The influence of the gender dimension in human-robot interaction

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1 Introduction

In order to design robots able to face complex challenges and tasks in real-world, it is of crucial importance to take into account how the gender dimension can be included in the design of Intelligent Autonomous Systems - IAS. In (Schiebinger, 2012) the problem of including the gender dimension in the contents of scientific research, has been widely analyzed. In this work we present the influence of gender in two cases:

- Assistive Technology for the elderly care
- Simulated-gender robot in Human-Robot Interaction

Then, we propose a general methodology useful to include the gender dimension in the content of the research. To this aim a formal reflection on the scientific method and a critical analysis of logical rules underlying the method used in Science are shown.

2 Gender dimension in Assistive Technology for the Elderly Care

In the field of Assistive Technology for the elderly, the analysis of data related to elder care, using sex and gender analysis, reveals new opportunities for development of assistive technologies and robotics. Researchers have studied the different needs of women and men according to their age (Scheibinger, 2012). This research, thanks to the direct collaboration of the elderly, their caregivers, and further stakeholders, provides to the engineers many insights for designing and developing assistive products that are more tailored to the users' needs. Understanding the characteristics of the elderly population is the key to successfully design new technologies and service systems. Understanding how sex (physiological needs) and gender (social issues) interact and influence aging can help designers to implement technologies that best fit the needs of the people involved. Here are some examples:

- Dementia: affects men and women alike in their age, but as women live longer in many developed countries, they suffer longer.
- Arthritis: It is much more common in women, about 2-3 times more than men of the same age.
- Deafness: this is much more common in men than women of the same age.

In complex scenarios in which the robot should be able to recognize the mood of the elderly through the facial expression, the influence of gender and ethnicity is particularly significant (Brody et al, 2008). In (Sheikhjafari et al, 2014) it is reported a concrete example of gender-based design. The robot tunes handshaking based on personal characteristics of the person who interacts with it. The characteristics which are considered in this research are gender and familiarity. Handshaking mode changes according to the value of these factors.
The algorithm used by the robot to tailor the handshake is designed as follows:

- The robot identifies the person
- Calculates "familiarity" and gender
- Adjust handshake based on computed data by setting duration and topology
- Robot starts handshake

As the familiarity increases, the duration of handshaking increases and stretches out the hand more. Generally, if the detected person is a man, the robot increases the frequency of handshaking and its duration. We want to point out, again, that studies of this type are of great importance, especially when the assisting robots are to be designed for people where greater adaptability is required than other scenarios.
Starting from the previous considerations, another important aspect is the study of how people perceive the aging process and how this perception is associated with the general aspects of accepting medical technology in terms of usability (Wilkiwska et al).

3 Simulated-Gender Robot in Human-Robot Interaction

In this section we show the results obtained in two experiments dealing with the influence of robot gender on human behavior.

To investigate the effects of human and robot factors and their interaction effects preliminarily, an experiment was conducted to measure and analyze human cognition and feelings toward a robot under the condition in which the robot was simply labeled as a male or a female (Takagi et al, 2011). The research question in the experiment was the following one: how can human educational background, human gender, and robot gender influence the cognition and feelings toward the robot?

To detect the influence of educational background in the perception of robot, the experimenters of both gender had two different backgrounds: 1. natural science and technology education and 2. social science education. The obtained results suggested differences dependent on the educational backgrounds of humans in human-robot interaction. The impression scores of the two items "politeness" and "assertiveness" proved that the subjects with educational backgrounds in natural science and technology considered the robot more polite and assertive than did those with social science backgrounds. Although robot gender did not have a sufficient effect in the experiment, the manipulation check suggested that even labeling the robot with gendered names could provide humans with the perception of robot gender. The subjects in the experiment had less perception of femininity for the male-labeled robot and less perception of masculinity for the female-labeled robot, regardless that the appearance, motions, and voices had no information on gender. Moreover, the perception of femininity had a positive effect on the recall of contents uttered by the robot. We can conclude that the results of this experiment show a strong indirect effect of gender labeling of robots on the human behaviors.

In (Breazeal et al, 2009) is described the study of persuasion as it applies to human-robot interaction. The experiment was run at the Museum of Science in Boston, where subjects interacted with a humanoid robot whose gender was assigned to them. After a short interaction and persuasive appeal, subjects responded to a donation request made by the robot, and subsequently completed a post-study

questionnaire. Findings showed that men were more likely to donate money to the female robot, while women showed little preference.
In Figure 1 it is reported the proportion of people that gave any donation separated by subject gender, robot gender and whether or not the subject was alone. Men consistently donate more often to the female robot, while women change their gender preference depending on whether or not they were alone with the robot. Women on the other hand donate more often to the female robot when accompanied, but reverse their preference to slightly favor the male robot when alone. This experimental result suggesting a cross-gender preference came as a surprise as some literature in social psychology would tend to suggest a same-gender preference rather than a cross-gender preference. This is surely still an open question to be studied in the HRI community.

4 About Gendered Innovations

From this insights it is clear that the gender dimension influences in an important way the design of robots for assisting and interacting with people. In scenarios where robots can assume complex behaviors, it is very important to consider these factors for better results in terms of robot's robustness and efficiency in running the various tasks.

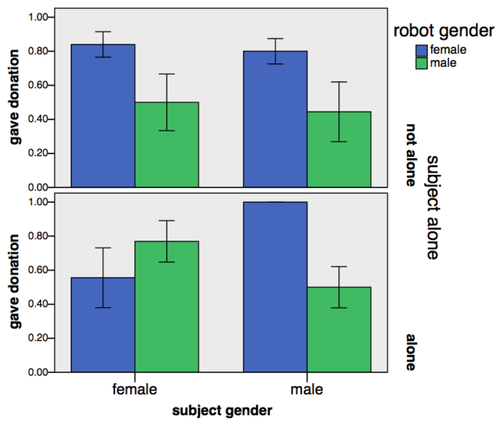

Figure 1. Proportion of people giving any donation separated by subject gender, robot gender and whether or not the subject was alone (Breazeal et al, 2009)

More in general, let's see how new gendered science can be developed together with new interpretations of facts with respect to an universal male-point-of-view proposed as neutral. It is important to understand how we can re-design the scientific theories, how we can propose new hypothesis taking into account the gender dimension, how we can formulate new scientific questions having the awareness that another science is possible, how we can produce a critical view of the method in re-shaping the science. According to (Sanchez, 2013): "*There is a need to go beyond stereotypical feminization of products – so called "pinking" – as female preferences can be drivers for substantial innovation*", the "pinking" method is not sufficient to produce a new gendered innovation.

Another point to take into consideration is the difference that women and men have in their approach to the use of technology. While women tend to be more interested in the ease of use of technological devices and in their social benefits, many men focus on the performance of the technology and often, technological devices can become for them quite a 'status symbol'. Also social needs and life models are different for women and men: this can largely influence technology and its products. As women represent the mentality, the preferences and the needs of every day by more than 50 % of the human race it is important that, as reported in (Sanchez 2013):

If research institutions and industry want to create valuable and sustainable research results and technologies for people (the market), it is recommended to include women at all stages of the research and innovation process.

With these premises, let's consider a formal reflection on the scientific method and a critical analysis of logical rules underlying the method used in Science (Badaloni, 2016).

A very common belief is that, in the first instance, experiments are conducted to test the hypothesis of a theory: if the expected observations of experiments are verified then the theory is fully demonstrated. Formally, if the assumptions of the theory are H and O the observations, the rule underlying the knowledge process can be the following:

$$\frac{H \rightarrow O \text{ and } \quad O}{H}$$

From the premises that H implies O and O is true, we can deduce that H is true. The logical rule that represents this schema goes under the name of *confirming argument*: it seems well representing the process of innovation in scientific research. But it is a wrong logical rule as proved in (Federspil, 2004). Science does not proceed for confirming argument and does not advance according to the progressive and continuous accumulation of truth but thanks to the attempts of refutation of the theories proposed, we advance if there are errors in the accepted theory. So the wright rule is called *falsifying argument*, represented by:

$$\begin{array}{c} H \rightarrow O \text{ and} \\ \neg\ O \\ \hline \neg\ H \end{array}$$

From the premises H→O (H implies O) and ¬ O (not O, O false) it can be deduced ¬ H (not H, H false). In other words, when the consequences of a theory are not verified in the experimental context then the theory has to be completely re-designed. This argument corresponds to a correct logical rule called *Modus Tollens*.

To consider the gender in the development of new science we can start from this rule. We have to put the following question: if a certain theory H doesn't take into account gender do we expect to find the observations foreseen by the theory true (eg medicine vs gender medicine)? Evidently not, because 50% of the users of the innovations are women but, as evidenced by a large literature, it is presumable state that the needs of this substantial part of users are not incorporated in the search and the innovation. Hence these observations can be false (¬ O) and the theories of departure, too (¬ H).

The rule underlying the scientific method in the production of gendered innovations is the falsifying argument: this leads us to say that to produce a new gendered science in all fields it is not sufficient to apply the 'pinking method' but it is necessary to radically change the assumptions. Only a complete redefinition of the method and the research model with new applications and new ways of observation can re-design the science in a gender perspective. Thus, in order to design Intelligent Autonomous Systems able to socially interact for facing complex challenges the gender dimension has to be taken explicitly into account re-formulating the questions that can produce responsible research innovations.

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