relevant results are shown in Table 2, the complete list of the questions can be seen online[1].

[1] http://goo.gl/forms/7OrESYgUtUp7esbD2

3 RESULTS AND DISCUSSION

The time participants took to finish the experiment was used to measure the efficiency of the robot's reminders.

We did a series of ANOVA tests, preceded by a Shapiro test to verify the normality of the data. We analyzed the performance on time for conscientiousness and extroversion separately, comparing introverts with extroverts and high conscientiousness people with low conscientiousness people.

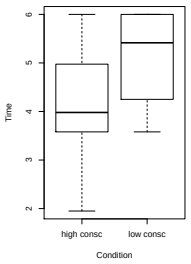
We did not found any relation on time performance of the participants grouped by personality traits and the different conditions.

We found significant differences between extroverts and introverts ($p = 0.047$) showing a better time performance of the introverts, as well as between high conscientiousness and low conscientiousness people ($p = 8.051e\text{-}05$) showing a better time performance of the high conscientiousness people. The results of an One-Way ANOVA test having time as dependent variable and personality traits as independent variables for each comparison of extroversion and conscientiousness are presented in Figure 2a). The means for the performance in time of each group are shown in Figure 2b) and Figure 2c).

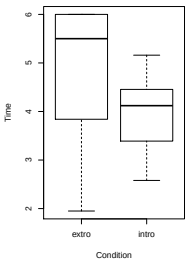
A paired Student's T-Test was applied to each group to analyze the differences of the time on each condition, the groups of Extroverts and Low conscientiousness people did not show any significant difference between the condition without the robot and the conditions with the robot. The results suggests that introverted participants took significantly less time to perform the task when reminded by the robot, the p-values and means of the time are presented in Table 3. We only show the results of introverted and high conscientiousness par-

High C.		Low C.	
Mean	std dev	Mean	std dev
4.1984	0.8948	5.1340	0.8784
Sum sq	Mean sq	Df	p
14.016	14.0157	1	8.051e-05
Extro.		Intro.	
Mean	std dev	Mean	std dev
4.8600	1.2781	3.9081	0.6879
Sum sq	Mean sq	Df	p
4.353	4.3529	1	0.047

(a) Two-Way ANOVA tests



(b) Conscientiousness



(c) Extroversion

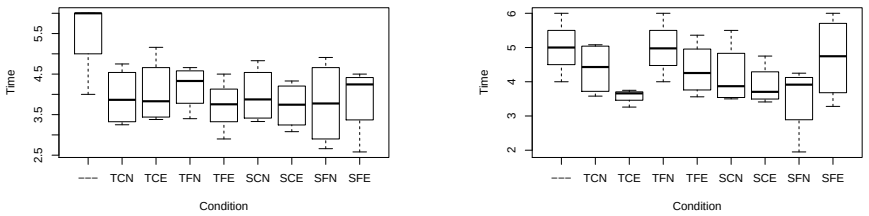
Fig. 2: Results of ANOVA tests on time performance of conditions 2-9. b) high conscientiousness people got better performance (mean time) than low conscientiousness people. c) Introverted people got better performance than extroverted people.

Table 3: Mean and Standard deviation of time (min.) of the participants on the task, and p-value of the t-test between condition 1 and conditions 2-9.
Introverted participants showed an improvement on time in all the conditions with the robot. High conscientiousness participants showed a significant improvement only in 2 conditions with the robot.

	Introversion		High conscientiousness	
Condition	**Mean (SD)**	**p-value**	**Mean (SD)**	**p-value**
1 —	5.5000 (1.0000)	-	5.0000 (0.9847)	-
2 TCN	**3.9325 (0.7247)**	**0.0094**	4.3800 (1.0346)	0.3090
3 TCE	**4.0500 (0.8155)**	**0.0153**	**3.5825 (1.0328)**	**0.0250**
4 TFN	**4.1800 (0.5602)**	**0.0260**	4.9875 (0.9373)	0.9830
5 TFE	**3.7275 (0.6539)**	**0.0038**	4.3575 (1.0329)	0.2920
6 SCN	**3.9775 (0.6948)**	**0.0113**	4.1850 (1.0811)	0.1840
7 SCE	**3.7250 (0.5794)**	**0.0038**	3.8925 (1.1360)	0.0750
8 SFN	**3.7800 (1.0547)**	**0.0048**	**3.5075 (1.5394)**	**0.0190**
9 SFE	**3.8925 (0.8859)**	**0.0079**	4.6925 (1.5394)	0.6110

ticipants because only in these groups we detected significant differences, and it should not be understood as a comparison between them.

In Figure 3 are presented the mean times performed by the introvert and the high conscientiousness people, High conscientiousness people were more promoted by the robot to perform the required task on 2 opposite conditions; Tall-Close-Smile and Small-Far-No smile, we suspect that the first one (TCE) caused more pressure on the participants, the Tall feature was perceived as stressful by all the participants, and the smile of the robot when it was close made the robot appear as "more intelligent" for people in the extroversion group, then



(a) Introversion (b) High conscientiousness

Fig. 3: a) Introverts improved their performance in time in all the conditions with the robot compared with the condition without the robot. b) High conscientiousness people improved their performance in time only in 2 conditions with the robot.

Table 4: Post-Experiment Questionnaire's results. Most relevant results shows significant differences on height on both personality traits and smile in the conscientiousness group and distance in the extroversion group.

(a) Conscientiousness

Q.	Var.	Sum sq	Mean sq	Df	P
Q14c	height	11.391	11.390	1	0.0089
Q15	smile	5.641	5.640	1	0.0206
Q19d	smile	5.063	5.062	1	0.0236

(b) Extroversion

Q.	Vari.	Sum sq	Mean sq	Df	P
Q12	height	16.844	16.843	1	0.0002
Q14c	height	9.766	9.765	1	0.0005
Q18	dist	4.516	4.515	1	0.0451

these combined features could had urged to the participants to perform the task more than in the other conditions (it was the condition with less variance on performed time), while than in the other condition (SFN) the robot can be have been perceived as less stressful (Far feature) and less aggressive (Small), which gave similar results but with more variance, also the last condition (SFE) was only different to this one on the smile, showing a smile on the robot while being close and small gave poor results.

The post-experiment questionnaire was analyzed applying a factorial ANOVA test for each question for each personality trait, with the questions as dependent variables and personality of the participants, and distance, height, and smile of the robot as independent variables. The most relevant results of the ANOVA test are shown in Table 4. The means and standard deviations of the questions with the most relevant results are presented in Table 5.

These relevant results can be interpreted as following: In the conscientiousness group, the height of the robot influenced the perception of dominance and stressful personality on it, increasing when the robot was tall. The robot was found to be more expressive when the robot showed the smile, and also this characteristic was rated to made the robot more efficient in the reminded task.

Table 5: a) People in the conscientiousness group perceived the robot more stressful(Q14c) in the tall condition, and more expressive(Q15, Q19d) in the smile condition. b) People in the extroversion group perceived the robot more aggressive (Q12) and stressful(Q14c) in the tall condition, and more intelligent(Q18) showing the smile in the close condition.

(a) Conscientiousness

	Small	Tall
	Mean (SD)	Mean (SD)
Q14c	2.000 (1.135)	2.843 (1.167)
	Smile On	Smile Off
	Mean (SD)	Mean (SD)
Q15	2.406 (1.160)	1.812 (0.692
Q19d	1.843 (1.167)	1.281 (0.634)

(b) Extroversion

	Small	Tall
	Mean (SD)	Mean (SD)
Q12	1.903 (0.830)	2.806 (1.216)
Q14c	2.187 (0.859)	2.968 (0.860)
	Close	Far
	Mean (SD)	Mean (SD)
Q18	3.187 (0.859)	2.656 (1.065)

In the extroversion group, the height of the robot when it was tall, was related with pressure and stress. The smile on the robot increased the perception of intelligence on it. Extroverted people found the robot more extroverted, attentive, helpful, and expressive than introverted people.

4 CONCLUSION AND FUTURE WORK

In this work, we found evidence that supports the greater performance of high conscientiousness people over low conscientiousness people, and the results suggest than introverted people are more promoted to finish the task earlier than extroverted people. The results suggest that the Hypothesis 1 (H1)is supported, because of the significant differences on the means of the time between high conscientiousness and low conscientiousness groups. Results from the questionnaire give us information to evaluate hypotheses H2 and H3. H2 is only partially supported by the higher rating on intelligence by extroverts than introverts in the close conditions. H3 is supported by the relation between the small robot and the smaller ranking for pressure and stress in both personality traits. H4 should be rejected, as there is no evidence that supports it.

We conclude that robots could be helpful for reminding tasks for people with high conscientiousness and introversion while they are working in a daily activity, this is just taking in consideration the factors used in the experiments (distance, height, and smile). For people with extroversion and low conscientiousness other factors may be of greater help to motivate them to perform the task required. We plan to continue studying the effects of these and other conditions that help to improve the performance of reminded tasks by a robot, and also reaching the objective of minimizing the stress caused to the users.

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