"Personality-Friendly" Objects: A New Paradigm For Human-Machine Interaction.

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***Abstract*—This work introduces the concept of "personality-friendly" objects. Its goal is to investigate the relationship that can exist between specific interactive products and the users' personalities. Nowadays, it seems that every object being advertised and put on the market has its own personality. This creates a strong and immediate connection between the customer and the object but often it does not go beyond the aesthetic level or the dialectic of the advertisement. For this reason, a methodology for the categorisation of interactive products has been developed. With this classication, we intend to measure the compatibility between the human way of thinking and the use of products. A set of experiments have been done and their results are reported in this work.**

***Keywords*–Usability; Personality-Friendly; Human-Machine Interaction; Human-Computer Interaction; Myers-Briggs (MBTI).**

I. Introduction

In recent years, everyday life devices like smart-phones, smart-watches, etc., evolved considerably at both structural level (e.g., novel interfaces) and functional level (e.g., novel services). In addition, the split between hardware and software, that guarantees regular firmware updates, allows to fully exploit the potential of the devices hardware adapting their functionalities to the user's needs.

The continuous interaction with these devices is changing our life modifying our habits and attitudes. For instance, recent studies report that a typical smart-phone user interacts with their phone about 150x per day [1].

The emerging phenomenon of the Internet of Things (IoT) [2], [3] is bringing us to become part of the technology-based immersive scenarios (i.e., smart-homes, smart-offices, etc.) where a heterogeneous set of *smart devices* or *objects* is interconnected through the network providing the users with added functionalities and services.

The conversion of our daily-life spaces and routines in smart ecosystems brings our smart devices to become a sort of appendix of our body and, more importantly, of our brain. Indeed, while interacting with smart devices and technology, humans tend to adapt their behavior to the communication skills of the machines they are using, exactly as a farmer does with their animals.

The grand challenge in designing innovative smart objects is the inversion of this paradigm. Designers need to figure out how to build machines that are able to communicate with users in a natural way so as to adapt their communication skills to the level of their users.

In addition, humans have a natural attitude to humanize technology and to associate personality to it [4]. For this reason, the judgment about devices personality is guided by several factors. Most of these factors are directly related with the device like the shape [5], the associated advertisement and the object functionalities and behaviour. On the other hand, the user personality affects the judgment and acceptance of the device.

In 2015, Pieroni et al. [6] proposed a novel framework for the personality-driven design of IoT smart devices called Affective Internet of Things (AIoT). In this paper, the authors tried to endow smart objects with affective capabilities to be used within the network and to enhance the level of communication while introducing affective interactions. The AIoT objects can endow different human-inspired personalities having also humanized reaction to somatic (i.e., sensors) and social (i.e., object-object interaction) stimuli.

While the link between associated personality and device behaviours and shapes have been already investigated, a comprehensive analysis which also includes other factors (i.e., advertisement, functionalities and human personality) doesn't exist yet. This analysis is essential to enable the development of interfaces that fully exploit the potential communication capabilities of these emerging devices.

Our aim is to investigate how the humans perceive the currently available technologies in terms of personality. In this particular work, a model that can be used for the classification of interactive products is developed and tested. The paradigm is based on the assumption that the user personality is a key factor driving the approach of the human to the machine. Indeed, any message or feedback sent by the machines is interpreted differently by humans according to their specific personality. We started by analyzing the distinctive features of the different human personalities and the interaction flow between users and objects. The analysis allowed to establish what factors determine the compatibility between the approach of the machine and the one of the user. The products are then classified according to which psychological type best fits them, in terms of the minor cognitive effort required to establish the interaction. The paradigm of *Personality-Friendly* Objects is based on this concept of compatibility and if included in the AIoT is expected to raise the level of communication and regulate the modalities of the human-machine dialogue on the basis of the traits that characterise the user's personality.

In summary, this work proposes and tests a methodology that allows to determine which are the user personalities that are the most suitable to use a specific interactive object. For the method assessment, we selected five well-known interactive objects according to their relevance with different levels of interaction and engagement. The rest of the paper is organized as follows: SectionII introduces objectives, possible applications and requirements related to the paradigm of personality-friendly objects; SectionIII describes the model used for the classification of products and services; the experimental protocol is discussed in SectionIV while the experiments and the results in SectionV; the conclusion and future research directions are given in SectionVI.

II. Personality-Friendly Objects

In this section, we propose the paradigm of *personality-friendly* objects in which any interactive system can be classified as compatible with certain types of human personalities on the basis of how it usually leads the human-machine interaction. The idea relies on the evidence that humans exploit their own mental process and resources when using interactive devices, therefore personal attitude in perception and action can make some devices more suitable for a particular subject but rather difficult for another person. In other words, a personality-friendly object owns those features in terms of appearance, affordances, functions, behavior and advertisement that allow subjects with a specific personality to interact with the object by using familiar mental processes. Such a classification is fundamental to guide the design of new products or the redesign of existing ones as well as to prevent many of the difficulties encountered by users in using objects. In order to achieve this goal, a dedicated classification instrument needs to be developed taking into account the many different situations of human-machine interaction.

A. Applications

The personality-friendly objects paradigm could have a large pool of applications and implications on the devices development and design. Firstly, adapting technology to user's psychological type might offer many advantages in terms of usability and user experience and, hence the name, make it possible to overcome the current concept of *user-friendly*. The possibility to associate an interactive object to a predetermined category of users leads to numerous and immediate practical repercussions in both the design of products and their commercialization and positioning on the market. For example, a product could be redesigned to make it more compatible with people who currently experience difficulties in the interaction. Another example is related to a product that now addresses a market niche and could be developed in multiple versions in order to attract different types of customers.

Secondly, assuming to know the personality of a user, in the development of a smart object a designer could include some functionalities and communication modalities that make the interaction with the device more immediate and easily understandable for that specific person. In addition, products may adjust their behavior, e.g., by modifying timing and frequency of dialogue in order to be not too intrusive (or conversely, to constantly keep company) and to meet user preferences. For example, considering a smart-watch, for an extroverted person it could act accordingly so as to continuously provide sound and light stimuli; while for an introverted person it could minimize the incentives to those strictly necessary in order to avoid disturbing the user. Analyzing the state-of-the-art for smart-watches, they seem designed to meet mainly extroverted people. This simple example shows how this tool could guide and improve the design of human-machine interaction for a single product.

Finally, considering the future smart environment scenarios (e.g., smart-home, smart-office, and the AIoT [6]) it is immediate to think about new applications that could benefit of the proposed paradigm. This would mean building an intelligent, personalized room that is harmonic in the way it reacts to events and custom-tailored to easily interface with the personality of people who live there. Furthermore, knowing the personality and the mood of the user makes possible to program the affective objects in the room in order to try to re-establish a positive mood within the domain (and therefore also in the user) when the negative emotional state of the person disturbs the environment.

B. Requirements

In order to implement a method for the classification of interactive objects and evaluate its possible benefits, it has been necessary to define several requirements:

1) What can be classified: the methodology to be developed and tested should allow to classify both real products and services. In fact, each service in which the interaction with the client (also through a human operator) is subject to procedures can be included in the classification. Following this we claim that what is true for products also applies to this type of services. On the contrary, if there was not any specific procedure, each call would be an interaction that differs from all the others and every interaction should be classified separately.

2) Limits of the classification: many multi-purpose devices have a large pool of functionalities that can be used by the user to accomplish several possible goals. This could lead to a misleading classification. Therefore, in cases where the product has several features or can be used for different purposes, it is recommended to consider only a single function and a single goal separately. The results obtained by decomposing a single product can then be integrated in a manner which is the most appropriate following a case-by-case approach.

3) Classification Process: the object classification occurs through a survey by submitting a questionnaire to the users. Preferably, the person performing the classification should have the chance to interact with the product for a period of time adequate to personally test all possible aspects of the interaction with that object. If, for practical reasons, this is not possible the person should thoroughly analyze the product on written description attempting to answer to the preliminary questions which are intended to guide the analysis.

On one hand, in literature we found several psychology studies aimed at modelling cognitive mechanism and estimating human performance in performing certain task (e.g., *Model Human Processor* (MHP) [7]). This data have been extensively used in the design of interactive objects in order to meet the human needs and resources.

On the other hand, these studies do not provide information about the dynamics that generate different behaviors in different people under identical conditions and that is more related to subject personality. For this reason we have developed the model of personality-friendly objects in order to consider the effect of different human personalities in the context of human-machine interaction.

III. The Objects Classification Model

This Sectionsummarizes the pillars of the proposed classification model.

A. Outline of Human-Machine Interaction

The simplest way to represent interaction between a system and a user is represented by the *feedback loop*. According to the scheme shown in Figure 1) the interaction occurs as follows: the user in the attempt to accomplish his goal gives one or more inputs to the system, which receives and replays according to its own behavior and communication modalities. At this point the user analyzes the responses of the system, then he/she interprets and compares them with the one expected. The outcome of this comparison determines what should be the next user action. Each new user action towards the machine triggers a new cycle of action and response.

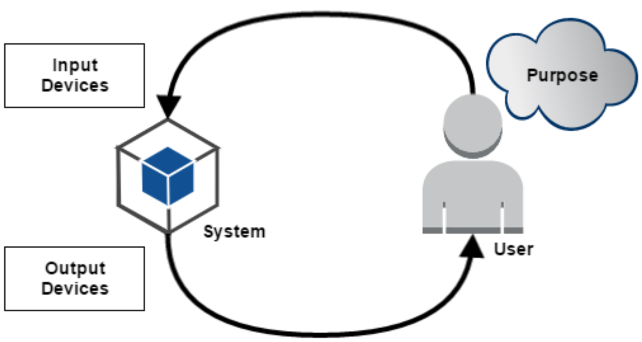

Figure 1. The Human-Machine interaction model based on *feedback loop*.

In this work we refer to the feedback loop model for describing the human-machine interaction. The necessary change done to the model consists in observing the interaction from the user perspective. From this point of view the human-object interaction is a situation in which the person is engaged alternately in two activities: to gather information about the object (and the context if necessary) through the five senses; to process the responses towards the object or to judge the situation that are both based on the data which have been previously acquired.

For example, in a common interaction with an ATM the user needs to acquire data by seeing (or by listening to) the information shown on the monitor (or transmitted from the speaker); then he/she uses this information to process the answers by pushing a button or by judging their own economic situation on the basis of the balance that has been just communicated.

Referring to the model of Norman [8] it is possible to identify the moments of the interaction in which the user may have difficulties in achieving the desired goal through the system. The problems arise when the subject is within two *gulfs*:

- **gulf of execution**, when on the basis of collected data the user has to switch from the intention to the action towards the system;
- **gulf of evaluation**, when on the basis of collected information the user has to assess the results of their actions.

The aim of our work is to classify any interactive system according to its compatibility with the different human personalities. Compatibility is measured from the point of view of the user and it is defined with the degree of naturalness with which a person interacts with the system. This is determined by (i) the effort necessary to obtain useful information, and (ii) the possibility for the user to respond (or judge) in the right way (in order to achieve the purpose of the interaction) without altering their own usual way of thinking.

In other words, the lower the cognitive effort required to overcome the two gulfs of execution and evaluation, the more the product is compatible with a certain personality.

B. Psychological Background

Regarding the personality, many theories have been proposed over the years [9], but a common vision at the academic level has not been reached yet. We analysed the available theories [10] and, for the purpose of this work, we selected the Jung's theory of personality types [11] and in particular the work of Briggs Myers and her mother, who developed the Myers-Briggs Type Indicator (MBTI) in the field of work psychology [12]. The essence of the theory is that the much seemingly random variation in the behavior is actually quite orderly and consistent, being due to basic differences in the ways individuals prefer to use their perception and judgment [13]. The indicator identifies sixteen psychological types, meaning sixteen different ways that people have to perceive reality, evaluate and act accordingly. The types, commonly called personalities, differ from each other in terms of how a person is located compared with four dichotomies.

The aim of this study is to understand how people approach the human-machine interaction. For this reason, to outline the personality traits that influence this process it is necessary to take into account only the process of information acquisition and the process of elaboration of answers or judgments. These two mental processes are defined in accordance with the psychological theories of reference: *perceiving* and *judging*. What is important for our work is the fact that according to the vision of Jung and Myers [13] a person may obtain information (*perceiving*) through two different ways:

Sensing (S) - acquiring data through the five senses in order to perceive information that are relevant in the environment;

Intuition (I) - collecting information by perceiving the possibility beyond the facts, focusing on the relationships between the facts and linking them together to build a model that justifies the changes of events over the time.

Also according to the same vision [13] a person can organize information and reach conclusions (*judging*) through two different ways:

Thinking (T) - making decisions impersonally through logical processes, assessing the consequences of choices or actions.

Feeling (F) - making decisions with respect to their deepest convictions and basing on subjective considerations.

Each person uses every day all of these four mental functions. However, each human being has a personal attitude in using one particular feature for perceiving and one for judging. Every person tends to follow their innate tendency and, even if unconsciously, to behave in a certain way. Having the possibility to use their preferred way of perceiving, or judging, in their own mental processes is extremely helpful for persons in order to feel more competent, secure and natural [13]. Behaving according to these preferences generates a sense of well-being, energy and satisfaction. Therefore there is a strong link between usability (especially one of its component, i.e., satisfaction) and user's personality. We used both to define the degree of naturalness of an interaction.

C. The Proposed Questionnaire

The framework described above outlines the link between the human personality and the way in which the user dialogues with a system. Here we describe a methodology that can be used to analyze objects and to determine their compatibility with different individual preferences and therefore human personalities. In particular the proposed questionnaire consists of two parts: the first part is dedicated to investigate how the product is delivering information to the user and the second part is about examining what kind of responses are required by the system in order to achieve the user's purpose. These two parts are intended to investigate the two phases in which we have previously outlined the interaction according to the requirements reported in SectionIV.

The first phase, the acquisition of information by the user, is associated with the two ways in which a person can deal with the mental process of *perceiving* (i.e., *sensing* or *intuition*). This first phase consists of seven closed questions conceived for analysing the stimuli sent from the product to the user during the interaction. The user filling out the questionnaire, in light of him/her experience with the object, has to declare how much the description reported in the questionnaire is adequate for illustrating the stimuli that are sent from the object. Selecting among multiple answers, the users shows their agreement with the description of the product and implicitly expresses whether this acquisition of information is easier through the use of *sensing* or *intuition*. On this basis it is possible to classify a product as *sensing-friendly*, if it facilitates this type of approach, *intuition-friendly* (vice versa) or *neutral*, if the stimuli are acquired equally through both the approaches.

The second phase, the processing of responses by the user towards the object (or elaboration of judgments on the current situation) is associated with the two ways in which a person can deal with the mental process of *judging*. Each of the seven questions investigates what are the types of judgements and responses required by the system from the user. The person who fills out the questionnaire declares how much the features that are reported in the questionnaire are adequate or not to describe the opinions and responses required. In practice this part of the questionnaire exploits the same methodology of the previous one but is aimed at classifying the object under study as *thinking-friendly*, *feeling-friendly* or *neutral* if it requests both kind of responses.

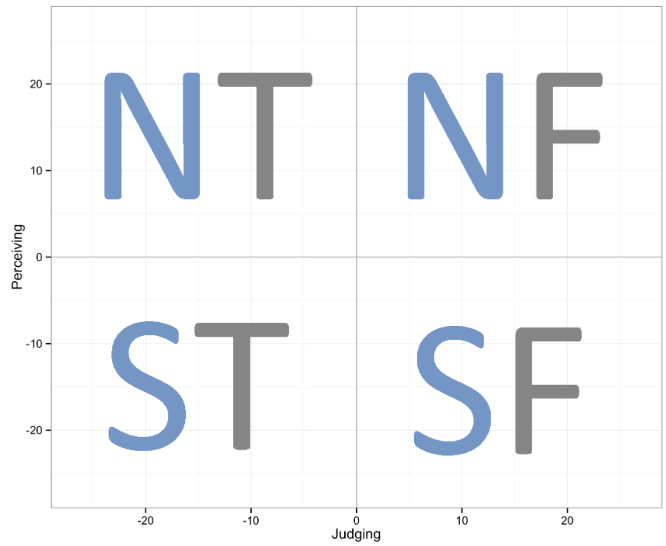

Figure 2. The space in which we represent the results of classifications, the *J-P plane*. The plane is divided in four quarters. In blue we highlighted the functions of *perceiving*, in gray those concerning *judging*.

D. The J-P Coordinate System

While the user fills out the questionnaire he/she expresses the level of agreement (through a scale of five values) with the statements. The answers are analyzed assigning points to each value. The two outer values lead to the attribution of four points to an approach (e.g., *sensing*) and zero points to the opposite approach (in this case *intuition*). The two inner values assign in one case three points to an approach (e.g., *thinking*) and one point to the opposite approach (*feeling* in this case). The central value assigns two points to both approaches. The maximum difference that you can get for the score of one approach against its opposite is twenty-eight points.

The results of classification can be represented in the *J-P plan* which is a Cartesian coordinate system where the x-axis represents J the *axis of judging* and the y-axis is P the *the axis of perceiving*. The goal is to identify a point in the plan which is the result of each classification. The J axis measures the difference between the score of *feeling* and the score of *thinking*. In this way a single value describes the user phase of *judging*: positive if the product is *feeling-friendly*, negative if it is *thinking-friendly*. The same for the P axis. In this case the single value measures the phase of *perceiving*: positive if the product is *intuition-friendly*, negative if it is *sensing-friendly*. Figure 2 shows an example of a J-P plane used to plot the results of our analysis.

IV. Experimental Protocol

This section shows the experiments we carried out in order to assess the consistency of the classification methodology and the model behind it. The experiments are oriented to evaluate (i) the comprehensibility of the questionnaire by people; (ii) whether the opinion of most people regarding the same interactive object might be agreed. In the case when most of people describes the same product, through the questionnaire, in a similar manner, it could be argued that the human-machine interaction can be categorised according to a

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particular subset of parameters. Since these parameters were created on the basis of trends (and recurring behaviors) that the psychological theory associated to individual preferences, it would be possible to support the principle that products could be classified according to the personality and then according to the paradigm of personality-friendly.

The experimental protocol has been built around the following pillars:

- people involved in the test did not have previous experience with the questionnaire or with its theoretical basis; participants have been informed that it was based on psychological basis only afterwards;
- the sample of participants was represented by 82 master students in Management Engineering of the University of Pisa;
- a real usage experience with the objects analyzed by the questionnaire was not possible for logistical reasons. To overcome such a limitation, each student was asked to read a pre-compiled description;
- all the object descriptions had the same structure and focused on how the user's interaction takes place with that particular interacting system;
- thanks to the descriptions, there was no information asymmetry between the participants. Descriptions contained images and videos, and have drawn from encyclopedias, press releases, reviews of industry experts and user manuals in order to avoid any authors' opinion or authors' influence.

In this first analysis, we classified five distinctive interactive systems requiring a different level of engagement to both gather information and reach a conclusion. The first system is the Tamagotchi which is a handheld electronic game created in 1996[1]. The aim is to ensure that the protagonist of the game lives as long as possible and grows politely. For people it is, like all games, a form of interactive entertainment. The second system is the Furby (1998)[2], a little and furry puppy available in various colors. It can be roughly considered an evolution of the Tamagotchi with more interacting functions. The third system is a video cassette recorder (VCR), an electronic device used for home entertainment. The fourth interacting system is a service, the Black Jack that consists in a gambling card game taking place between the dealer and the players. The last interacting system is a design installation that has as main subject the one who benefits from it entering in it. Everything must be built to change, or solicit, the viewer's perception, which becomes part of the work. Without the viewer, the design installation does not make any sense.

Before starting with the analysis, a 'warm-up exercise' was performed to introduce the students to the tool. After reading the description about the functioning and interaction with each object, fifty-nine students have been asked to complete the questionnaire related to these objects.

V. Results and Discussion

We did not record particular problems regarding the comprehensibility of the questionnaire. In order to establish if the students who analyzed the same case studies were aligned on the same conclusions, we analyzed their answers. This is important because through the closed answers they described the interaction that a user plays with the product to achieve a certain purpose in a particular context. If these descriptions were consistent, we can say that the questionnaire is versatile, meaning that it can be applied to very different interactive objects, but also that it is possible to categorise products according to the degree of compatibility with human personalities.

The overall classification result is reported in Figure 3 and shows that every considered product is characterised by a different degree of compatibility with human personalities. Each product has its own way to provide information and to react to the users actions. Therefore, the system leads the person to use only a subset of cognitive processes. For instance, the design installation is in the top right quarter of the J-P plane. This means that the object sends stimuli in a manner consistent with intuition users and requires mental processes which are usual for feeling users. The centroid of the point cloud has coordinates $J = 13$ and $P = 8.1$. The data demonstrate that the interaction between a user and an installation should be done in an empathic way, it requires an approach that consists in harmonizing with the environment (feeling) while understanding rationally its every single parts is quite useless. In addition, the installation requires the ability to abstract the meaning of what the user sees, to understand how the different parts are combined and communicate together. Such results are consistent with an intuition-friendly user. Instead, the Blackjack is easier for people who usually interact with the world in a logical and intuitive way.

Although the results are similar each participant has classified the objects in a slightly different way. As reported in Table I, the variance is smaller when people describe how a product sends stimuli (e.g., the mean value of the variance is about 64 for the SN dichotomy) than when they have to imagine the results of their actions with the system (e.g., the same value is about 90 for the TF dichotomy). Such behavior can be explained by the evidence that second exercise has much more solutions than the first one.

The video recorder has rather low values of the variance because this device is almost in every house and during the test everybody remembers how it works. Conversely, understanding how to interact with Tamagotchi and Furby through their descriptions is not easy for a student who has never interacted with them thus implying the high level of variance for the TF dichotomy. However the provided descriptions of both Tamagotchi and Furby are able to clarify efficaciously how these toys send stimuli (i.e., low values in the SN dichotomy).

The variances of variances are 116 for the TF dichotomy and 113 for the SN dichotomy. The values of the variance fluctuate a bit probably because some products are well known by the students while others are barely new, e.g., everyone had a notion of a VCR, few have already played Blackjack, many have seen Tamagotchi or Furby but no one has ever been into the described design installation.

The interacting systems were chosen in order to have a different level of interaction and engagement with the humans, then we can consider how the path of the consumer electronics has been evolved over the last decades. Figure 3

[1]https://en.wikipedia.org/wiki/Tamagotchi
[2]https://en.wikipedia.org/wiki/Furby

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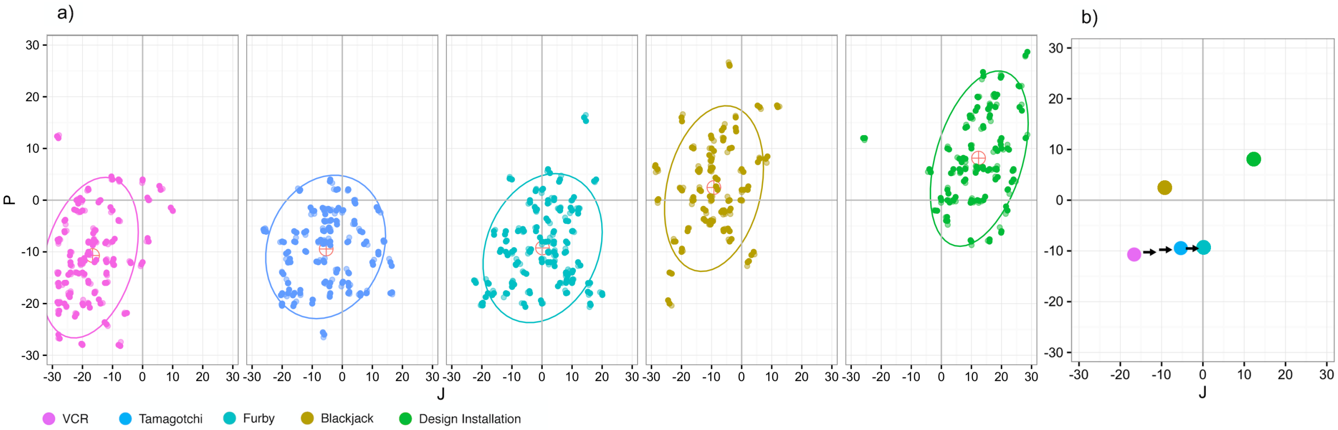

Figure 3. a) Personality-friendly object classification of five interacting systems: Tamagotchi, Furby, Video Cassette Recorder, Black Jack and Design Installation. Each centroid of the point clouds is represented though a crossed circle and the ellipse reports the 95% interval of confidence
b) Position of the five interactive systems (Tamagotchi, Furby, Video Cassette Recorder, Black Jack and Design Installation) within the J-P plane. The arrows report the evolution of the consumer electronics.

TABLE I. AVERAGE AND VARIANCE TABLE

VCR		**Tamagotchi**		**Furby**		**Black Jack**		**Design installation**	
Avg.FT	Avg.SN	Avg.TF	Avg.SN	Avg.FT	Avg.SN	Avg.FT	Avg.SN	Avg.FT	Avg.SN
-16,65	-10,71	-5,35	-9,45	0,16	-9,24	-9,24	2,45	12,37	8,14
Var.TF	Var.SN	Var.TF	Var.SN	Var.TF	Var.SN	Var.TF	Var.SN	Var.TF	Var.SN
78,29	69,62	102,66	46,34	102,57	57,16	80,25	74,63	84,4	71,98

shows the centroids related to the five case studies highlighting with arrows the evolutionary path made by the electronic devices for entertainment. According to the students answers $(J = -16,6; P = -10,7)$ it is evident that VCR is characterised by a remarkable compatibility with the mental function named thinking. The interaction between a traditional electronic device (e.g., video recorder) and the user is led by an algorithm, which works only in a logical and objective way. Probably this is the cause of this kind of compatibility. Tamagotchi works through a similar algorithm but this fact is not explicit because each stimulus sent by the device and each answer of the user are about the needs of a puppy. The participants seem to perceive such a difference, in their opinion $(J = -5,4; P = -9,4)$ it is possible to interact with Tamagotchi not only through the logic but also via an emotional way (i.e., mental function named feeling). For a person who prefers reaching conclusions through an emotional way a Tamagotchi is more natural to use than a video recorder. Tamagotchi was the first electronic product equipped with this feature and probably this was one of the reason of its enormous commercial success. This idea is supported by the analysis of Furby, which can be considered the evolution of Tamagotchi. It results equally compatible with both thinking and feeling people $(J = 0,2; P = -9,2)$. In our opinion, the designers of the Furby have improved the compatibility with the people who prefer the feeling function in order to reach a trade-off and to create a product suitable for a larger audience.

VI. CONCLUSION

In this paper, the new paradigm of personality-friendly products is presented. Its scope is to clarify the influence of the personality of people during their interaction in the context of human-machine interaction. To achieve this goal we proposed and tested a questionnaire for the classification of interactive objects. This tool is based on a model for describing the human-device interaction and a model for human personalities (i.e., Jung's theory of personality types) that allows to categorize products on the basis of certain characteristics that may occur or not in the human-machine interaction. The approach we propose here derives from MBTI and it was demonstrated to be useful in mapping the ability of an inanimate object to be friendly with respect to different types of users on the basis of their personalities. The experimental results showed how different objects are designed to better fit with particular sets of users than with others. This paradigm looks at the interaction with objects from the point of view of different users so as to be able to highlight different features of the object itself. Future studies will be oriented to refine the classification tool in terms of number of questions and level of details. In addition, we will test the model in the design of the interaction between people and humanoid robots, and in the field of smart object affordances. In long term vision, this methodology will help the designer to customize the human-device interaction taking into account the differences between the personality of potential users by using both questionnaires and real interactions with the products.

VII. ACKNOWLEDGEMENTS

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