USER PREFERENCES FOR PERSONALITIES OF ENTERTAINMENT ROBOTS ACCORDING TO THE USERS' PSYCHOLOGICAL TYPES

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Abstract: The purpose of an entertainment robot is to provide intimacy and enjoyment for people rather than to give any function. Therefore, personality design as well as emotion design is necessary for an entertainment robot. When we endow an entertainment robot personality, it gives a robot the consistency and the distinction of behavior.

The purpose of this paper is to suggest a design process for constructing personality of an entertainment robot based on psychological types, and investigate user preferences for robot personalities according to the users' psychological types.

Four temperaments derived from 16 personality types in a psychological type Indicator, MBTI(Myers Briggs Type Indicator), were applied to design the personality of an entertainment robot. The process is composed of four steps- concept design of an entertainment robot, situation scene design and perception device design, reaction design based on temperaments, and demonstration of robot temperaments in terms of reaction and via experiments.

***Key words*:** *Entertainment Robot, Personality Design, Temperament*

1. Introduction

To date, robotics has focused on the development and research of industrial robots. However, recently personal robots have begun to attract more attention than industrial robots. Personal robots are closely connected with people's daily lives [1]. In this paper, we define personal robots as autonomous robots, which interact with people or an environment in human daily life. Personal robots can be subdivided based on the purpose of use or the environment where they are used. Entertainment robots are one type of personal robots. They have the purpose of providing intimacy and enjoyment to people, or in other words, 'entertaining' them. To achieve this, both emotion design and personality design are essential.

In this study, we provide robots with personality in order to lend them consistency and distinction of behavior. Consistency allows users to understand robots' behavior more easily and naturally, and distinction provides users with various types of robots so that users can select robots according to their preferences.

Recently, Terrence Fong identified Big Five as well as MBTI as useful personality guidelines [2]. In this study, we suggest a personality design process for entertainment robots based on four temperaments, which are derived from human psychological types obtained via MBTI (Myers Briggs Type Indicator). We conducted a case study to verify the effectiveness of the process and investigated user preferences for the personality of an entertainment robot

according to the users' psychological types.

2. Methods – Personality Design Process of Entertainment Robots

In this study, we apply temperaments to robots and suggest a personality design process for entertainment robots.

The process is divided into four steps, concept design of a robot, situation scene design and perception device design, reaction design based on robot temperaments, and demonstration of robot temperaments in terms of reactions through experiments[Figure1].

2.1 Robot Temperaments

Four Temperaments

Temperament is the manner of thinking, behaving, or reacting characteristics of a specific person [3]. David Keirsey contends that temperaments determine behavior, because through behavior, people obtain what they desire and thereby satisfy their desires [4]. This means temperaments reflect the basic and ultimate desires of people, and different behaviors are determined according to different temperaments.

The attributes of each temperament are as follows:

- Sensing-Perceiving (SP Temperament: Experiencers): attributes: free, impulsive, spontaneous, interesting, brave and active, expert at tools, eclectic and adaptable
- Sensing-Judging (SJ Temperament: Traditionalists): want to be attached to a position and serve, responsibility, respect duties and systems, conservative values, diligence, getting by experience
- Intuitive-Thinking (NT Temperament: Conceptualizers): intellectual understanding, principle comprehension, organization of thinking, theoretical, logical, long-term plan, constructing abstract structure
- Intuitive-Feeling (NF Temperament: Idealists): want to be sincere, searching for meaning and identity, developing latent faculties, existentialism, seeking for self-realization, futuristic [5]

Robot Temperaments

In this study temperaments were used as a guideline to design the personality of a robot, and 'Robot temperaments' are identified according to the attributes of each temperament.

- Sensing-Perceiving robot temperament (action-preferred robot temperament)
- Sensing-Judging robot temperament (responsibility and duty-oriented robot temperament)
- Intuitive-Thinking robot temperament (thinking-oriented robot temperament)
- Intuitive-Feeling robot temperament (ideal-oriented robot temperament)

2.2 Personality Design Process of Entertainment Robots Based on Robot Temperaments

2.2.1 Concept Design of Entertainment Robots

In this stage, the type of entertainment robot is selected based on the robots' appearance and function. The appearance and function of robots determine the range of possible movement and perception.

2.2.2 Situation Scene Design and Perception Device Design

A situation means "Position or status with regard to conditions and circumstances,"[6] and in this study it indicates the input that the robots perceive. Designers can design a situation scene first and embody necessary sensors to perceive the scene. They can also construct a perception device with possible sensor technology first and then design the situation scene.

Most proper situation scene design includes the following characteristics. First, a proper situation scene distinguishes reactions clearly based on robot temperaments. Second, the minimum number of situations that expresses the personality of robots best should be determined. To find more suitable situation scenes, iterative process and experiments are inevitable.

2.2.3 Reaction Design Based on Robot Temperaments

In this stage, reactions are designed based on robot temperaments. Reactions can be designed based on the 'five W's and one H'. Among the six components, 'Who' and 'Why' are determined by the robot and the robot temperament, 'When' is the moment when the robot perceives the situation, and 'Where' is the place where the robot is situated at the moment. Therefore, the main factors that should be designed are 'What' and 'How'. 'What' indicates which part of the robot's body is activated, and 'How' indicates the manner in which the robot reacts with the part of its body.

When generating ideas for reactions, brainstorming and wizard-of-oz techniques [7] are useful methods. The wizard-of-oz techniques are efficient to describe motions and interactions that are not easily expressed in words.

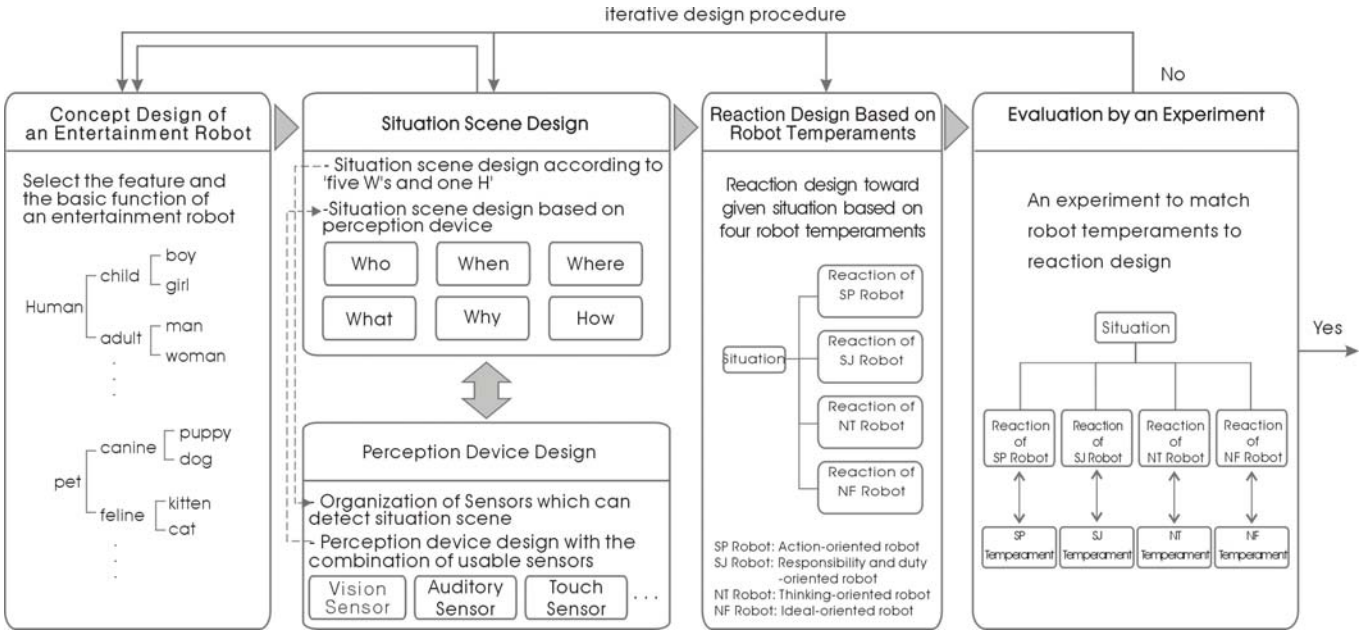

Figure 1. Personality Design Process for Entertainment Robots

2.2.4 Evaluation by Experiment

In this stage, we evaluate the distinction of reactions based on temperaments. Through an experiment robot temperaments are matched with reaction design. The purpose of this experiment is to show how easily participants recognize the attributes of temperaments through reactions.

We wish to address the following questions.

- Does each reaction display distinctive features according to different robot temperaments?
- Which situation distinguishes reactions more vividly based on robot temperament?
- Is there any improvement method in terms of reaction design to express robot temperaments more distinctively?

3. Results and Discussions

We applied a case study to the personality design process. Three experimenters from the fields of computer science, industrial engineering, and industrial design participated in the case study.

3.1 Concept Design of an Entertainment Robot

In this stage, the experimenters selected AIBO ERS-210 as an object for the case study. AIBO is a well-known entertainment robot, and the behavior of AIBO is designed based on canine ethology [8]. The appearance of AIBO ERS-210 is an amalgamation of a puppy and a lion cub. AIBO has various sensors, such as 'touch sensor', 'auditory sensor', 'vision sensor', 'equilibrium sensor', etc. It can express dynamic walking with four legs and flexible movements with ears and a tail[9].

3.2 Situation Scene Design and Perception Device Design

In this case study, we chose three situation scenes that AIBO can perceive.

- Situation scene 1: When the master turns on AIBO (when the master awakes AIBO)
- Situation scene 2: When AIBO perceives a pink ball
- Situation scene 3: When AIBO perceives its name, which is called by the master

3.3 Reaction Design Based on Robot Temperaments

In this stage, experimenters designed reactions for three situations based on four robot temperaments. The reactions for situation 1 are shown in [Table 1].

Table 1. Reaction Design for Situation 1

Situation 1: When the master turns on AIBO (when the master awakes AIBO)	
Robot Temperament	Reaction Scenario
SP	As soon as AIBO wakes up, it wanders around.
SJ	After AIBO wakes up, it sits and waits for the order of the master while wagging its tail.
NT	After AIBO wakes up, it walks around slowly while observing environment.
NF	After AIBO wakes up, it waves paw to human as an invitation to play.

[Table 2] displays the reactions for situation 2.

Table 2. Reaction Design for Situation 2

Situation 2: When AIBO perceives the pink ball	
Robot Temperament	Reaction Scenario
SP	As soon as the ball is found, AIBO walks towards the ball. Unreservedly kicks the ball and plays with it.
SJ	When the ball is found, AIBO walks towards the ball. Keeps the ball and waits for the master's order.
NT	When the ball is found, first carefully looks at the ball and observes the ball, then slowly walks towards the ball. Occasionally kicks the ball and again carefully observes.
NF	When the ball is found and the voice of human is recognized, AIBO brings the ball to the human's location and subsequently waves paw to human asking to play.

[Table 3] shows the reactions for situation 3.

Table 3. Reaction Design for Situation 3

Situation 3: When AIBO perceives its name, which is called by the owner	
Robot Temperament	Reaction Scenario
SP	AIBO recognizes the master and then runs to the master and expresses happiness by waving tail as well as other different behaviors with sound.
SJ	When the owner is recognized, calmly goes toward the owner and wags its tail, waiting for the next move or next order.
NT	When owner's call is recognized, AIBO carefully observes the owner, confirming whether human is indeed the owner. Upon confirming this, AIBO slowly walks towards the owner and expresses joyfulness.
NF	When the owner is recognized, AIBO runs toward the owner and asks the owner to play by waving its paw and head.

3.4 Experiment and Analysis Using a Web-Based Experimental Tool

The experiment is composed of five parts – reference of temperaments, situation, reaction, check box for selecting robot temperaments, and check box for choosing the preferred robot temperament[Figure 2].

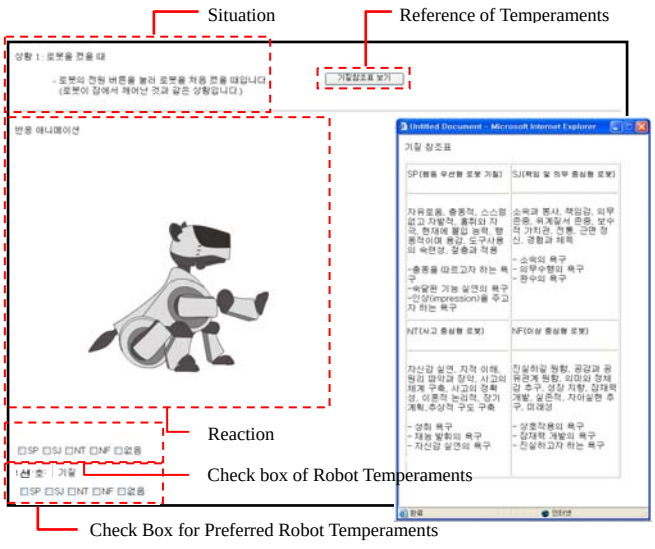

Figure 2. Main survey page

3.4.1 Experiment Execution

An experiment using a Web-Based Experimental Tool was executed to evaluate the distinction of reactions based on robot temperament. 57 people participated in this experiment. Most were in their early twenties. There were 24 male participants and 33 female participants.

3.4.2 Data Analysis

The results of the experiments are shown in [Figure 3]. We compared robot temperaments that experimenters applied to reaction design with those that participants identified. We then analyzed the averages of the most common answers.

1) *Most preferred answers by participants corresponded with robot temperaments that the experimenters applied to reaction design.*

As [Figure 3] shows, participants distinguished robot temperaments of reactions. That is, participants matched reactions with the temperaments that experimenters applied to the reaction design. This indicates that robot temperaments are useful guidelines to design the personality of entertainment robots.

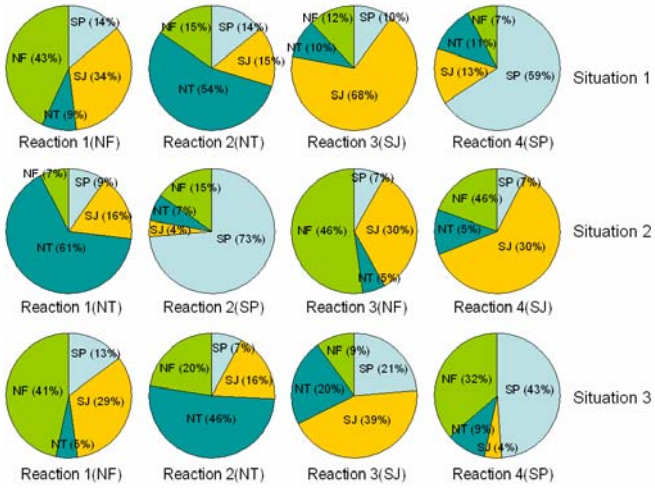

Figure 3. Participants Responses

(SP: Action-preferred Robot, SJ: Responsibility and duty-oriented robot, NT: Thinking-oriented Robot, NF: Ideal-oriented Robot)

2) *Evaluation of Situation Scene Design*

In order to evaluate the situation scene design, we averaged the percentage of the most preferred answers by participants according to each situation. Each situation displays different average rates: the situations that show higher average rates distinguish reactions better based on temperaments, while those that show lower average rates distinguish reactions worse. The averages of the most preferred answers according to

situations are 56% for situation 1, 59% for situation 2, and 43% for situation 3. Situation 2 expresses reaction most distinctively, and situation 3 describes reaction least distinctively [Table 4].

Table 4. Evaluation of Situation Scene Design

(Unit: %)

	Reaction 1	Reaction 2	Reaction 3	Reaction 4	Average
Situation 1	NF: 43	NT: 54	SJ: 68	SP: 59	56
Situation 2	NT: 61	SP: 73	NF: 46	SJ: 57	59
Situation 3	NF: 41	NT: 46	SJ: 39	SP:43	43

(SP: Action-preferred Robot, SJ: Responsibility and duty-oriented robot, NT: Thinking-oriented Robot, NF: Ideal-oriented Robot)

3) *Evaluation of Reaction Design*

To evaluate reaction design, two methods are used: comparison of the most preferred answers by participants and analysis of the equality of the other three answers except the most preferred answer. The reactions with higher percentage describe temperaments better and those with lower percentage represent temperaments worse. When the other three answers except the most preferred answer are less equal, the reaction reveals the attribute of temperament more ambiguously.

4) *Evaluation of the Ambiguity of Reaction Design*

In order to evaluate the ambiguity of reaction design, we compare the differences between the first preferred answer and the second preferred answer. The smaller the differences between the first and the second preferred answers are, the more ambiguous the reaction is. [Table 5] shows the differences between the first and the second preferred answers.

Table 5. Evaluation of ambiguity of reaction design

(Unit: %)

	Reaction 1			Reaction 2		
Situation 1	SJ 34	NF 43	Differences* 9	SJ/NF 15	NT 54	Differences 39
Situation 2	SJ 16	NT 61	Differences 45	SP 73	NF 15	Differences 58
Situation 3	SJ 29	NF 41	Differences 12	NT 46	NF 20	Differences 26
	Reaction 3			**Reaction 4**		
Situation 1	SJ 68	NF 12	Differences 56	SP 59	SJ 13	Differences 46
Situation 2	SJ 30	NF 46	Differences 16	SJ 57	NF 18	Differences 39
Situation 3	SP 21	SJ 39	Differences 18	SP 43	NF 32	Differences 11

(SP: Action-preferred Robot, SJ: Responsibility and duty-oriented robot, NT: Thinking-oriented Robot, NF: Ideal-oriented Robot)

* (Differences) = (the 1st preferred answer) – (the 2nd preferred answer)

5) *Evaluation of Ambiguity of Robot Temperaments*

In order to evaluate the ambiguity of robot temperaments, we average the percentage of the most preferred answers according to robot temperaments and compare the results. The averages of most preferred answers according to robot temperaments are 58% for Action-preferred Robot, 54% for Thinking-oriented Robot, 51% for Responsibility and duty oriented Robot, and 43% for Ideal-oriented Robot [Table 6]. These results demonstrate that Action-preferred Robot expresses the attribute of robot temperaments most effectively, and Ideal-oriented Robot least effectively represents the attribute of robot temperaments.

Table 6. Evaluation of ambiguity of expression of robot temperaments

(Unit: %)

	Situation 1	Situation 2	Situation 3	Average
SP	59	73	43	58
SJ	68	57	39	51
NT	54	61	46	54
NF	43	46	41	43

(SP: Action-preferred Robot, SJ: Responsibility and duty-oriented robot, NT: Thinking-oriented Robot, NF: Ideal-oriented Robot)

6) *Users' Preferences for an Entertainment Robot's Personality*

[Table 7] shows that SJ participants preferred NT for situation 1, SP for situation 2, and SP for situation 3. SP participants preferred NF for every situation. NT participants preferred SJ for situation 1, NF for situation 2, and SP for situation 3. NT participants preferred different robot temperaments except their temperament for each situation. NF participants preferred NF and SP equally for situation 1, NF for situation 2, and SP for situation 3.

Table 7. Users' Preferences for Entertainment Robot's Personality

(Unit: %)

		SJ	SP	NT	NF	Preferences based on each temperament
SJ`	Situation 1	20	20	40	20	NT
	Situation 2	0	60	0	40	SP
	Situation 3	10	50	0	40	SP
SP`	Situation 1	22	11	22	45	NF
	Situation 2	0	33	11	56	NF
	Situation 3	33	22	0	45	NF
NT`	Situation 1	41.7	16.7	8.3	33.3	SJ
	Situation 2	8	33	0	59	NF
	Situation 3	0	54.5	0	45.5	SP
NF`	Situation 1	13.3	20	6.7	60	NF
	Situation 2	0	13	13	74	NF
	Situation 3	0	60	7	33	SP
None	Situation 1	27.2	36.4	0	36.4	NF/SP
	Situation 2	0	36.4	18.2	45.4	NF

	Preferences based on each situation			
	SJ	SP	NT	NF
Situation 1	24.6	21	14	40.4
Situation 2	1.8	33.3	8.8	56.1
Situation 3	7.1	48.2	5.4	39.3

(SP`: Subjects with SP temperament, SJ`: Subjects with SJ temperament, NT`: Subjects with NT temperament, NF`: Subjects with NF temperament, None: Subjects without MBTI test result, SP: Action-preferred Robot, SJ: Responsibility and duty-oriented robot, NT: Thinking-oriented Robot, NF: Ideal-oriented Robot)

We also analyzed all participants' preferences based on each situation. Participants preferred NF (40.4%) and SJ (24.6%) for situation 1, NF (56.1%) and SP (33.3%) for situation 2, and SP (48.2%) and NF (39.3%) for situation 3. These results show that users' preferences for robots' personality vary according to the users' psychological types, and the majority of the participants prefer action-preferred robot temperament and ideal-oriented robot temperament. This indicates that users expect entertainment robots to exhibit diverse impulsive actions and to be sociable with them in a friendly manner.

4. Conclusions

In this study, we suggest a design process for constructing the personality of an entertainment robot based on temperaments. Based on the process, three selected experimenters carried out a case study with AIBO. They chose three possible situations that the current AIBO can perceive, and for each situation they organized reaction scenarios that AIBO would represent. With the designed reactions, an experiment was executed to match the reactions with the attributes of temperaments and to choose the most preferable reaction for each situation. Through the case study, we discovered that the reactions designed based on the personality design process reveal the attributes of the robot temperaments, and the result rates of the participants' answers vary according to different situations and reactions. The case study yielded several important findings. First, most preferred answers of participants corresponded with the robot temperaments that experimenters applied to reaction design. This indicates that the robot temperaments are an effective indicator to construct the personality of an entertainment robot. Second, some situations represent robot temperament more distinctively while others represent it more ambiguously. This shows that situation scene design is an important factor to make the reaction distinctive according to the robot temperament. Third, some reactions express robot temperament more vividly, while others do so more ambiguously. This should allow robot developers notice which reaction design should be modified or supplemented. Fourth, some robot temperaments are expressed more effectively through reaction while others are more difficult to display. Fifth, users' preferences for robot temperaments varied according to the users' temperaments. The majority of participants preferred the Ideal-oriented robot and Action-preferred robot.

The process suggested in this study will provide a useful guideline for constructing the personality of entertainment robots, thus making it possible for robot developers to design robot's personality more easily. With iterative execution of the process, more appropriate situations and reactions to express the personality of entertainment robots will be identified, and as a result, entertainment robots will be able to interact with people more naturally and intimately.

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