Experiencing the Familiar, Understanding the Interaction & Responding to a Robot Proactive Partner

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***Abstract*—This is the 2^d stage of a study on the familiar during HRI. We demonstrated the interest of better understanding the human experience of the familiar for an adapted and successful HRI. Here, we explore the relation between experiencing the familiar, understanding the robot's engaging actions, and reacting to them. We look at participants' response to 3 non verbal actions of NAO. The analysis uses the participants' answers to a questionnaire, their decisions to react or not to the robot's actions and motion data.**

***Index Terms*—Experimentation, Human Factors, Familiar**

I. Introduction

Most of the research conducted in HRI aim for "socially adapted" and "natural/intuitive" interactions. The essential components for achieving such interactions are still under study. We believe the familiar to be a comprehensive notion to access the human experience during HRI and we believe it to have a major impact on the interaction quality and efficiency. We also think that working on building robots that humans would feel familiar with, could be the key for successful HRI. Therefore, we started an innovative study [1] investigating directly the familiar and aiming at better defining it in relation to other important concepts in HRI such as anthropomorphism or the robot's social skills. In the second stage of our study lead in an interdisciplinary approach involving psychology and robotics, we explore the association existing between experiencing the familiar, understanding the robot's engaging actions and reacting adequately to them.

II. Related works & hypothesis

Humans tend to draw inferences about a robot in a way going beyond its observable actions, satisfying a need for control the environment in order to reduce stress [2] and favor a more efficient HRI. Effectance motivation, the 3d psychological determinant of the "Three- Factor Model of Anthropomorphism" [2], reflects the need to understand one's environment [3] and reduce feelings of uncertainty. Recently, [4] provided the first evidence that unpredictability of a robot's actions does not necessarily lead to less acceptance, and that anthropomorphism, by its effectance motivation factor, facilitates HRI by increasing ability to subjectively make sense of a robot's behavior. As introduced, the familiar is addressed in our work as a main research object. We're interested in the familiar state experienced in new encounters. Our approach of the familiar differs from the "familiarity principle" which links preference to familiarity built through repeated exposure. In our 1^{st} study [1] we innovatively proved the familiar to be associated with positive feelings and to be possibly experienced in new situations. Moreover, our results showed that the more participants perceived the robot as sociable, the more their interaction with it was familiar. We also observed moderate to high levels of experiencing the familiar when the robot was highly anthropomorphized. Here we question the relation between 3 levels: understanding the robot's behavior, experiencing the familiar while interacting with it, and responding. We hypothesized and tested: (H1) The more humans experience the familiar during an interaction with a robot, the more they are prone to react to its engaging actions. (H2) The more humans understand and make sense of the robot's engaging actions while interacting with it, the more they react adequately to them. (H3) The more humans understand and make sense of the robot's actions while interacting with it, the stronger they experience the familiar.

III. Methodology & experiments

The robot is NAO (Aldebaran). We deliberately chose feed-forward control for repeatability. 20 pairs of candidates (14 women, 26 men) volunteered to participate. NAO's behavior when giving the envelope differs from X to Y: 'Smooth Handing' vs. 'Keeping 4 sec the envelope". Participants are only told they're invited to answer a questionnaire on HRI and are informed that the set is filmed and IMU are used for hand and head motion capture. They do not know about NAO's intervention. NAO punctuates the interaction's beginning & end with non-verbal greetings. It has a real task to accomplish: bringing the envelopes containing the questionnaire. The interaction (greetings & envelope exchange) could happen or not as the participants do not receive particular instructions and are left to their own judgement. The questionnaire, in Japanese, consists of 3 parts (7-point Likert scale, Multiple Choice Questions, open-ended questions) addressing different topics but also the same topic considered from different perspectives

[1]. The IMU data is processed to obtain: (1) "the intensity of the movement" (I.) corresponds to an integration over the time of the interaction of the data, normalized to adjust to the 0-7 Likert scale. It is computed during the envelope exchange and when greeting back goodbye. (2) From PCA of feature vectors we find cluster formation in the motion data[5]. We calculate the distance (D.) from the cluster center for each trial. We calculate the descriptive statistics for the participants' responses to the robot's engaging actions and to their answers to the questionnaire (Tables I,II).

IV. Main results

Understanding & Decision making: Most participants found NAO's actions easy and clear to understand (X: M=5.3, SD=1.7/ Y: M=4.8, SD=1.7) as well as its behavior (X: M=5.0, SD=2.0/ Y: M=4.6, SD=1.8). They understood NAO's intention of giving them the envelope and found it easy to react (80% X, 75% Y), whereas making sense of NAO's greetings and deciding on how/whether to react to them was less obvious(35% X & 25% Y). Motion data showed that the more participants understood clearly NAO's actions, the more they were close to the general tendency of the group depicted by the cluster: react to NAO's gesture and take the envelope (Table 1). Also, motion data revealed that the more participants found no confusion in NAO's actions and found it easy to react to it, the more intense was their greeting it back goodbye (Table 1).

Experiencing the familiar while interacting with NAO: Most participants reported that NAO's behavior was familiar all along the interaction, with the highest scores when "exchanging the envelope" and at the end of the encounter. 45% X, 50% Y found NAO familiar mostly from its behavior; 60% X found NAO familiar from the way it moves. 15% X, 10% Y found NAO not familiar at all. Most participants found interacting with NAO medium-to-high familiar (X: M=5.0, SD=2.0, Y: M=5.0, SD=1.6). Results also showed that the more participants found the interaction with NAO familiar, the more they were to answer its solicitations: greeting back, as well as taking the envelope (Table 2). Furthermore, high correlations (Spearman) were validated only for X showing that the more the interaction was familiar to them, the more they found it easy to react (P=0.01, R=0.57) and the more it made sense for them (P=0.05, R=0.47). Finally, motion data showed that the more participants found the interaction familiar, the more they were close to the general tendency of the group to react to NAO's gesture and take the envelope from it (Table 2).

Reacting to NAO: Though haven't been informed about the interaction or instructed about what they ought to do, 80% X & 85% Y were proactive towards NAO's arm movement and took the envelope. Of course, Y had seen NAO performing the same movement with X which might have facilitated their reaction, knowing that this possible effect was not addressed in our study. Nevertheless, as the novelty of NAO resisting before handing the envelope is introduced with Y, the large number of participants who adequately reacted is to be noted.

TABLE I
Pearson Correlations between Movement data & Understanding interaction (U.).

Criteria	P	Corr.
D. when taking envelope & (U.)		
D. & Action clear to understand	0.01	-0.48
D. & Confusion about taking the envelope	0.01	0.47
I. when greeting goodbye & (U.)		
Greeting byebye/easy to decide	0.01	0.49
Greeting byebye/nothing confusing	0.01	0.44

TABLE II
Correlations between Familiarity (F.) & Reactions to NAO's actions

Spearman correlations

	X		Y	
Criteria	P	Corr.	P	Corr.
Greeting hello/ F.	0.05	0.57	0.05	0.23
Greeting goodbye/ F.	0.05	0.49	0.05	0.53
Taking envelope/ F.	0.01	0.71	0.05	0.56
Pearson correlation between F. & D. for X & Y				
Criteria	P		Corr.	
D. when taking envelope/(F.)	0.01		-0.48	

Reacting to NAO's greetings was less effective as less than half participants answered to it (hello: 45% X, 35% Y ; goodbye; 30% X, 35% Y). More generally, the more participants were able to make sense of the interaction, the more they found it easy to react to NAO's engaging actions (X: P=0.023, R=0.50; Y: P=0.04, R=0.46).

V. Conclusion

The novelty is brought not only by the results showed, also by combining the analysis of the mental and affective experience of the participants with motion data at the 3 key-moments of the interaction. We show a co-occurrence of high levels of understanding of NAO's actions and of experiencing the familiar when handing the envelope. Nevertheless, the correlation between understanding the action and the familiar was only validated for X participants (H3 partly validated), which suggests that we need further experimentation on a larger sample. This study successfully showed that understanding NAO's actions and the interaction, as well as perceiving this interaction as familiar, have a direct impact on the human's readiness to respond adequately to the robot (H1 & H2 validated). Feeling familiar during the interaction and being able to make sense of it prove to be 2 essential components of a successful and reciprocal HRI.

References

[1] R. Baddoura and et al., "The familiar as a key-concept in regulating the social and affective dimensions of hri," *Proc. IEEE/RAS Int. Conf. on Humanoid Robots*, pp. 234–241, 2012.

[2] N. Epley and et al., "On seeing human: A three-factor theory of anthropomorphism," *Psychological Rev.*, vol. 114, pp. 864–886, 2007.

[3] R. White, "Motivation reconsidered: The concept of competence," *Psychological Rev.*, no. 66, pp. 297–333, 1959.

[4] F. Eyssel and et al., "Anthropomorphic inferences from emotional nonverbal cues: A case study," *Proc. IEEE Int. Symp. Robot and Human Interactive Communication*, pp. 681–686, 2010.

[5] T. Zhang and et al., "Individual recognition from gait using feature value method," *Cybernectics & Information Tech.*, vol. 12, pp. 86–95, 2012.