SAARLAND UNIVERSITY

Faculty of Mathematics and Computer Science
Department of Computer Science
BACHELOR THESIS or MASTER THESIS (PICK!)

TITLE

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Saarbrücken
May 2020

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Declarations

Acknowledgements

Abstract

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Introduction

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Related Work

This chapter presents the background and current works related to our research and is organised as follows. Sections 2.1, 2.2, and 2.3 provide an introduction of basic concepts related to our prototype. Then, in section 2.4, we present a system that inspired us to expand it. Starting from section 2.5, we discuss some methodologies that help us to expand the existing system.

2.1 Ubiquitous Computing

The attempts to make technologies invisible in the background of people's life led to the emergence of a new approach in the area of Information Technology whereby making the term Ubiquitous Computing prominent in recent years. The "Ubiquitous Computing" was initially put forward by Mark Weiser in "The computer for the 21st Century" [1]. In this paper, the author touched two issues related to the concept of Ubiquitous Computing such as the location and scale.

The traditional computers which existed before the introduction of this paradigm had no idea about their location. The location-aware system may have information about how far or close it is from other objects and may even later be able to adapt its behaviour accordingly. An example application that leveraged the location-aware paradigm was introduced by Hupfeld and Berge in their RAUM system [2]. The authors claim that information about the location of objects plays a more important role than their identities. They explain the essence of location by giving an example of people who prefer to communicate while standing in front of the person who participates in the conversation, rather than turning their backs on him. With the help of the concept of Ubiquitous Computing, the prototype presented in our research uses the location information in order to select a communication partner.

Another issue related to the concept of Ubiquitous Computing is the scale, that is, systems of various sizes serve different purposes. In the context of our prototype, mascot, tablet, lamp, and speakers are all in different sizes and, therefore, perform different tasks. Moreover, the size of objects is also reflected in its location, for example, a lamp, compared to other devices has a larger size, which limits its location to one point, whereas the mascot which is a pocket-size phone allows changing the location depending on the location of its owner.

2.2 Internet of Things

The rapid development of electronics led to the emergence of the concept of "Internet of Things". IoT can be both ubiquitous and non-ubiquitous technologies. Moreover, in the context of Ubiquitous Computing, IoT adds a new dimension to the interaction between objects: from any time, any place connectivity for everyone, we will have connectivity for anything [3]. Thus, in comparison to Ubiquitous technologies, IoT focuses not only on the interaction between humans and devices but also between the devices themselves.

The idea of IoT was first proposed by Kevin Ashton in 1999 [4] by linking the idea of RFID (Radio Frequency Identification) to the topic of the Internet. We can characterize IoT as one big network where all devices can share information about their status with each other allowing to achieve deeper automation and integration within a system. In "Internet of Things: A Literature Review" [5], authors describe the genesis of the term "IoT" which help us to understand the general concept behind it and corresponding key technologies that it uses. They explained the concept by dividing the definition of IoT into two components: "Internet" (as a global system of interconnected computer networks that use the Internet protocol to serve users worldwide) and "Thing" (as real objects in the physical or material world). This explanation helps us to understand that inanimate objects such as lamp, speakers, etc can communicate with other objects with the help of the Internet without any explicit human instructions. Thus, in our work, we use mascots, tablet, lamp, and speakers as a representation of inanimate objects called "things", which can interact with each other and send information over the local network. In addition, this paper provides key technology of IoT such as Radio Frequency Identification, Electronic Product Code, ZigBee, etc. From the technical point of view, RFID is primarily relevant to the unique identification of a "thing" in order to communicate with other objects. Moreover, ZigBee is widely used, short-range, low-rate wireless network technology, so in our prototype, the communication between mascot and lamp is built with the help of Zigbee Lighting protocol. Additionally, an inexpensive radio technology Bluetooth Low Energy is also very useful for our research for proximity sensing. In addition to these technologies which are considered as a pillar for communication between objects, the more detailed description of their usage can be found in the Implementation chapter (see chapter 4).

An example of research work in the area of IoT may be “Explorations on Reciprocal Interplay in Things Ecology” [6] where the authors are trying to stimulate scientists to a more detailed discussion on designing qualities of IoT devices. For that, Chung et al. conducted the HiddenLocal workshop (HWL) in order to explore and design IoT systems, where they take into account reciprocal interplay believing that it makes the design of IoT systems more dynamic. As a starting point, authors show 7 perceptual qualities as follows: focus the senses; show explorative behaviour; subtleness of movement; react to the external event; recognize explorative behaviour subject; reflex contextual noise; remember and anticipate perception over time. Authors believe that these perceptual qualities are a good approach for designed explorative features of devices and therefore for the things-to-things interaction.

2.3 Social Internet of Things

According to the “The Internet of Things: A survey” paper [7], unfortunately, there are many research issues related to the IoT that require further research and need to be addressed. One of them is that people still cannot be sure about the privacy of the transferred data through IoT technologies. Another issue is network navigability which must ensure that the discovery of objects can be performed effectively and better reaction to the state changes of objects. Atzori et al. [8] formalized a new paradigm of Social Internet of Things (SIoT) where the interaction among smart objects is based on the notion of Social Relationship of things rather than their owners. Thus, the application of this concept to the IoT can lead to the improvement of the network navigability and scalability. The architectural model of SIoT describes the establishment of the social relationships among objects in a fashion that is relatively similar to the human social network relationship.

Applying new paradigm to the IoT concept can lead to the following advantages:

- establishing the level of trustworthiness by leveraging relationship types and by supporting services usable among things that are “friends”;
- improvements in network navigability;
- a guarantee of the higher scalability and efficiency; [9];

By integrating social networking concept to the Internet of Things, intelligent things establish a connection with other peers in an autonomous way by exploiting things’ social relationships. An exemplary connection between smart things that we also refer as "social things" in our study may be Mascot-Mascot, Mascot-Tablet, Mascot-Lamp and Mascot-Speakers interactions. The application of the SIoT concept will help to accomplish complex tasks such as changing object behaviour according to the given information. Thus, with the help of the

advantages provided by social networking principles the IoT evolves into the SIoT, in which social relationships can be established among the devices in order to advertise information about their current state and provide services to their peers.

2.4 Autonomous interaction of things

Most devices using the concept of IoT are designed to involve the user in the process where user's actions trigger certain functions of a system in order to effects the behaviour of objects. This design contradicts to the concept of a fully automated system where objects can cooperate with each other beyond the control of a human. The following paper [10] , which is an inspiration for our work, introduces the design methodology to achieve a more autonomous system. The authors applied the concept of SIoT and consider objects as living beings which are able to communicate with others and exchange information autonomously. This approach allows objects to have their own social circle similar to human social network. This broadcast information calls certain functions that affect the behaviour of objects, thus, allowing objects to be aware of the status of other objects and the surrounding environment.

The concept of Social Things which is also an essential for our prototype helps the objects to know: own goals; what to do with the received information; and what actions need to be taken to achieve these goals. In our work, goals and the combination of actions that will be triggered depending on the received information, are all predefined.

As a case study, the authors developed a system with two devices. One of them is Mascot (which is a small keychain of three colours: red, green and blue) presented in the form of a personal object that the user can carry with him everywhere. Another device is a Bench with built-in lamps presented as a more static device for public use. Moreover, in the prototype described in that work, two scenarios are considered:

- **Mascot - Mascot** interaction, as one mascot approaches another, they both start to blink where the intensity of blink depends on the distance objects are from each other.
- **Mascot - Bench** interaction, as Mascot goes close to the bench, the lights start to change their colors based on the color of mascot that is approaching.

The biggest contribution of this paper was to introduce the autonomously cooperative system where mascot and bench represented as a private and public thing. Moreover, authors also considered proximity-based cooperation: devices blink more often when approaching closer than 30 cm and and blink with less intensity when approaching more than 150 cm. By using the concept presented in this study, namely, autonomous interaction between objects/things achieved with

the help of the SIoT concept, we are planning to expand the system by adding more objects. Afterwards, we are going to apply the theory of Proxemics and Personality Traits which will be covered in the following sections. In addition to the two categories that authors described in their paper (i.e. private and public "things") presented by two objects (mascot and bench, respectively), in section 2.5 we are planning to look at more detailed divisions.

2.5 The Theory of Proxemics

Edward Hall [11] [12] conceptualized the idea of a personal space bubble by creating a whole system of notation in order to understand and record how people navigate shared space. He correlated physical distance to social distance. According to these papers, Hall identified four distances which are measured horizontally:

- **Intimate distance** which varies from 0 to 45 cm is a distance used for romantic partners and family members.
- **Personal distance** varies from 46 to 122 cm is a space bubble which allows your extended family members and close friends to enter this zone.
- **Social distance** varies from 122 to 370 cm is often used for acquaintances and colloquies
- **Public distance**, having a range of 370 cm and more, is often used in public speaking situation and with strangers you want to maintain your distance from.

He also analyzed vertical distances, for example, the difference in vertical distance between people can reflect the degree of dominance. However, in our study we focus only on horizontal distances.

Nowadays, there are many studies in which Proxemics has been used to design interactions. For example, Jo Vermeulen et al. in their work [13] used zones to interact with vertical interactive displays where they suggested floor display as an auxiliary device. The contributions of using the secondary display are the following: it provides peripheral information about tracking status of a user; it shows interaction zones; it invites the user to interact with the main display; it suggests possible interaction steps. This kind of floor visualization with continuous feedback about proximity gives the user more control over their interaction with the system.

Another example system using Proxemics is Remote Controls system introduced by Ledo et.al in their [14] paper. Remote control devices were created in such a way that people could control appliances from a certain distance. However, with the increase in the number of home appliances, the number of remote controls

also increasing. For this purpose, the universal remotes have been proposed providing a one-remote-to-many-appliances solution. Unfortunately, this design has setup issues and poorly adaptable interface. Authors of this paper presented proxemic-aware controls that utilize the spatial relationship between mobile devices owned by user and appliances surrounding it. With this system user can discover and select the devices within large ecologies of appliances, view their current status and control their features. Moreover, as a user moves closer or farther to a particular device, the interface adjusts accordingly. For example, in the initial state, the tablet screen visualizes icons representing the location of appliances at the edge of the screen, these icons are dynamically updated as he moves. Through spatial interactions, people can leverage mobile devices to discover and select appliances. This allows for situated interaction that balances simple and flexible control while seamlessly transitioning between different control interfaces. Ubicomp, which they use as short for Ubiquitous Computing, may be a starting point for developing a new type of remote control interface within our increasingly complex world.

In addition, Ballendat, Nicolai Marquardt, and Saul Greenberg in their paper [15] introduce proxemic-aware interactive media player system, where they consider information regarding nearby people and devices in order to mediate the interaction. They cover a small space Ubicomp environment considering the relationships of people to devices; devices to devices; and non-digital objects to people and devices. The system reacts to a person's presence, distance and orientation regarding the display. Proxemic interaction also considers a person's relationship to nearby objects. The authors propose different cases, for example, the video displaying on the screen pauses when a person is having a phone conversation or when he picks a magazine to read it. Another case is when a person enters the room, the screen shows a video title as additional information for him. Moreover, the video is paused when both people face away from the screen in order to start a conversation with each other. Furthermore, the system turns off when everyone has left the room. However, the authors also emphasize that one of the biggest unsolved problems in this area might be how the system can respond to the received information about proxemics because sometimes the devices can make a mistake by taking a certain action. In spite of all these problems, the authors, as well as we believe that proxemics will become an important factor in the embodiment of the interaction between social objects where they can meet the social expectations of people.

In our research, we are planning to extend the autonomous system, which was described in section 2.4, by categorizing devices according to the theory of Proxemics using only horizontal measurements. Our goal is to cover all four categories of Proxemics which are represented by four artefacts such as Mascot, Tablet, Lamp and Speakers, thereby, constituting four case studies. Thus, each of these devices is located at a certain distance from each other representing the relationships between them. These relationships will help us to conceptualize their interactions, come up with case study and possible actions.

2.6 Interaction design for SIoT

The following paper [18] motivated us to apply a concept of personality in the context of social devices. An example use of Personality as a method to design an interactive object's behaviour was proposed in "Designing the Behaviour of Interactive Objects" [19]. The author came to the conclusion that in order to design a more stable and understandable for user behaviour of a device, it is necessary to add inner logic to which we can refer. Marco et al. proposed to apply the concept of metaphor, which represents human stereotypes of personality in order to visualise the inner logic. Their system was based on a Big Five Personality Traits model, and thus, by assigning these personalities to objects, users could describe its behaviour more easily. The authors believe that stereotypes and metaphors are simplified descriptions of being and behaviour, and thus making it an ideal method for displaying the sustainable behaviour of a smart object. During the research, they used robotic sofa as a case study and tried to analyze how users perceive the consistency of its behaviour. The use of the Personality model in the device design process, helps a user to create a mental model of how an autonomous sofa-bot will act in the future.

Having a system, where tablet, lamp and speakers are considered as static objects, whereas mascots are dynamic, we can apply the Personality Model. And since only mascots are a major factor affecting the environment (for example, if mascot come close to the lamp, it changes the light color), we decided to assign a personality to dynamic objects (meaning to each mascot).

In our prototype we assume that this approach may help user to better understand mascot's behaviour. Knowing which goals and intentions this object follows, may help users to understand the behaviour and the reason of certain decisions of a mascot. We assume that these goals and intentions set certain boundaries in behaviour of social devices. And since the behaviour as a whole consists of actions, we suppose that personality model sets implicit instructions to the devices. Meaning that, instead of the user giving explicit instructions to the object, the object with the assigned personality makes decisions autonomously. Thus, the device with assigned personality can help users who knows the definition of that personality to understand the system behaviour at least in an intuitive way. This concept may give the system a more understandable and consistent behaviour, and to user a better awareness of object functionality In the following subsection we will describe the Personality Model in more details.

2.7 Definition of Personality Traits

Personality is important in human relationship, so we assume that it also may be important for device relationship. In order to assign a personality to each mascot, we first need to give a definition of personality in the context of social devices. We can try on an intuitively explain the meaning of a person's personality trait,

unfortunately, it is hard to apply it in the context of SIoT. For that, we need a generally accepted model, and we decided to use Big Five Personality Traits (aka OCEAN) for the description of each personality. We expect that providing a description of personality will help to define goals and more targeted actions which in turn will lead the system to more stable behaviour. The following book [20] gives a good introduction to the personality types describing possible existing personality models. One of the models that can be used was introduced by Costa and McCrae's five-factor model which is also known as Big Five Personality Traits and the OCEAN model. Moreover, their concept formed a basis for the widely used NEO-Personality Inventory-Revised (NEO-PI-R) measurement scale.

The OCEAN model consists of the following features: Openness to experience, Conscientiousness, Extroversion, Agreeableness and Neuroticism. The authors lists the facets associated with each of these five domains:

- **Openness to experience**: creativity, innovative quality; quick receptivity to new and abstract ideas, high intelligence and openness to novelty;
- **Conscientiousness**: organized, well-prepared, discipline, likes planned action more than spontaneity, more focused.
- **Extroversion**: energetic, assertive personality, like to be the center of attention, like to dominate, feel comfortable around people;
- **Agreeableness**: friendliness, compassion for other people, interested in people, sympathize with the feelings of others, soft-hearted;
- **Neuroticism**: irritability, more hostile towards others, most often feel anxiety when they are surrounded by others, frequent mood swings, emotionally unstable;

We assigned a set of personalities to dynamic objects each of which is described in the above-mentioned list. In addition, in spite of the fact that people usually have a combination of these five traits, we are going to consider only extreme cases.

Chapter 3
Concept

This chapter introduces the main concept of our research. Section 3.1 describes the theory that helps us to come up with the case-studies and the possible interactions of social devices. Section 3.2 identifies the mascots' personality traits that they will display during interactions described in previous section. From section 3.3, based on the assigned personalities, we explore the possible actions that social devices can show while interacting with each other. In section 3.3, we identify the vibration levels that convey personality traits. In section 3.4, we associate the music genre with personality traits. Section 3.5 describes colors that convey mascots' personality traits.

3.1 Identifying case studies and actions

In our research, we extended the "Autonomous Cooperation of Social Things" [10] by applying Proxemics Theory and Personality Traits Model.

Based on Proxemics theory, we classify our devices in the following way: Mascot will belong to the Intimate, Tablet to a Personal, Lamp will be considered as a Social and Speakers as Public distance. In this way, these objects represent cooperation among these distances. According to this theory, the distance between people represents their relationship which affects the way how they interact with each other. Having understood how people use distance when interacting with each other, and then applying this concept to social devices, we can come up with four case studies: Mascot-Mascot, Mascot-Tablet, Mascot-Lamp and Mascot-Speakers interactions.

Intimate distance has a very narrow range (i.e from 0 to 45 cm), and in the context of human-human interaction, this distance used for romantic partners or family

members. Thus, by applying it in the context of a device-device interaction, we can come up with a device whose functionality is only visible and accessible for their owners such as phone vibration. In our study, we substitute a phone with a term Mascot represented as a ubiquitous personal thing.

Personal distance varied from 46 to 122 cm can be presented by Tablet. In comparison to phone vibration where information is only available for owners, the size of tablet allows to display information for more members.

Social distance covers from 122 to 370 cm and can be reflected by lighting of the lamp. Our prototype contains only one lamp which can be visible for the large number of members.

Public distance is used for public speaking situations. In the context of SIoT, we can use Speakers as a representative of this distance. We suppose that the functionality of Speakers (i.e music play) will be available for everyone in the room. In comparison to the visibility of the lamp light which is limited due to the size of the lamp, speakers with the fixed volume of music play will be available for larger members.

Thus, Proxemics Theory helps us to choose devices, conceptualise their interactions, come up with case-studies and possible actions that these devices represent.

After identifying case-studies, we apply the concept of Personality in the context of social devices by assigning personality trait to each mascot. In our prototype, Mascots are dynamic and tablet, lamp and speakers are static devices. The movements of dynamic devices, interacting with all other devices effect the environment (i.e. the state of interacted devices). Thus, we assigned a unique personality to each dynamic device which we cover in the following section.

We now can take a closer look at the interactions represented by each case study:

- **Mascot - Mascot** interaction, as mascot approaches another, they both start to vibrate where the duration of vibration depends on the personality of approaching mascot.
- **Mascot - Tablet** interaction, as mascot goes close to the tablet, the background color of a screen starts to change based on the personality of approaching mascot.
- **Mascot - Lamp** interaction, as mascot goes close to the lamp, the lights start to change their colors based on the personality of approaching mascot.
- **Mascot - Speakers** interaction, as mascot approaches speakers, the music start to play the genre based on the personality of approaching mascot.

Each of these interaction types are characterized by actions such as phone vibration, background screen color change, lighting color transformation and music play. Since these actions are triggered based on the personality trait of approaching mascot, we need to associate personalities with more specific actions. The identification of these action will be described in sections 3.3, 3.4 and 3.5.

3.2 Identifying personality traits

In our prototype, personality is the primary focus of our investigation and it is based on the Big Five Personality Models which we briefly described in the related work section 2.7. Costa and McCrae integrated their five factors model with many other personality schemes of that time. Moreover, their enhanced scheme forms the basis of the "NEO-Personality Inventory-Revised" which is a widely used measurement scale [31]. The NEO-PI-R constitutes five personality traits which we also refer as personality dimensions or domains. These personality traits are **O**penness, **C**onscientiousness, **E**xtraversion, **A**greeableness and **N**euroticism (also known as OCEAN Model). Each of these personality dimensions is composed of six facets which are described in Table 3.1.

Personality Traits	**Personality Facets**
Openness	Fantasy, aesthetics, feelings, actions, ideas, values
Conscientiousness	Competence, order, dutifulness, achievement striving, self-discipline, deliberation
Extraversion	Warmth, gregariousness, assertiveness, activity, excitement seeking, positive emotions
Agreeableness	Trust, straightforwardness, altruism, compliance, modesty, tender-mindedness
Neuroticism	Anxiety, angry hostility, depression, self-consciousness, impulsiveness, vulnerability

Table 3.1: Personality facets associated with the five dimensions of the Costa and McCrae five factor model of personality

In addition, the enhanced scheme of Costa and McCrae (see Table 3.1) helps us in forming questionnaire that we use in our study. The questionnaire is a Likert scale containing 30 personality facets instead of five personality dimensions. Participants measured each facet with such device behavior as music, color and vibration level (see Chapter 5). The questionnaire consists of 30 questions including all six facets of all five dimensions based on NEO-PI-R measured scale [31]. The reason of not giving participants five questions consisting of the personality dimensions as a measurement is the desire to get more detailed feedback from them. Personality dimension are too broad, and as a result leads to less powerful predictions of behavior [32]. Moreover, participants may not be familiar with OCEAN model and giving them the description of each personality domain might assign them our opinion and might be biased. In this sense, it would be desirable to have a longer questionnaire which measured traits at both the domain and facet level to have a better understanding of which features of a trait influence aesthetic preference. Facets would provide greater descriptive details and a better understanding of the personality in comparison to traits.

In addition, considering human-human interaction, people reflect the mixture of

all these personality traits with a different proportions. A person who is highly straightforward and modest (facets of agreeableness personality see Table 3.1) also can have such facets as achieving striving and dutifulness in different proportions (facets of conscientiousness personality). Thus, since human personality has a more complex pattern, while applying this concept to social devices, we decided to simplify it. That means, If the mascot is assigned agreeable personality, we are planning to consider only this trait, by making this device, for example, highly trustworthy, and extremely modest and neglecting all other personality traits.

3.3 Identifying the vibration level based on the personality traits

First, we can consider the case of vibrating mascots, where the vibration level represents or at least gives a clue about which type of personality the approaching mascot has. In order to associate the level of vibration with a certain personality trait, we make an assumption about the vibration being conceptualized as a quality of self-expression that can be characterized as assertive behaviour. Depending on the personality of the device, the levels of assertiveness, which are presented as vibration levels, will differ. Since we decided to base our theory on the Big Five Personality Model, which, as its name implies, is characterized by five factors, the vibration levels in our system will vary from one to five (where L1 is scored as the lowest level of assertiveness and L5 represented as a highly assertive personality). Subsequent studies [26] [27] [28] [29] investigated the relationship between assertiveness and five personality factors (i.e. extraversion, neuroticism, openness to experience, agreeableness, and conscientiousness). The consistent findings of the differences in personality traits between assertive and non-assertive behaviors which are described in these papers can aid in developing our prototype.

In the following study [26], authors describe the correlation between assertiveness and personality traits based on regression analysis. This analysis together with a correlation coefficient presented in Table 3.2 [26] shows that neuroticism, extraversion and conscientiousness factors are the main predictors of assertiveness having a p-value<0.01 (denoted with asterisks) which indicates the significance of the relationship between these variables. The factors of agreeableness and openness to experience have shown no significant relationship in predicting assertiveness.

Based on Table 3.2, there is a linear correlation between extraversion and conscientiousness with assertiveness. Conversely, the inverse relationship between neuroticism and assertiveness makes this personality traits the lowest predictor. In addition, the authors did not find any significant relation between agreeableness and openness with assertiveness. We considered this table as an example, and the results found in other works [27] [28] [29] are also consistent with the results shown in this table. On the one hand, the high level of assertiveness and

	N	**E**	**O**	**A**	**C**
N	1.000				
E	-0.423**	1.000			
O	-0.047	-0.001	1.000		
A	-0.253**	0.351**	0.057	1.000	
C	-0.356**	0.387**	0.091	0.0263**	1.000
asseriveness	**-0.253****	**0.241****	**-0.002**	**0.064**	**0.225****

Table 3.2: Correlation Coefficients between personality traits and assertiveness

extraversion can be explained as individuals with this type of personality tend to seek stimulation from the environment that helps them to assert their opinions without hesitation or to take the initiative while starting a communication with others. In the case of Conscientiousness, since these individuals are more concentrated and goal-oriented, they may see assertiveness as a tool to achieve these goals. A neurotic personality trait, on the other hand, is characterized by people who are unable to assert or approve themselves and have difficulty in coping with stressful interpersonal situations which explains why assertiveness and neuroticism are inversely correlated to each other.

However, the relationship between Openness and Agreeableness personality traits with assertiveness is more ambiguous, in order to draw a conclusion out of it. Unfortunately, in many research papers that we studied, the correlation between these personality types and the level of assertiveness is not significant. In order to make an assumption about what level of vibration would better characterize these two personality dimensions, we need to refer to other factors. For example, in addition to assertiveness, we can also consider which motives or needs these individuals pursue and therefore, make an assumption based on this additional factor. The authors of the following papers [30] studied the relationship between personality traits and needs and provided us PRF (The Personality Research Form) pattern, which measures 20 needs that each personality trait may have. Before we study the PRF pattern, let us examine what are the characteristic features inherent in these two types of personalities.

In the following book [20], Openness to experience personality trait is described as a more open individuals with a deep imagination, who are always open to new knowledge, to some extent even curious and inquisitive and have wide interests. Given these characteristics, we can consider the needs and motives that these traits have according to the PRF pattern. The examination of this pattern may help us to understand how individuals behave in a wide variety of situations. For example, according to Table 3.3, the high score of CH describes that individuals with Openness personality dislike routine and avoid it, readily adapts to changes in the environment, which show how much they appreciate variety. The high level of UN scale shows that open individuals want to understand different

areas in order to satisfy intellectual curiosity. Whereas the low level of HA describes their adventurous side of the personality. All these scales demonstrate the types of behaviors that openness personality may show to fulfill their needs. Consequently, we can make an assumption that individuals high in openness personality trait generally behave in a relatively assertive manner (i.e they take the initiative, lead discussions) in order to broaden their knowledge. By relatively, we mean that the level of assertiveness needs to be less than the in Extravert and Conscientiousness and more than Neuroticism personality since they are the main predictors of assertiveness and the results have high significant value. The level of vibration that we can assign to our Mascot with this personality trait is L3.

Table 3.3: Joint Factor Loadings for NEO-PI Factors and PRF Scales

PRF scores	**O**	**A**
Social Recognition (SR)	-10	-19
Defendence (DE)	-13	**-48**
Succorance (SU)	**-34**	18
Affiliation (AF)	-13	19
Exhibition (EX)	23	**-31**
Play (PL)	07	-06
Understanding (UN)	**64**	10
Change (CH)	**60**	-12
Sentience (SE)	**53**	13
Autonomy (AU)	**47**	-26
Harmavoidance (HA)	**-52**	**32**
Abasement (AB)	12	**58**
Nurturance (NU)	10	**55**
Dominance (DO)	**45**	**-46**
Aggression (AG)	14	**-68**
Achievement (AC)	**46**	02
Order (OR)	-25	-17
Endurance (EN)	**33**	15
Impulsivity (IM)	24	03
Desirability (DY)	07	10

Agreeableness is described as a personality trait that is perceived as sympathetic, kind, warm, generous, helpful, forgiving, friendly, unselfish and gentle personality [20]. In addition to this definition, having examined the Table 3.3 we will analyze their goals, motives and needs that they fulfill while communicating with others. For example, this type of personality has a high score in AB, NU, HA and low level of AG, DO. To summarize, the Table 3.3 gives us clues that individuals who are high in Agreeable personality like to be modest, tend to be self-effacing, does not need and want to be the centre of attention. According to the needs of

this personality trait, they can also be interpreted as being shy individuals who feel tense in the presence of others. Thus, making plausible for us to assume that, in general, people high in Agreeableness behave less assertive than ones who are low in this personality trait. This shows that the level of assertiveness that Agreeable people have should be relatively less than who have high Openness personality. The level of vibration that we can assign for this personality trait is L2.

To summarize, the vibration level values that we assigned for each personality traits in our system are the following:

- L1 is assigned to the mascot with Neuroticism personality trait where the vibration has the lowest level of amplitude (i.e. 100 milliseconds per time).
- L2 is assigned to Agreeableness (i.e. 200 milliseconds per time)
- L3 is assigned to Openness to Experience (i.e. 300 milliseconds per time)
- L4 is assigned to Conscientiousness (i.e. 400 milliseconds per time)
- L5 which represents the highest vibration level and the longest duration is assigned to Extravert personality trait (i.e. 500 milliseconds per time)

3.4 Identifying the music preferences based on the personality traits

The next case-study that we consider is the Mascot - Speakers interaction. When a person holding a Mascot approaches the speakers, the music starts to play according to the personality of an approaching device.

People use their favourite music as a badge of social identity to share information about themselves with others [33] [34]. Given that they see music as a tool for revealing one's personality characteristics [35], in our study, we make the assumption that music can be a good representation of the personality of social devices.

For years researchers have investigated the correlation between genres of the music and personality traits [40] [39] [36] [41]. However, the genre labels can be biased and subjective, meaning that the user or participant might have a different understanding of these genres [37]. Thus, genre labels might not be able to fully describe someone's music preference. The preferences focused on genres are limited in several ways and the authors of the following paper tried to give a more nuanced assessment of music preferences.

Rentfrow and Gosling [38] were first who provided a categorisation of musical genre preferences that were not based on exemplary genres but on the musical characteristics that make the genre within a dimension unique. They developed

a five-factor model of music preferences in terms of the following orthogonal dimensions: **M**ellow, **U**npretentious, **S**ophisticated, **I**ntense, and **C**ontemporary abbreviated as MUSIC [37]. The fact that preferences for each dimensions are independent of the preferences from the other dimensions makes this model orthogonal. Before associating these music dimensions with the Big Five personality factors, we would like to take a close look at other music patterns.

While categorizing music preferences, other authors proposed a different number of music genres and dimensions. For example, George et al [39] studied 30 music styles and revealed eight categories. Schafer and Sedlmeier [40] used 25 genres and found six dimensions. Whereas, Rentfrow and Gosling decided to arranged 23 styles into five dimensions. The authors also validated their categories in 3 different studies using a large sample size which makes this model robust. Moreover, using the parsimonious number of musical genres is important since otherwise, it would result in too few studies falling within a single category. Thus, we expect that the MUSIC model is the most elaborate and robust multidimensional framework to date for conceptualising and measuring music preferences and personality traits.

We, now, take a close look at each dimension of MUSIC pattern. The factor analysis of the music preferences from each of three studies proposed five dimensions: **m**ellow, **u**npretentious, **s**ophisticated, **i**ntense, and **c**ontemporary:

- The first factor features the following attributes: romantic, relaxing, quiet, slow, sad, unaggressive. Examples of music genre that might describe this category are smooth jazz, R B/soul, soft rock, adult contemporary, electronica, mainstream country and so on.
- The second factor is described with uncomplicated, soft, acoustic pieces of music and is from new country, bluegrass, rock-n-roll, mainstream country, soft rock, religious, pop music genres.
- The third factor is perceived as inspiring, intelligent, complex, and dynamic including avant-grade classic, classical, traditional jazz, world beat, electronica, adult contemporary genres.
- The fourth factor features loud, aggressive, and not relaxing attributes. The music genres that describe this factor are punk, classic rock, heavy metal, and power pop.
- The fifth factor is defined as not sad, percussive, and electric pieces of music and are from rap, R B/soul, europop, electronica genres.

Given the description of each of the musical dimensions, we can now correlate them to personality traits. The scientific predictions or assumptions that we are going to make are based on empirical patterns. In a review of the following papers, we found a relatively stable relationship between the above-mentioned MUSIC factors and Big Five personality [44] [45] [46] [47] [48]. The most

consistent positive correlation that we have noticed within all these papers was between Openness to Experience and Sophisticated dimension. Meaning that participants who scored high in Openness liked Sophisticated music more than those participants who scored low. However, one should expect them also show heightened preference for Mellow musical styles. The next significant relationship that the authors mentioned was the linear correlation between Extraversion and Contemporary which includes rap, R B/soul, europop, electronica music genres. Agreeableness is correlated with linking for Unpretentious music category. Comparing the relationship between Openness and Extraversion and the music categories fits them, the correlation between Agreeableness and its musical dimension is more weak. Moreover, it was also difficult to find the strong correlations between Conscientiousness and Neuroticism personality traits and MUSIC factors which are also consistent across all above-mentioned studies. Thus, we are planning to make a weak assumption that individuals with the Conscientiousness and Neuroticism are inclined to enjoy Unpretentious and Contemporary music respectively. In addition, the results across all these papers suggest the negative correlation between Neuroticism and Conscientiousness with Intense dimension. We believe that the knowledge of the negative relationship between these variables will aid us to eliminate the possibility that participant during experiments might assign this personality traits to this music genre.

To summarise the categories that we decided to assign to each personality trait in our prototype are the following:

- Openness to Experience will be linked with Sophisticated dimension. Meaning that when the mascot with this personality trait will approach the speakers, the avant-grade classic, classical, traditional jazz, world beat, electronica, adult contemporary music genres will be played.
- Extraversion which will be linked with Contemporary music will imply that as soon as the extravert Mascot will come close to the speakers, the rap, R B/soul, europop, electronica music genres will be played.
- Agreeableness will be linked to the Unpretentious dimension which consists of new country, bluegrass, rock-n-roll, mainstream country, soft rock, religious, pop music genres.
- Conscientiousness will be linked Unpretentious
- Neuroticism will be linked Contemporary

Additionally, we assume that assigning a music category to each personality trait, as opposed to assigning a particular genre, will help participants to broaden the understanding of music preferences. Therefore, with the help of the arrangement of these genres into categories, the correlation between personality traits and Music categories will be less varied. Moreover, in order to help participants to better understand the system and the personality of a Mascot, instead of giving to

them a questionnaire with the list of songs and with the genres that they belong to, our system plays the music from each dimension category. The main reason for doing that is to measure the personality traits at the right level of specificity. Zuckerman, Kuhlman, and Camac [42] pointed out that the level at which one should evaluate personality characteristics depends on the purposes for which these characteristics are being assessed. This leads us to the decision to add a context to our experiments. We expect that participants seeing the Mascot affecting the environment (e.g triggering speakers to play the music), will be able to measure mascots' personality according to their activities and the change of environment as a result of that behavior.

3.5 Identifying the color based on personality traits

In this section we consider two case studies: Mascot-Lamp and Mascot-Tablet interactions. Both of these interaction types are represented by the color change such as lighting color and background screen color respectively. The two scenarios that we considered are the following: when a person holding a Mascot comes close to the lamp in first scenario and to the tablet in the second scenario, the lighting or the screen changes their color according to the personality of approaching mascot.

Before we design the system, it is necessary to understand and clarify the characteristics of the colors and therefore associate them with a description of the personality traits. There are many research papers from a variety of disciplines that describe the relationship between color, behaviors, and personality traits. For example, Max Lüscher [21] found out the effect of color preferences on the human behavior which, therefore, may help to determine personality trait. Herman Cerratto in his work [22] characterizes colors by dividing them on their positive and negative aspects. The following table 3.4 is adapted from various research papers [21] [22] [23] and summarizes the characteristics of the colors that we later apply to the design of our prototype.

Based on the characteristics describes in Table 3.1, we now can correlate some aspects of colors to Big Five personality dimensions. For example, according to the following papers [24] [25], the black color represents intense anxiety, fears, depression, upset, hostility and the red color may connote facets that varies from happiness, excitement, intense, stimulating to aggression, hate, hostility. Some of these facets [30] belong to the neuroticism personality trait. Thus, in order to convey the **Neurotic Personality Trait**, we decided to apply the mixture of these two colors which lead us to the dark shade of the red which we refer to as blood-red color.

Herman Cerrato in his paper explains the meaning of turquoise color as a separate color, whereas all other research papers concentrate on blue and green colors. Since turquoise is a mixture of pale blue and green colors, we decided to combine these colors and refer it as turquoise. Based on the reported aspects of these colors

Colors	**Affective Aspects**
Red	energy, strength, attention-seeking, exciting, warm, spontaneous, assertive and confident, aggression and anger, quick-tempered, ruthless, fearful, intolerant, pain
Black	depressing and pessimistic, secretive and withholding, conservative and serious, sadness and negativity
Yellow	cheerful, happy, playful, fun, optimistic, uplifting, illuminating, logical, mental clarity, aids decision-making, originality, creativity, challenging, academic and analytical, communication of new ideas
Orange	warm, sociable, optimistic, enthusiastic, cheerful, adventurous, risk-taking, vibrant, flamboyant, stimulating to the senses, self-confident, independent, extroverted and uninhibited, attention-seeking, encourages to socialize
Pink	compassion and understanding, nurturing, warmth, hope, calming, sweetness, naiveté, innocence and inexperience
White	innocence, purity, cleanliness, simplicity, self-sufficient, pristine and open, new beginnings
Turquoise	communication, clarity of thought, balance and harmony, calmness, idealism and inspiration, self-expression
Green	growth and vitality, renewal and restoration, self-reliance, reliability, being tactful, emotionally balanced and calm, practical and down to earth, generous, kind and loyal with a high moral sense, adaptable and flexible
Blue	loyalty, trust and integrity, tactful, caring and concerned, reliability, responsibility, perseverance, idealistic and orderly, authority, devotion and contemplation, peace and calm

Table 3.4: Color meaning

(see Table 3.4), we can associate turquoise with **Conscientiousness Personality Trait**. Especially, the characteristics of turquoise color such as clarity of thought, self-expression, self-sufficiency reported in Table 3.4 matches the facets that constitute conscientiousness personality.

Yellow color signifies warmth, creativity, adventures, logic, openness to new ideas, freedom (see Table 3.4). According to the Max Lüscher, this color refers to one's desire for development with which emotions and feeling are associated. Since openness personality portrays such facets as imagination, adventurousness, intellect, ideas and so on [30], we assume that the meaning of yellow color matches these facets. Therefore, we expect yellow color to convey **Openness to experiences Personality Trait**.

Despite the fact that some characteristics of red color also can connote extraver-

sion personality, there are also some negative aspects of this color such as aggression, fearfully, hostility and so on which may also represent neuroticism personality trait. Thus, we decided to emphasize the negative side of red color by mixing it with black color, in order to highlight the neurotic personality trait even more. Meanwhile, for extraversion personality trait we decided to pick orange color. According to the spectral colors, orange is the color between red and yellow on the spectrum of visible light. Orange combines the energy of red color and the cheerfulness of yellow [22]. Orange color represents optimism, cheerfulness, self-confidence, encouraging to socialize which constitute the facets of **Extraversion Personality Trait**. Thus, by assigning an orange color to our social device, we hope that participants will interpret our mascot as an extravert.

For **Agreeableness**, we assume that softer shade of pink can convey this personality trait. Psychologically pink is associated with compassion, understanding, warmth, innocence and calming aspects. White color also represents innocence, purity, openness in terms of straightforwardness (see Table3.4). The affective aspects of both of these colors constitute the facets of agreeable personality trait [30]. Since white is achromatic and has no hue, we decided to combine pink and white colors, which lead us to the softer shade of pink color. Therefore, we hope that pink color (i.e soft pink) connotes agreeableness personality trait.

To summarise the colors that we decided to assign to personality traits in our Mascot-Tablet and Mascot-Lamp interaction are the following:

- Blood-red color1 is assigned to the mascot with Neuroticism personality trait
- Turquoise color is assigned to the mascot with Conscientiousness personality trait
- Yellow color is assigned to the mascot with Openness personality trait
- Orange color is assigned to the mascot with Extraversion personality trait
- Pink color is assigned to the mascot with Agreeableness personality trait

Chapter 4
Implementation

In this study, we implemented a prototype that achieves the autonomous interaction of social things by providing them with user-predefined parameters such as the personality of a Mascot. Further, given these parameters, Mascot starts to influence the state of other devices.

The chapter is structured in the following way: In section ——, we give an overview of the prototype from the user perspective which includes two subsections: one explains steps the user takes and how it affects the state of other devices, and the other describes the limitations that users have when using the prototype. Section —— introduces the architecture of the prototype, namely, the workflow of the devices-server and server-APIs interactions. Section —— describes the software and hardware that were used to implement the prototype, more specifically, it gives an overview of each implemented application, the list of used frameworks and APIs and the hardware requirements that the prototype needs to meet.

4.1 Overview of the prototype

4.1.1 User-side description of a system

When the user runs the application for the first time, it displays the form that the user has to fill in order to configure his Mascot. For that, the user needs to follow the steps: he can choose the beacon ID that will help this application to measure the distance between devices; he can give his Mascot a custom name; he is required to choose one out of five personalities displayed on the screen.

Column name	Column type	Description
device id	d	unique auto-generated value
beacon uuid	d	the ID of beacon that user assigned to its device
device type	d	which can be Mascot, Lamp, or Tablet)
device name	d	a custom given name for only Mascots
device personality	d	the personality that the user decided to attach for Mascot. This column is a foreign key of the “personality id” column in “Personality” table

Table 4.1: Devices Table

4.1.2 User restrictions

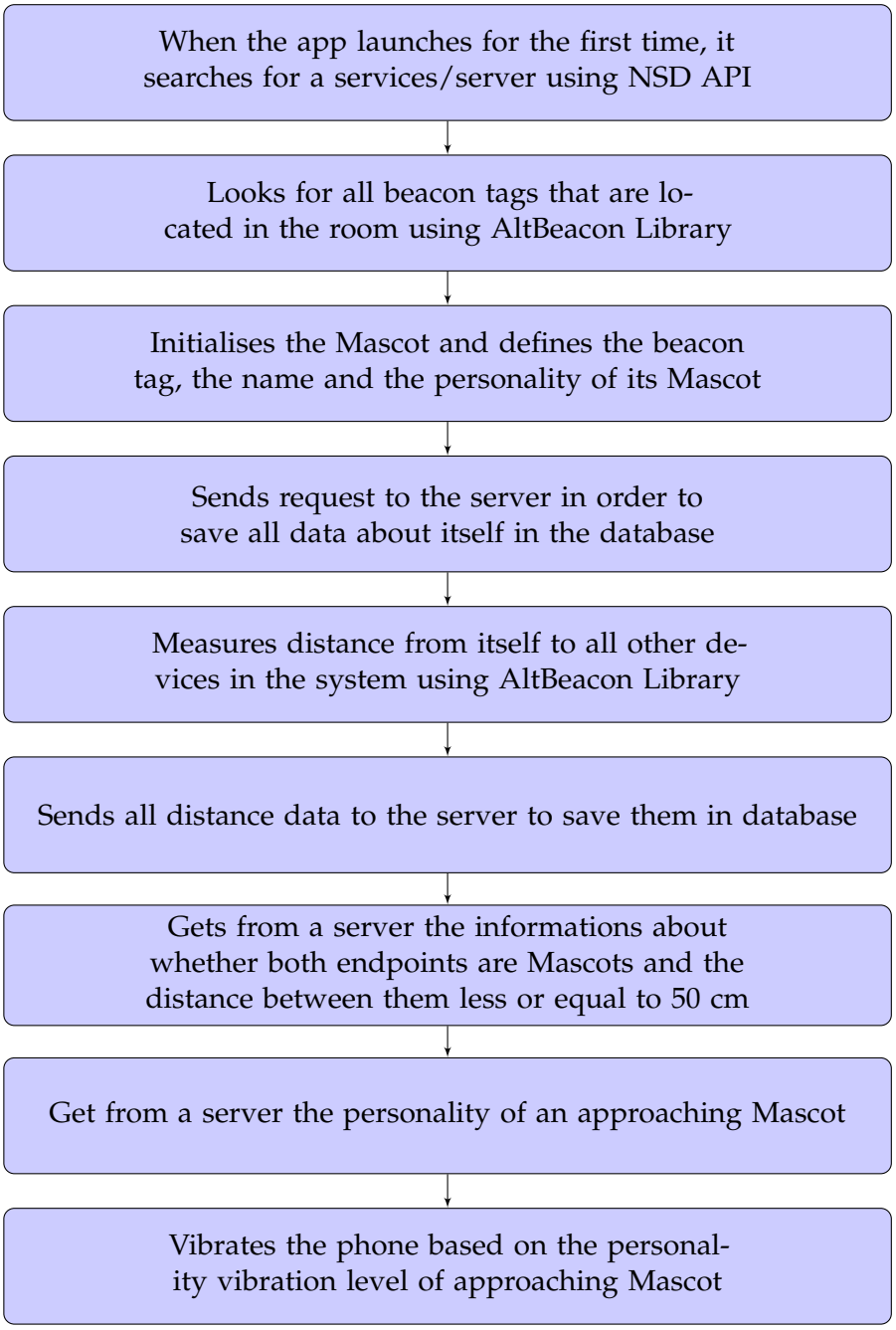

Figure 4.1: The interaction between Android Mascot application with a server with the libraries and APIs that it is using

Chapter 5
User Study

5.1 Participants

In total, 25 volunteers participated in this study, where 13 of them were male and 12 female students. The sample was drawn from university populations having an age range from 19 to 31 years with a mean age of M = 26.12 (SD = 3.1). Participants were selected from various discipline areas (see Figure 5.1). We consider academic disciplines as three categories (Social, Natural and Formal Science) where almost 30% of participants are from social sciences and 70% from formal sciences. Moreover, the participants had a different education levels: the majority of them were studying Masters's degrees, and only 32 percent were Bachelors's and Ph.D. level students (see Figure 5.2).

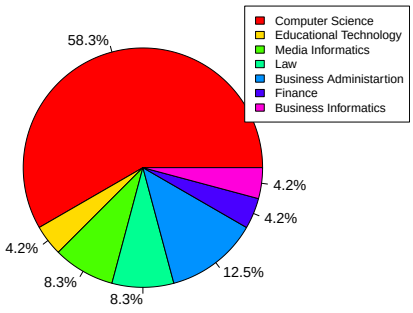

Figure 5.1: Participants' majors obtained from Demographics questionnaires

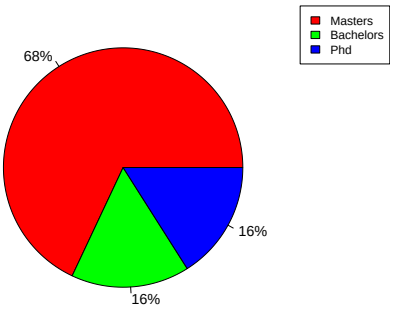

Figure 5.2: Participants' education level obtained from Demographics questionnaires

In the demographics form, participants also informed how frequently they used such devices as phones, smart lamps, tablets, and speakers (see Figure 5.3 and Figure 5.4).

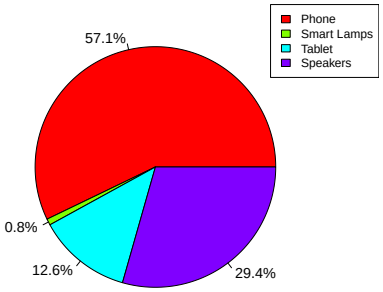

Figure 5.3: Participants' use of devices obtained from Demographics questionnaires

Overall, the experience level with above mentioned devices is listed in descending order: phone, speakers, tablet, and smart lamps. Figure 5.4 shows how many hours participants spend on these devices per day. The demographics questionnaire showed that the most popular device among our participants were phone with approximately 1/3 of participants who spent more than 6 hours on them. In all time ranges, the speakers were the second most used devices in comparison to the number of participants using of Tablet and Smart Lamps.

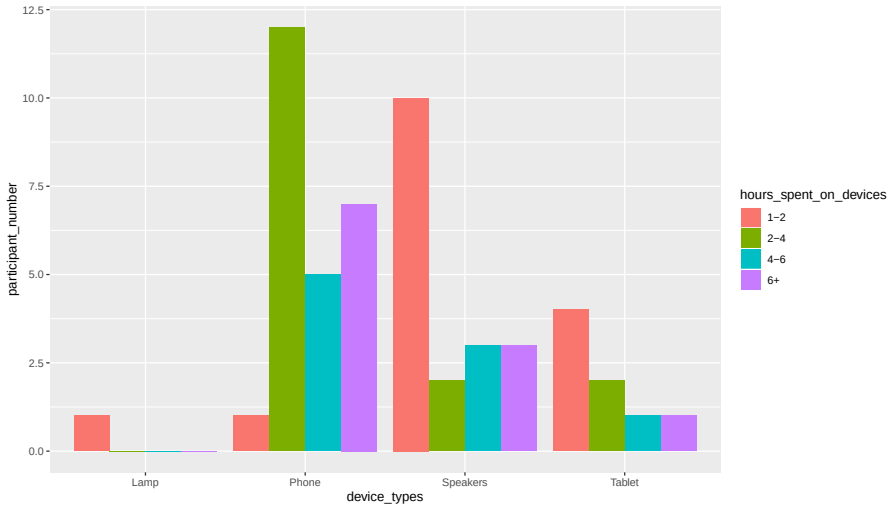

Figure 5.4: Participants' device use in hours obtained from Demographics questionnaires

In addition, Table 5.1 describes the participants' preference of the music genres. The more fluent the participant would be with the music, the more rapid becomes the assessment of genre-specific features [Gjerdigen, R.O., Perrot, D., 2008. Scanning the dial: the rapid recognition of music genres]. Moreover, if the majority of participants prefer to listen or like certain genre of music, it may result in biased opinions. The mascot that triggers genre that they prefer may give participants more positive impression about their personality. Thus, the main reason of gathering data regarding participants' the music preferences was to see whether the liking factor affects the study or not.

According to the One-Sample t-test with $p>0.05$, there was no significant effect of the participants' music preference on the music genres that we chose for our study. Thus, we have insufficient evidence to conclude that one music genre is more preferable than the other. Meaning that, among the genres of music that we have chosen for our experiments, there were no distinguishably favorite genres and the participants had different music tastes (see Table 5.1).

5.2 Procedure and Tasks

When the experiment started, first, the participants were given an introductory paper describing the following aspects:

- The implemented prototype introducing the devices used in our study
- The key idea of a study
- The purpose of the experiment

	t-value	df	mean	p-value	95 percent confidence interval	
					lower	upper
Country	1	24	0.04	0.3273	- 0.04255594	0.12255594
Pop	3.6742	24	0.36	0.001195	0.1577801	0.5622199
Hip-hop	1.8091	24	0.12	0.08299	- 0.01690354	0.25690354
Rap	1	24	0.04	0.3273	- 0.04255594	0.12255594
Jazz	2.4495	24	0.2	0.02198	0.03148339	0.36851661
Classic	3.0551	24	0.28	0.005443	0.09084057	0.46915943
Rock&Roll	1	24	0.04	0.3273	- 0.04255594	0.12255594

Table 5.1: T-test for participants' familiarity with music genres used in our study

- The goal of the participants during experiment
- The number of phases and the overall duration of the experiment

Regardless of the introductory paper, the participant was allowed to ask open questions. After agreeing and signing the consent form (see appendix A), the main part of the experiment took place.

In general, we have 4 phases for each of interaction types: Mascot-Mascot, Mascot-Lamps, Mascot-Tablet, Mascot-Speakers. The order of all phases were counterbalanced by using Latin Square. Each phase consists of 5 videos with a duration of 20 seconds, with the exception of Mascot-Speakers interactions where we have 9 videos with duration 40 seconds long. Moreover, for each participant, there were a different order of displaying the videos which are also randomized inside each phase based on the Latin Square. All phases and all videos within those phases were counterbalanced across all participants. Moreover, each participant was tested alone to ensure that the opinions of other participants do not affect their own.

Before each phase, we describe the participant what kind of interaction they should expect from video and remind them their goals during that experiment. The goal is that, after watching short videos, participants will need to evaluate the personality of a Mascot according to the interaction that they have seen in the videos. When accomplishing watching the video, the participants were given a questionnaire (see appendix B) with 30 Likert scale questions and were asked to rank the personality trait on a scale of 'Strongly Inaccurate' to 'Strongly Accurate'. When this is done the experiment continues to the next video. After accomplishing watching all the videos in one phase, we move forward to the next phase.

In addition, the only phase where the participants are given an extra phone is the Mascot-Mascot interaction phase, where two Mascots start to vibrate with a different duration based on the personality of approaching Mascot. Since it is difficult to see or hear the vibration from these videos, the phone runs an application to simulate the different levels of a vibration that we showed

participants in the video. After watching the video, the participants were again given a questionnaire in order to assess the personality of a Mascot based on the video that they have seen and the vibration that they have felt.

After finishing the experiment, the participants were given a demographic questionnaire with general information about themselves and their preferences. The reason for giving this questionnaire at the end of the experiment was in order to not to affect the opinion of the participants. Giving personal questions up-front, respondents can feel concerned that their personal information is going to be linked to the experiment and therefore, knowing which characteristics will be taken into the account by the researchers, they may try to fit their responses to the demographic questions that they filled.

The experiment, overall, lasts from one hour to hour and a half, depending on the speed of participant to fill the questionnaires.

5.3 Design of experiments

It should be noted that as a design of the experiment we did not include a real-life interaction with devices, but instead, we showed participants videos containing the interaction between these devices. The main reason for that was the distraction of participants on various factors.

From an implementation perspective, the application using BLE (low-energy Bluetooth) technology measures the distance between objects is highly accurate and precision, it can measure the distance from the phone to the beacon tag with a margin error of 1 cm which is a very good result. However, the position histories are saved every few seconds [Location Aware Tracking with Beacons Gary Mansell, Kevin Curran] and since the application measures the distance every millisecond, the current distance can only be saved after a few seconds.

Moreover, the step of one person covers several centimeters at once, and the application calculates each of these centimeters at a time. Since asking participants to move slower or with small steps may distract them by focusing on their own behavior rather than on the assessment of the mascot's personality, we decided to use videos in our experiments. Moreover, having tested many other commercial applications that measures the distance between objects, we noticed the same limitation.

Another design decision was instead of showing one video with all interaction types, we split it into 5 short videos for Mascot-Lamp, Mascot-Table, Mascot-Mascot each and into 9 short videos for Mascot-Speakers cases. Even thought our prototype supports multi dimensional device interactions (i.e multiple mascots can interact with lamp, tablet, speakers and other mascots at the same time), we decided to split interaction types into four phases. The main goal was to help participant to focus on one interaction and make it easier for them to evaluate the personality of Mascot.

5.4 Apparatus and Materials

The experiment's setup consisted of the following devices:

- MacBook Pro running Mac OS Catalina (Version 10.15.2)
- 55-inch monitor with built-in speakers for music play
- Tablet to fill questionnaire in the google forms
- Nexus One for simulating the vibration during mascot-mascot interaction

As a survey tool for collecting data from participants, we used Google Form which consisted of the thirty Likert scale type questions scaling from 'Strongly Inaccurate' to 'Strongly Accurate' scales. Subsequently, in order to use obtained data in our statistical analysis, the questions from our survey tool were transformed in a more permanent form (i.e. four CSV files were generated, one for each phase).

5.5 Design of a study

The study consists of four case-studies: Mascot-Lamp, Mascot-Table, Mascot-Mascot and Mascot-Speakers interactions which, therefore, designed as four phases during experiments. The experiment was a within-subjects design where each participant tests all conditions within each phase. For example, for Mascot-Lamp phase each participant watch all five videos and evaluates the personality of a Mascot for each lighting color separately. The within-subjects in comparison to the between-subjects design can help us to reduce errors associated with individual differences. Individual participants have different backgrounds, contexts, levels of concentration and so on. The same participant interacting with all 4 phases, will affect the result in the same way which can the lower the probability that individual differences will skew the results. Moreover, the within-subject design requires fewer participants, which may lead us to the streamlined process of an experiment.

In our study the independent variables (IVs) are factors that are triggered due to the behavior of a mascot. For each case-study, we have different number of IVs which are the followings:

- For Mascot-Lamp case-study, there are five variable: turquoise, blood-red, yellow, orange and pink lighting colors
- For Mascot-Mascot case-study, there are five vibration levels varying from 100 to 500 milliseconds per time
- For Mascot-Speakers case-study, there are nine songs categorized to three variables: Sophisticated, Contemporary and Unpretentious categories

- For Mascot-Tablet case-study, there are five variable: yellow, orange, turquoise, blood-red and pink background screen colors

In fact, we do not compare case-studies with each other, namely, the interaction types has a more effect on the measurements of the personality trait of mascots. We consider one case as a separate study, where we only compare IVs.

Our dependent variable is the measurements of the personality traits based on the OCEAN model. The main research question that we asked: "Is the interpretation or the measure of the Mascot's personality effected by these factors?"

5.6 Measures

As a measurements of the experiments we used questionnaires that were given after each video watch. Overall, there were 24 questionnaires with five questionnaires for each phase, except mascot-speakers interaction phase, where we had nine questionnaires. Each questionnaire consists of 30 questions portraying six facets of each personality based on NEO-PIP survey. The questionnaire items were answered using a Likert-scale (Very inaccurate, Inaccurate, neutral, Accurate, Very accurate). These questionnaires were given via Google Forms which are further transformed into cvs formats.

Chapter 6
Results

This chapter presents the statistical analysis of the main study where the results for each use case, namely, Mascot-Lamp, Mascot-Mascot, Mascot-Tablet, and Mascot-Speaker's interactions are reported in each section separately. In each section, there are two subsections where we report statistical tests for two studies: within personality trait and within condition such as lighting color, music category, vibration level or screen color. In our first study, we focus on each personality trait individually and the variation of the impacts of each state of conditions within that personality trait. In the second study, we focus on each state of condition separately and how personality trait varies the difference between five personality traits within that condition state we will describe in the following section in a more detail.

6.1 Analysis of Mascot-Lamp interaction

This section describes each personality trait that Mascot was assigned in terms of the effect of the lighting color in evaluating them. The factors that we compare for Mascot-Lamp interaction are orange, turquoise, yellow, blood-red and pink lighting colors. Since the data that we gathered are ordinal and we do not assume that the outcome will be normally distributed, we focused on non-parametric tests. Moreover, since each case-study consists of more than two compared groups and compare data against within-subject factor, we decided to use Friedman test followed by the Wilcoxon Signed-rank test. In addition, we also report Effect sizes in order to show the strength of the difference between lighting colors. In both studies, we analyze the effect of the lighting color on how the mascot's personality is measured. The first study analyzes this effect within each personality trait separately, particularly, we consider each personality trait and the various effects

of each color within this personality. The second study considers this effect within each color condition separately, namely how each personality trait is assessed differently within one color condition. For each study Wilcoxon test compare 10 groups with each other which makes 20 compared groups in total. Since, in our study, we have a large number of statistical tests, some of the results may have $p<0.05$ purely by chance. Thus, in order to control family wise error rate, we use Bonferroni correction which will divide all p-values in 20 which is a number of compared groups for both studies. Finally, at the end of each subsections, we show a graphical display of the results from each study. Subsection 6.1.1 describes the results for within personality study and subsection 6.1.2 for within lighting color study.

6.1.1 Analysis of within personality trait study

In the first study, we test the effect of all predefined lighting colors on the measurements of each personality trait. Friedman tests reported in Table 6.1 reveal a significant impact of lighting colors on the perception of the personality trait of mascots with $p < 0.01$. During the experiments, the change in color of the Lamp significantly influenced the participant's rating of the Mascot's personality traits. Thus, knowing that there is a statistically different effect of all predefined lighting colors with the help of the Wilcoxon test, we report where exactly this difference is concentrated.

Table 6.1: The results from Friedman test for all Five Personality traits in case of Mascot-Lamp interaction

Personality trait	χ^2	**df**	**p**
Extraversion	39.959	4	p<0.01
Agreeableness	56.448	4	p<0.01
Conscientiousness	25.847	4	p<0.01
Neuroticism	52.377	4	p<0.01
Openness	18.156	4	p<0.01

Extraversion. The result of post hoc Wilcoxon signed-rank tests reported in Table 6.3 indicates six groups of colors affecting the measurements of Mascot's Extraversion trait significantly with $p < 0.01$. In addition to the statistical significance (p-value), this table also reports the substantive significance (effect size) which comprises only groups with 'large' effect sizes out of 10 compared groups. According to the results, yellow showed significant difference in rating extraversion comparing to turquoise, blood-red and pink lighting colors (See Table 6.3). Since participants were rating six facets of each personality trait, they rated mascot that triggered yellow lighting color as friendly, gregarious, assertive, energetic, excitement seeking and cheerful in comparison to blood-red, turquoise and pink colors. Since all above mentioned facets represent extraversion personality trait, participants rated the mascot interacting with yellow lighting to be

	Extraversion					Agreeableness					Conscientiousness				
	Y	O	T	B	P	Y	O	T	B	P	Y	O	T	B	P
Min	2.3	2.3	1.8	1.0	1.7	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5
Med	3.7	3.0	2.7	1.7	2.8	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5
Max	4.8	4.8	4.2	4.5	3.7	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5
	Neuroticism					**Openness**									
	Y	O	T	B	P	Y	O	T	B	P					
Min	D1	D2	D3	D4	D5	E1	E2	E3	E4	E5					
Med	D1	D2	D3	D4	D5	E1	E2	E3	E4	E5					
Max	D1	D2	D3	D4	D5	E1	E2	E3	E4	E5					

Table 6.2: Some Caption. Y is yellow, O is orange ...

extravert. In contrast, the mascot interaction with blood-red lighting was rated very low on being extravert. This is also visually displayed in Figure A.1, the blood-red color having the lowest median (M = 1.7, Q3 = 2.5) and yellow having the highest value (M = 3.7, Q3 = 4.2).

Agreeableness. According to the Wilcoxon test (see Table 6.3), blood-red and orange lighting which were rated very low on being agreeable (padj<0.01). Figure A.1 shows that in comparison to all other colors, the pink boxplot has the greatest and the blood-red boxplot has the smallest median values with M = 4.0, M = 2.0 respectively (see Appendix A.1). The median values, in descending order, for pink, turquoise and yellow lights are approximately similar (M = 4.0, M = 3.5 and M = 3.7).

Conscientiousness. Considering each group of colors individually, the Wilcoxon-Signed Rank test showed that there is a significant with $p < 0.01$ differences between the following color groups for being rated as conscientiousness personality trait (see Table 6.3). After Bonferroni correction, the mascot interracting with blood-red and orange lighting were assessed as being very low on conscientious personality trait. Table form Appendix A.1. indicates that the lowest blood-red has a lowest median (M = 2.2) and turquoise, pink and yellow have relatively similar medians (M = 3.7, M = 3.5, M = 3.5 respectively in descending order). This level shows that the mascot was assessed high on having orderly, dutiful, disciplined and other facets that constitute this personality trait.

Neuroticism. Table 6.3 indicates the positive relationships between blood-red and neuroticism personality of a mascot. Blood-red color has a significantly very different effect on neuroticism in comparison to all other colors with the $p < 0.001$ for Bonferroni correction. The highest and lowest medians are observed in blood-red and pink box-plots respectively with 4.3 and 1.7 respectively as reported in Appendix A.1. Thus, there is an explicit distinction between blood-red and pink colors while perceiving the neurotic personality of a Mascot.

Openness. After applying the Bonferroni correction on Wilcoxon test the results showed the very significant with $p < 0.01$ difference of yellow and blood-red colors. By increasing the level of significance up until 0.05, the difference between orange and red colors, yellow and pink is also revealed (see Table 6.3). Figure A.1 shows the similarity of the median values for all colors concentrating around neutral attitude for mascot being measured as openness which is represented by median close to 3 (see Appendix A.1).

Table 6.3: The statistically significant comparisons of each group individually using the Wilcoxon signed-rank test and Bonferroni correction while measuring Five Personality Traits for Mascot-Lamp interaction. In addition reporting effect sizes which are large

	Group 1	**Group 2**	**Wilcoxon tests**		**r**	**padj**
			z	**p**		
E	Yellow	Turquoise	3.5315	p<0.01	0.706	p<0.01
	Yellow	Blood-Red	4.185	p<0.01	0.837	p<0.01
	Yellow	Pink	3.8951	p<0.01	0.781	p<0.01
	Orange	Blood-Red	4.1461	p<0.01	0.829	p<0.01
	Turquoise	Blood-Red	3.3966	p<0.01	0.682	p<0.01
	Blood-Red	Pink	-3.5166	p<0.01	0.711	p<0.01
A	Yellow	Orange	3.6211	p<0.01	0.724	p<0.01
	Yellow	Blood-Red	4.0237	p<0.01	0.805	p<0.01
	Orange	Turquoise	-4.0613	p<0.01	0.832	p<0.01
	Orange	Pink	-4.294	p<0.01	0.859	p<0.01
	Turquoise	Blood-Red	4.2807	p<0.01	0.856	p<0.01
	Blood-Red	Pink	-4.1868	p<0.01	0.842	p<0.01
C	Yellow	Orange	3.3333	p<0.01	0.660	p<0.01
	Yellow	Blood-Red	3.1945	p<0.01	0.657	p<0.05
	Orange	Turquoise	-3.8186	p<0.01	0.767	p<0.01
	Orange	Pink	-3.7784	p<0.01	0.755	p<0.01
	Turquoise	Blood-Red	3.2405	p<0.01	0.644	p<0.05
	Blood-Red	Pink	-3.1456	p<0.01	0.619	p<0.05
N	Yellow	Blood-Red	-4.3193	p<0.01	0.864	p<0.01
	Orange	Blood-Red	-4.2602	p<0.01	0.862	p<0.01
	Turquoise	Blood-Red	-4.287	p<0.01	0.872	p<0.01
	Blood-Red	Pink	4.3738	p<0.01	0.875	p<0.01
O	Yellow	Blood-Red	3.4619	p<0.01	0.692	p<0.01
	Yellow	Pink	2.8482	p<0.01	0.574	p<0.05
	Orange	Blood-Red	3.0702	p<0.01	0.614	p<0.05

6.1.2 Analysis of within lighting color study

In both studies, we analyze the effect of the lighting color on how the mascot's personality is measured. The first study analyzes this effect within each personality trait separately, particularly, we consider each personality trait and the various effects of each color within this personality. The second study considers this effect within each color condition separately, namely how each personality trait is assessed differently within one color condition. For the second study, Friedman test reveals a significant difference of all personalities within each color condition with $p < 0.01$ (see Table 6.4). Pink and blood-red conditions have the most significant effects on the measurements of the personality traits (Z=60,082, $p< 0.01$ and Z=45.475, $p< 0.01$ respectively).

Table 6.4: The results from Friedman test for all Five Personality traits in case of Mascot-Lamp interaction

Personality trait	χ^2	**df**	**p**
Yellow	23.566	4	p<0.01
Orange	38.178	4	p<0.01
Turquoise	37.123	4	p<0.01
Blood-red	45.475	4	p<0.01
Pink	60.082	4	p<0.01

Yellow. According to WIlcoxon test using Bonferroni correction, there is a significant negative correlation between yellow lighting color and neurotic personality trait (padj<0.01). The effect sizes of each color condition group show that when participants were assessing the personality traits based on a yellow color, 79% of scores given for extraversion, agreeableness, conscientiousness, and openness were higher than all scores given for neurotic personality (see Table 6.5). In addition, the similarity of the median values for all personality traits except neuroticism (M = 3.7, M = 3.7, M = 3.5, M = 3.5) reveals a small effect of yellow color on these four personality traits (see Appendix A.2). Thus, for yellow color only negative correlation is statistically substantial.

Orange. Statistical tests report a positive relationship between extraversion and openness personality traits, and orange lighting color with $p < 0.05$ (see Table 6.5). Thus, when participants were measuring the personality traits based on orange lighting color, they gave high scores on mascot being perceived as extravert and openness. The median values and the Bonferroni correction for orange color did not show any significant differences between extraversion (M = 3.0, Q3 = 4.3) and openness (M = 3.0, Q3 = 3.7) (see Appendix A.2 and Table 6.5).

Turquoise. Wilcoxon test using Bonferroni adjustment shows that when the turquoise lighting is displayed, the agreeableness and conscientiousness personality traits are substantially distinguishable from other personality traits. Thus there is a positive correlation between these personality traits and turquoise

color with $p < 0.05$ (see Table 6.5). However, there is conscientiousness and agreeableness are not correlated to each other, meaning that they both can be measured high when turquoise color is displayed. Because of the p-values, these two personality traits are not comparable. In Spite of that fact, the median value of conscientiousness (M = 3.7) is slightly higher than agreeableness (M = 3.5) (see Appendix A.2).

Blood-red. There is a significant relationship between blood-red lighting and neuroticism personality trait with padj<0.01 (see Table 6.5). Moreover, according to Figure A.2, there is an excellent separation of neuroticism boxplot from all other personality traits. In addition, some observations can be classified as potential outlier for extraversion personality, which may effect the overall dispersion of the boxplot for a larger samples. Thus, an extraversion might need to merit special attention for a larger survey.

Pink. According to the Table 6.5, agreeableness and conscientiousness shows a significant effect on pink lighting color with the $p < 0.01$ except for conscientiousness and openness group. Moreover, there is a negative relationship between pink color and neuroticism trait. Based on the medians reported in Appendix A.2, agreeableness has the highest (M = 4.0) in contrast to the neuroticism which has a lowest value (M = 1.7).

Table 6.5: Mascot-Lamp interaction

	Group 1	**Group 2**	**Wilcoxon tests**		**r**	**padj**
			z	**p**		
Yellow	E	N	3.9296	p<0.01	0.789	p<0.01
	A	N	3.561	p<0.01	0.722	p<0.01
	C	N	3.4599	p<0.01	0.692	p<0.01
	N	O	-3.6295	p<0.01	0.721	p<0.01
Orange	E	A	4.0294	p<0.01	0.818	p<0.01
	E	C	0.679	p<0.01	0.679	p<0.01
	E	N	0.661	p<0.01	0.661	p<0.01
	A	O	-4.1086	p<0.01	0.840	p<0.01
	C	O	-2.9182	p<0.01	0.587	p<0.05
	N	O	-3.1376	p<0.01	0.636	p<0.05
Turquoise	E	A	-3.8621	p<0.01	0.776	p<0.01
	E	C	-3.339	p<0.01	0.668	p<0.01
	E	N	3.0291	p<0.01	0.617	p<0.05
	A	N	3.7697	p<0.01	0.754	p<0.01
	A	O	2.8456	p<0.01	0.552	p<0.05
	C	N	4.1879	p<0.01	0.843	p<0.01
	C	O	3.4339	p<0.01	0.687	p<0.01
	N	O	-3.4777	p<0.01	0.690	p<0.01
	E	N	-4.3464	p<0.01	0.869	p<0.01

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Blood Red

Table 6.5 – *Continued from previous page*

	Group 1	Group 2	Wilcoxon tests		r	padj
			z	p		
	E	O	-2.9088	p<0.01	0.596	p<0.05
	A	C	-2.9421	p<0.01	0.597	p<0.05
	A	N	-4.2335	p<0.01	0.857	p<0.01
	A	O	-3.2177	p<0.01	0.631	p<0.05
	C	N	-3.8625	p<0.01	0.773	p<0.01
	N	O	3.9709	p<0.01	0.794	p<0.01
Pink	E	A	-3.9842	p<0.01	0.797	p<0.01
	E	C	-3.4545	p<0.01	0.714	p<0.01
	E	N	3.6722	p<0.01	0.735	p<0.01
	A	N	4.2394	p<0.01	0.848	p<0.01
	A	O	3.9193	p<0.01	0.792	p<0.01
	C	N	4.2392	p<0.01	0.848	p<0.01
	C	O	3.1883	p<0.01	0.638	p<0.05
	N	O	-3.9322	p<0.01	0.794	p<0.01

6.2 Analysis of Mascot-Speakers interaction

This section includes the Mascot-Speakers use case, where we analyze which effect the music genre has on the assessment of the Mascot's personality traits. As we discussed in section 2 and section 3, our choice of the music genre is based on the MUSIC pattern. For statistical analysis, we examine the effect of each category by distributing genres into three categories as the following:

- Sophisticated: jazz, classical and contemporary adult
- Contemporary: rap, soul, and rap
- Unpretentious: pop, rock&roll / country and bluegrass

Subsection 6.2.1 and subsection 6.2.2 describe the statistical results for each study respectively. For the current case-study, we have also conducted the same tests that we covered in section 6.1.

6.2.1 Analysis of within personality trait study

In this subsection, we report a statistical analysis of how the impact of the music category varies within each personality trait. Friedman's test reported in Table 6.6 shows that there is a significant difference in the measurements of the mascot's personality depending on which song is played. Except for conscientiousness, all categories reveal their effect (with $p < 0.01$) on the assessment of each personality

trait. However, with $p < 0.05$, there is a less than 5% chance that the music category has no impact on the perception of the mascot's conscientious traits.

Table 6.6: The results from Friedman test for all Five Personality traits in case of Mascot-Speakers interaction

Personality trait	χ^2	**df**	**p**
Extraversion	21.44	2	p<0.01
Agreeableness	29.01	2	p<0.01
Conscientiousness	6.4536	2	p<0.05
Neuroticism	15.122	2	p<0.01
Openness	25.838	2	p<0.01

Extraversion. Wilcoxon test using Bonferroni correction showed an extremely significant difference between Sophisticated and Unpretentious categories with $p < 0.001$, r=0.864 (see Table 6.7). According to Appendix A.3, the Unpretentious category has a median higher than for Sophisticated with a value of 3.3 and 3.0 respectively. Based on Figure A.3 , the samples of Contemporary boxplot are right-skew and more spread out meaning that there is a high frequency of higher votes for mascot being an extrovert. Meanwhile, samples for Sophisticated and Unpretentious categories are more condensed in negative and positive direction respectively, which shows us that while listening to songs from these categories participants were more consistent on attributing the extraversion traits to the mascot.

Agreeableness. There is a significantly large effect of Sophisticated and Contemporary, and Contemporary and Unpretentious groups on measuring the mascot's agreeableness facets with p<00.1. According to Panel A in Figure A.3, it discriminates most of the Contemporary samples from samples of the other two categories having 75% of votes in inaccurate direction.

Conscientiousness. For Mascot's Conscientiousness trait, the results revealed the effect of the same groups as we have observed for an Agreeableness personality trait. Scores for Mascot having Conscientiousness personality traits increased sharply during listening Sophisticated (median = 3.2) and Unpretentious (median = 3.2) music in comparison to scores for Contemporary music (median = 2.8) (for more details see Appendix A.3). The Wilcoxon test using Bonferroni correction confirms the statistically significant difference between Sophisticated and Contemporary (Z = 3.0545, p<0.01, p<0.01), and Unpretentious and Contemporary (Z = -2.7863, p<0.01, padj<0.05) categories.

Neuroticism. Panel N of Figure A.3 shows that the scores given for Contemporary music while assessing Neuroticism personality traits are highest with the average scores (median = 3.1) higher than 73% of scores given for the other two categories. According to the Wilcoxon test with Bonferroni adjustment, there are two significant differences between Sophisticated and Contemporary, and Contemporary and Unpretentious music with Z = -3.9739, p<0.01, padj<0.01 and

Z = 3.7269, p<0.01, padj<0.01 respectively (see Table 6.7). The correlation between Sophisticated and Unpretentious is not consistent enough in order to draw a conclusion. Thus, the analysis shows a substantial positive relationship between Contemporary music and the Neuroticism personality trait of a Mascot.

Openness. Panel O of Figure A.3 shows good separation of Sophisticated with median = 3.8 and max = 4.9 from other music categories (see Appendix A.3 and Figure A.3). The samples for the mascot with a current personality trait are well behaved. There is a large effect size between Sophisticated and Contemporary (r=0.859), and Sophisticated and Unpretentious (r=0.630) which is also confirmed with the Wilcoxon test using Bonferroni correction with p<0.01 (see Table 6.7). However, there is also a correlation between Contemporary and Unpretentious (Z=-3.9709, p<0.01, padj<0.01).

Table 6.7: The statistically significant comparisons of each group individually using the Wilcoxon signed-rank test and Bonferroni correction while measuring Five Personality Traits for Mascot-Speakers interaction. In addition reporting effect sizes which are large

	Group 1	**Group 2**	**Wilcoxon tests**		**r**	**padj**
			z	**p**		
E	Sophisticated	Contemporary	-4.2111	p<0.01	0.842	p<0.01
	Sophisticated	Unpretentious	-2.7188	p<0.01	0.544	p<0.05
	Contemporary	Unpretentious	3.8751	p<0.01	0.775	p<0.01
A	Sophisticated	Contemporary	4.2864	p<0.01	0.872	p<0.01
	Contemporary	Unpretentious	-4.2121	p<0.01	0.842	p<0.01
C	Sophisticated	Contemporary	3.0545	p<0.01	0.611	p<0.01
	Contemporary	Unpretentious	-2.7863	p<0.01	0.546	p<0.05
N	Sophisticated	Contemporary	-3.9739	p<0.01	0.797	p<0.01
	Contemporary	Unpretentious	3.7269	p<0.01	0.745	p<0.01
O	Sophisticated	Contemporary	4.2932	p<0.01	0.859	p<0.01
	Sophisticated	Unpretentious	2.9869	p<0.01	0.595	p<0.01
	Contemporary	Unpretentious	-3.9709	p<0.01	0.794	p<0.01

6.2.2 Analysis of within music category study

Our second study for mascot-speakers interaction shows how three music categories convey each personality trait differently. In this study, we analyze the effect of each music category separately, particularly how each personality trait is assessed differently within one music condition. Based on Friedman's tests there is a very significant difference between five personality traits within each music category with p< 0.01. Sophisticated condition has the most distinctive measurements of mascot's personality trait (Z = 66.573, df = 4, p< 0.01).

Table 6.8: The results from Friedman test for all Five Personality traits in case of Mascot-Speakers interaction

Personality trait	χ^2	**df**	**p**
Sophisticated	66.573	4	p<0.01
Contemporary	44.395	4	p<0.01
Unpretentious	57.433	4	p<0.01

Sophisticated. On average, Sophisticated music conveyed Openness personality trait with padj < 0.01 and large effect sizes reported on Table 6.9. Moreover, openness, agreeableness, and neuroticism personality traits shows significant difference between each other and all other personality traits in the group. For neuroticism personality trait, there is a negative correlation to sophisticated music with p < 0.01.

Contemporary. According to the Figure A.4, there is a clear separation of extraversion samples from all other personality traits. Table 6.9shows a sufficiently great difference between extraversion and all other personality traits for Contemporary music with adjusted p< 0.01.

Unpretentious. There is a negative relationship between neuroticism personality trait and Unpretentious category with p < 0.01 (see Table 6.9). The median values of all other personality traits slightly differ from each other, resulting in insignificant difference between them (see Appendix A.4).

Table 6.9: Mascot-Speakers

	Group 1	**Group 2**	**Wilcoxon tests**		**r**	**padj**
			z	**p**		
Sophisticated	E	A	-3.9431	p<0.01	0.789	p<0.01
	E	N	3.6469	p<0.01	0.729	p<0.01
	E	O	-4.3459	p<0.01	0.869	p<0.01
	A	C	2.8937	p<0.01	0.579	p<0.05
	A	N	4.3732	p<0.01	0.875	p<0.01
	A	O	-3.3377	p<0.01	0.668	p<0.01
	C	N	4.1446	p<0.01	0.829	p<0.01
	C	O	-3.8436	p<0.01	0.762	p<0.01
	N	O	-4.373	p<0.01	0.875	p<0.01
Contemporary	E	A	4.2574	p<0.01	0.861	p<0.01
	E	C	4.2659	p<0.01	0.853	p<0.01
	E	N	4.1175	p<0.01	0.824	p<0.01
	E	O	4.2866	p<0.01	0.872	p<0.01
Unpretentious	E	A	-3.1034	p<0.01	0.630	p<0.05
	E	N	4.3736	p<0.01	0.875	p<0.01
	A	C	3.4615	p<0.01	0.742	p<0.01

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Table 6.9 – *Continued from previous page*

	Group 1	Group 2	Wilcoxon tests		r	padj
			z	p		
	A	N	4.3463	p<0.01	0.869	p<0.01
	C	N	3.7949	p<0.01	0.759	p<0.01
	C	O	-2.9387	p<0.01	0.569	p<0.05
	N	O	-4.3734	p<0.01	0.875	p<0.01

6.3 Analysis of Mascot-Mascot interaction

This section covers the analysis of the effect of each level of vibration on the perception of the personality trait of approaching mascot which triggers this vibration. In subsection 6.3.1, we examine the results of statistical tests for within each personality trait and in subsection 6.3.2 the analysis of within each vibration level. In addition, from now on each vibration level is abbreviated accordingly. For example, the vibration with 500-millisecond duration is abbreviated as 'Level-5', and with 100-millisecond long as 'Level-1' and so on.

6.3.1 Analysis of within personality trait study

The first study covers the analysis of each personality trait and the variation of all vibration levels within this personality group. In this study, we analyze each personality trait separately and see which vibration level conveys it most. According to Friedman's tests, all vibration levels affect the measurements of the mascots' personality traits with a significance $p < 0.001$ (see Table 6.10) except openness personality which has 0.05 level of significance. As a result, the different levels of vibration can be associated with the personality trait that mascot presents. The highest difference of measurements between vibration levels was observed for Conscientiousness and Extraversion personality traits with χ^2 = 43,236, df = 4, p< 0.01 and χ^2 = 30,82, df = 4, p< 0.01 respectively. Further, the groups where this difference is concentrated will be reported for each personality trait.

Table 6.10: The results from Friedman test for all Five Personality traits in case of Mascot-Mascot interaction

Personality trait	χ^2	df	p
Extraversion	30.82	4	p<0.01
Agreeableness	19.767	4	p<0.01
Conscientiousness	43.236	4	p<0.01
Neuroticism	28.212	4	p<0.01
Openness	11.169	4	p<0.05

Extraversion. According to Table 6.11, in comparison to all other levels, Level5 and Level-4 show a significant correlation to the attributed mascot's extraversion personality. Based on the analysis, there is no relationship between Level-5 and Level-4. Both of these levels were highly measured as the behavior of an extravert mascot. While the 50% of votes for Level-5 are concentrated between "accurate" and "very accurate" scales (M = 4.0), the lowest vibration levels (M = 2.0, M = 2.0) showed the lower perception of a mascot as an extravert (see Appendix A.5).

Agreeableness. Both Level-2 and Level-3 revealed a significant positive correlation to mascot being assessed as agreeable with padj < 0.05 and large effect sizes (see Table 6.11). According to Figure A.5, half of the samples for Level-2 are located around a "very accurate" scale. Overall, the majority of votes given for Level-2 and Level-3 attributing agreeableness personality, are higher than most votes given for other vibration levels (see Figure A.5).

Conscientiousness. The analysis revealed strong positive relationships between Level-4 and the levels Level-3 and Level-4 with padj < 0.01 (see Table 6.11). The median values for Level-3 (M = 3.8) and Level-4 (M = 4.0) are high enough to conclude that there is a strong effect of these levels to perceive mascot as Conscientious.

Neuroticism. For a Neuroticism personality trait, there is a good separation of samples for Level-1 from all other vibration levels (see Figure A.5). According to Table 6.11, Level-1 is correlated with all other levels. Despite the significant relationship between Level-1 and Level-3, the outlies from Level-3 may affect the potential overlay dispersion for larger sample sizes.

Openness. The Wilcoxon test revealed a significant relationship between levels one and two, and the openness personality trait with p < 0.05. The median values for Level-5, Level4, Level-2, and Level-1 imply the overall similarity of votes concentrated on the "neutral" scale (see Figure A.5). Moreover, the outlier for Level-3 vibration may change the overall range of samples to more negative direction (i.e lower scales).

Table 6.11: The statistically significant comparisons of each group individually using the Wilcoxon signed-rank test and Bonferroni correction while measuring Five Personality Traits for Mascot-Mascot interaction. In addition reporting effect sizes which are large

	Group 1	**Group 2**	**Wilcoxon tests**		**r**	**padj**
			z	**p**		
E	Level-1	Level-4	-3.9316	p<0.01	0.786	p<0.01
	Level-1	Level-5	-3.5756	p<0.01	0.714	p<0.01
	Level-2	Level-4	-3.687	p<0.01	0.743	p<0.01
	Level-2	Level-5	-3.4301	p<0.01	0.678	p<0.01
	Level-3	Level-4	-3.545	p<0.01	0.708	p<0.01
	Level-3	Level-5	-2.9168	p<0.01	0.582	p<0.05

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Table 6.11 – *Continued from previous page*

	Group 1	Group 2	Wilcoxon tests		r	padj
			z	p		
A	Level-1	Level-2	-3.5566	p<0.01	0.703	p<0.01
	Level-1	Level-3	-3.6336	p<0.01	0.727	p<0.01
	Level-2	Level-4	3.028	p<0.01	0.595	p<0.05
	Level-2	Level-5	3.0421	p<0.01	0.608	p<0.05
	Level-3	Level-4	3.0827	p<0.01	0.617	p<0.05
	Level-3	Level-5	2.8476	p<0.01	0.552	p<0.05
C	Level-1	Level-3	-3.8995	p<0.01	0.809	p<0.01
	Level-1	Level-4	-4.0659	p<0.01	0.813	p<0.01
	Level-2	Level-3	-3.3019	p<0.01	0.657	p<0.01
	Level-2	Level-4	-3.817	p<0.01	0.767	p<0.01
	Level-3	Level-5	3.3624	p<0.01	0.671	p<0.01
	Level-4	Level-5	3.8499	p<0.01	0.784	p<0.01
N	Level-1	Level-2	3.326	p<0.01	0.665	p<0.01
	Level-1	Level-3	3.8172	p<0.01	0.779	p<0.01
	Level-1	Level-4	3.8607	p<0.01	0.776	p<0.01
	Level-1	Level-5	3.4724	p<0.01	0.694	p<0.05
O	Level-1	Level-2	-2.8243	p<0.01	0.578	p<0.01

6.3.2 Analysis of within vibration level study

In our first study, we analyzed the variety and the difference of each vibration level within specific personality traits individually. In this subsection, we report the results from a different perspective. The second study analyzes each vibration level individually and the difference of each personality trait within a specific vibration level. According to the Friedman test, there is a statistically significant difference between the measurements of each personality trait within each vibration level. In addition, Level-4 and Level-3 revealed that the measurements of personality traits are very different from each other within these two vibrations (χ^2 = 46.603, p< 0.01 and χ^2 =35.165, p< 0.01 respectively)

Table 6.12: The results from Friedman test for all Five Personality traits in case of Mascot-Mascot interaction

Personality trait	χ^2	df	p
Level-1	24.008	4	p<0.01
Level-2	24.525	4	p<0.01
Level-3	35.165	4	p<0.01
Level-4	46.603	4	p<0.01
Level-5	24.1	4	p<0.01

Level-1. The Wilcoxon Signed-rank test showed a positive relationship between Level-1 and a neuroticism personality trait with a p<0.05 and large effect sizes (see Table 6.13). The median rates given for extraversion, agreeableness, conscientiousness and openness personality traits are relatively similar, namely 2.0, 2.5, 2.5, 2.3 (see Appendix A.6).

Level-2. Moreover, there is also a positive correlation between Level-2 and an agreeableness personality trait with a p< 0.05. The samples from agreeableness are separated with 60% of votes still being higher than all votes given for all other personality traits (see Appendix A.6)

Level-3. Based on the statistical tests, Level-3 conveys two personality traits: agreeableness and conscientiousness with p< 0.05. Moreover, there are outliers reported for neuroticism and openness personality traits that can change the dispersion for larger sample sizes (see Figure A.6).

Level-4. Level-4 is also associated with two personality traits such as conscientiousness and extraversion with a very significant p < 0.01.

Level-5. There is a positive relationship between the vibration with the longest duration and extraversion personality trait with a p< 0.05. The median values for all other personality traits are at about the same scale lower than neutral votes (see Appendix A.6).

Table 6.13: Mascot-Mascot

	Group 1	**Group 2**	**Wilcoxon tests**		**r**	**padj**
			z	**p**		
Level-1	E	A	-2.9843	p<0.01	0.609	p<0.05
	E	N	-3.3934	p<0.01	0.671	p<0.01
	A	N	-3.0749	p<0.01	0.603	p<0.05
	C	N	-3.0975	p<0.01	0.620	p<0.05
	N	O	3.0542	p<0.01	0.604	p<0.05
Level-2	E	A	-3.7586	p<0.01	0.757	p<0.01
	A	C	3.1519	p<0.01	0.620	p<0.05
	A	N	3.3024	p<0.01	0.654	p<0.01
	A	O	3.1503	p<0.01	0.617	p<0.05
Level-3	E	A	-2.9298	p<0.01	0.584	p<0.05
	E	C	-3.3928	p<0.01	0.660	p<0.01
	A	N	3.8758	p<0.01	0.775	p<0.01
	A	O	3.303	p<0.01	0.660	p<0.01
	C	N	4.039	p<0.01	0.808	p<0.01
	C	O	3.6229	p<0.01	0.722	p<0.01
	N	O	-3.1867	p<0.01	0.627	p<0.05
Level-4	E	A	3.5903	p<0.01	0.719	p<0.01
	E	N	4.1601	p<0.01	0.837	p<0.01
	E	O	3.8034	p<0.01	0.765	p<0.01

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Table 6.13 – *Continued from previous page*

	Group 1	Group 2	Wilcoxon tests		r	padj
			z	p		
	A	C	-3.7747	p<0.01	0.759	p<0.01
	C	N	4.1315	p<0.01	0.826	p<0.01
	C	O	3.7164	p<0.01	0.738	p<0.01
Level-5	E	A	2.9346	p<0.01	0.587	p<0.05
	E	C	3.1512	p<0.01	0.617	p<0.05
	E	N	3.7113	p<0.01	0.748	p<0.01
	E	O	3.4195	p<0.01	0.684	p<0.01

6.4 Analysis of Mascot-Tablet interaction

The section describes the impact of the screen color of a tablet on the assessment of the personality trait that mascot was assigned. Subsection 6.4.1 shows the analysis of within personality study and subsection 6.4.2 of condition study

6.4.1 Analysis of within personality trait study

In our first study, we focus on each personality trait separately. Friedman's tests reveal a significant ($p < 0.01$) difference in the measurements of the mascot's personality depending on which background color will be displayed on the tablet (see Table 6.14). The most significant effect if the predefined screen colors are observed in agreeableness and openness personality traits with $\chi^2 = 52.895$, df = 4, $p< 0.01$ and $\chi^2 = 37.725$, df = 4, $p< 0.01$ respectively.

Table 6.14: The results from Friedman test for all Five Personality traits in case of Mascot-Tablet interaction

Personality trait	χ^2	df	p
Extraversion	28.841	4	p<0.01
Agreeableness	52.895	4	p<0.01
Conscientiousness	32.891	4	p<0.01
Neuroticism	30.466	4	p<0.01
Openness	37.725	4	p<0.01

Extraversion. According to the Wilcoxon tests using Bonferroni correction, for extraversion personality, the most significant difference was observed in orange and the colors blood-red and pink with padj < 0.05 (see Table 6.15). Figure A.7 shows that samples from yellow and orange colors are separated from blood-red and pink samples. Moreover, based on median value, 50% of samples for orange

are concentrated around an "accurate" score (M = 4.2, max = 5.0) (see Appendix A.7).

Agreeableness. Table 6.15 shows a good separation of turquoise and pink colors from all others implying that there is a positive correlation to the agreeableness personality traits having padj < 0.01. However, there is no strong difference between turquoise and pink colors. Two potential outliers for orange and turquoise colors indicate that for larger sample sizes the dispersion of turquoise may spread in a negative and for orange in a positive direction.

Conscientiousness. According to Table 6.15, there is a significant relationship between tablet displaying turquoise color and mascot being assessed as conscientiousness with padj < 0.05. The median values for yellow (M = 2.7), pink (M = 2.8) and orange M = 2.7) colors are concentrated around the "neutral" scale. However, there are three large potential outliers that would have an effect on the overall measurements of a mascot's personality for larger sample sizes.

Neuroticism. According to Figure A.7, there is a great separation of blood-red samples from all other screen colors. Moreover, blood-red is statistically significantly different from other colors with a p < 0.01. There are some extreme values observed for yellow and turquoise colors (see Figure A.7). All colors except blood-red are evaluated as a behavior of mascots being low in neuroticism personality with median values around 2.5 (see Appendix A.7).

Openness. According to the Wilcoxon test using Bonferroni correction, during the measurements of a mascot's 'openness to experience' personality trait, the yellow is significantly different from all other screen colors with padj < 0.05 (see Table 6.15). Most of the samples of yellow color are discriminated from all others concentrating around an "accurate" scale with a median = 4.0 (see Appendix A.7 and Figure A.7).

Table 6.15: The statistically significant comparisons of each group individually using the Wilcoxon signed-rank test and Bonferroni correction while measuring Five Personality Traits for Mascot-Tablet interaction. In addition reporting effect sizes which are large

	Group 1	Group 2	Wilcoxon tests		r	padj
			z	p		
E	Yellow	Blood-Red	3.1011	p<0.01	0.627	p<0.05
	Yellow	Pink	3.2335	p<0.01	0.650	p<0.05
	Orange	Blood-Red	3.7314	p<0.01	0.751	p<0.01
	Orange	Pink	3.1295	p<0.01	0.627	p<0.05
A	Yellow	Turquoise	-3.8448	p<0.01	0.780	p<0.01
	Yellow	Blood-Red	3.7734	p<0.01	0.781	p<0.01
	Orange	Turquoise	-4.0936	p<0.01	0.819	p<0.01
	Orange	Blood-Red	3.1542	p<0.01	0.650	p<0.05
	Orange	Pink	-3.305	p<0.01	0.653	p<0.01

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Table 6.15 – *Continued from previous page*

	Group 1	Group 2	Wilcoxon tests		r	padj
			z	p		
	Turquoise	Blood-Red	4.3755	p<0.01	0.875	p<0.01
	Blood-Red	Pink	-3.7573	p<0.01	0.757	p<0.01
C	Yellow	Turquoise	-3.9161	p<0.01	0.791	p<0.01
	Orange	Turquoise	-3.204	p<0.01	0.641	p<0.05
	Orange	Blood-Red	3.4736	p<0.01	0.697	p<0.01
	Turquoise	Blood-Red	4.0152	p<0.01	0.802	p<0.01
	Turquoise	Pink	3.7126	p<0.01	0.749	p<0.01
N	Yellow	Blood-Red	-3.8045	p<0.01	0.786	p<0.01
	Orange	Blood-Red	-3.5754	p<0.01	0.724	p<0.01
	Turquoise	Blood-Red	-4.1588	p<0.01	0.837	p<0.01
	Blood-Red	Pink	3.6195	p<0.01	0.724	p<0.01
O	Yellow	Orange	3.1986	p<0.01	0.658	p<0.05
	Yellow	Turquoise	3.461	p<0.01	0.704	p<0.01
	Yellow	Blood-Red	4.2273	p<0.01	0.845	p<0.01
	Yellow	Pink	4.2307	p<0.01	0.856	p<0.01

6.4.2 Analysis of within screen color study

For the second study, we focus on each color separately by considering the different measurements of five personality traits within each screen color. Friedman's test shows that Turquoise color has the most significant effect on all personality traits (Z=46.199, df=4, p< 0.01). Orange color has the least substantial effect on overall measurements of all five personality traits (Z=19.992, df=4, p< 0.01).

Table 6.16: The results from Friedman test for all Five Personality traits in case of Mascot-Tablet interaction

Personality trait	χ^2	df	p
Yellow	38.142	4	p<0.01
Orange	19.992	4	p<0.01
Turquoise	46.199	4	p<0.01
Blood-Red	29.95	4	p<0.01
Pink	21.68	4	p<0.01

Yellow. The Wilcoxon Sign rank test with applied Bonferroni correction revealed that there us a positive relationship between yellow screen color and openness personality trait with $p < 0.01$. The possible outliers for neuroticism may change the dispersion of samples for a larger number of participants. However, since the outliers are not very far from higher adjacent values, we can assume that it will

not affect the correlation between openness and yellow color.

Orange. As observed in Friedman's test, there are still statistical significant results for orange screen colors. However, in comparison to all other screen colors, the variation of measurements of personality traits is not substantially different from each other. The Wilcoxon test shows the only three distinguishable groups between extraversion, agreeableness, and neuroticism personality traits within the orange color condition (see Table 6.17). However, there is no separation of one personality from others so that we can correlate it with orange screen color. The extraversion seems to have the highest overall positive opinions with median = 4.2 (see Appendix A.8)

Turquoise. Turquoise screen color shows the most amount of distinguishable effects of colors on all personality traits. Particularly, conscientiousness and agreeableness personality traits are the most conveyed by turquoise colors with a $p< 0.05$ (see Table 6.17). Moreover, the median value for conscientiousness (M = 4.2) is higher than for agreeableness (M = 3.7) and all other personality traits (see Appendix A.8). Two outliers are reported in Figure A.8. We assume that for neuroticism, it will not affect the overall result since the samples are already located toward negative opinions. For agreeableness, the overall dispersion may affect the result which, therefore, may make the turquoise color even more influential on conveying a conscientiousness personality trait.

Blood-red. For blood-red color, there is a strong positive relationship between blood-red and neuroticism personality trait with $p < 0.05$. The effect sizes and visually presented boxplots show a great separation of neuroticism samples from all other personality traits (see Table 6.17and Figure A.8). In fact, only one outlier reported for an openness personality trait.

Pink. There is a positive relationship between pink and agreeable personality traits with $p < 0.05$. However, we could not find a statistical difference between pink color and such personality traits ads agreeableness and conscientiousness. For pink color, there are so many outliers for almost every personality trait except for agreeableness. This can affect the overall spread of samples for larger sample sizes.

Table 6.17: Mascot-Tablet

	Group 1	**Group 2**	**Wilcoxon tests**		**r**	**padj**
			z	**p**		
Yellow	E	C	2.9954	p<0.01	0.599	p<0.05
	E	N	3.4443	p<0.01	0.717	p<0.01
	E	O	-3.7585	p<0.01	0.751	p<0.01
	A	O	-3.8775	p<0.01	0.807	p<0.01
	C	O	-4.0453	p<0.01	0.810	p<0.01
	N	O	-4.1998	p<0.01	0.840	p<0.01
Orange	E	A	3.6158	p<0.01	0.724	p<0.01

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Table 6.17 – *Continued from previous page*

	Group 1	Group 2	Wilcoxon tests		r	padj
			z	p		
	E	N	3.0578	p<0.01	0.603	p<0.05
	A	C	-3.1027	p<0.01	0.628	p<0.05
Turquoise	E	A	-3.7457	p<0.01	0.743	p<0.01
	E	C	-3.9292	p<0.01	0.787	p<0.01
	A	N	3.8643	p<0.01	0.773	p<0.01
	A	O	3.1941	p<0.01	0.639	p<0.05
	C	N	4.0721	p<0.01	0.826	p<0.01
	C	O	3.5643	p<0.01	0.737	p<0.01
	N	O	-3.1846	p<0.01	0.642	p<0.05
Blood-Red	E	N	-3.1303	p<0.01	0.622	p<0.05
	A	N	-3.6735	p<0.01	0.740	p<0.01
	A	O	-3.7897	p<0.01	0.774	p<0.01
	C	N	-3.0814	p<0.01	0.616	p<0.05
	N	O	3.3013	p<0.01	0.665	p<0.01
Pink	E	A	-3.1366	p<0.01	0.627	p<0.01
	A	N	3.2557	p<0.01	0.646	p<0.01
	A	O	2.9877	p<0.01	0.598	p<0.05
	C	N	2.8606	p<0.01	0.582	p<0.05

Chapter 7
Discussions

This chapter covers discussion of the results obtained from statistical tests. In our study, we tried to conceptualize the behavior of a mascot with four interaction types which we refer as use-cases. We discuss the results of each use in four sections separately. Moreover, as we mentioned in the Chapter 6, we analyzed results from two perspectives: the study of within personality trait and within condition. Each study splitted into subsections and discussed for each use-case separately.

7.1 Mascot-Lamp interaction

The study shows that there is a significant impact of the lamp emitting one of the predefined colors on the way how participants interpret the personality of a mascot. During the user study we explained participants that while interacting with the lamp, a mascot with its behavior tries to convey specific personality trait. Analysis shows that in this case participants did not just see the lamp as artificial light source, but also it gives an impression about mascot which triggered this light. In the following subsections we will discuss which lighting colors have a correlation to the particular personality traits.

7.1.1 Discussion for the first study

Extraversion Personality Trait. The results show that predefined lighting colors have an impact on the way how participants measured the personality of mascots. Almost 100% of participants found a negative relationship between blood-red color and mascot's extraversion trait. Thus, by seeing this lighting color, participants did not reflect any positive opinion toward the Mascot measuring as

friendly, warm, sociable, cheerful, positive and so on. Moreover, participants measured yellow color for a mascot which conveys positive, cheerful and all other characteristics that are close to extraversion personality traits. Unfortunately, since there is no difference found between yellow and orange colors after Bonferroni correction, we cannot conclude that yellow color is positively correlated to the extraversion. Despite that, with the help of the Bonferroni correction, the assumption that blood-red is measured as the opposite of all extraversion facets is consistent and does not include any false positives even for larger sample sizes.

Agreeableness Personality Trait. The majority of participants had a positive opinion on attributing pink color to cooperative, trustworthy, modest mascot (see Figure-1). While the results for blood-red color showed the opposite direction implying the disagreement for this specific mascot to be Agreeable. Moreover, among all the colors, when the participants compared orange and pink and red and pink groups, their results were significantly different. They were giving the highest points to the mascot for being assessed as cooperative and modest in case of pink and the lowest points when they saw orange and blood-red lighting colors (see Figure-1).

Conscientiousness Personality Trait. When measuring mascot for being conscientious, there was a clear separation of votes given for blood-red and orange with all other colors. Moreover, turquoise, pink and yellow, in descending order, were relatively similarly voted in a positive direction.

Neuroticism Personality Trait. Blood-red color achieves an excellent separation from all other colors having a sample of almost 100% lying between 'neutral' and 'strongly accurate' scales showing a high perception of a mascot conveying being an angry, anxious, unstable behavior. While opinions for the pink color concentrated on the "inaccuracy" of this statement. Moreover, the mascots representing yellow, turquoise and especially pink lighting colors were measured as very low in the Neuroticism personality trait. Overall, the analysis revealed that by showing the participants blood-red together with any other colors, the majority will choose blood-red as an expected behavior for Neurotic Mascot.

Openness Personality Trait. Overall, 75% of the samples for yellow box-plot were concentrated between 'neutral' and 'accurate' toward mascot being interpreted as imaginative, adventurous, intelligent, having 25% of votes condensed between 'accurate' and 'strongly accurate' scores. However, according to the statistical analysis (see Table-6.2), yellow color has a significant effect only when it is compared to blood-red and pink colors. Thus, during mascot lamp interaction, for Openness Mascot the yellow color is more preferable than the blood-red or pink.

7.1.2 Discussion for the second study

Yellow lighting color condition. Since there is no positive relationship between yellow lighting and any of predefined personality traits. We can summarize

that participants seeing yellow color will measure mascot as an extravert, or agreeable, or conscientious, or open to the experience. In addition, there is a low chance that the mascot representing the yellow lighting color will be perceived as neurotic. By knowing the significant negative correlation between variables, we can conclude with yellow lighting, the mascot will not be perceived as neurotic even for larger sample sizes.

Orange lighting color condition. When participants were shown orange lighting color, they measured mascots' personality as both extravert or open to the experience. Thus, on the one hand, the mascot conveying the orange light was perceived as friendly, sociable, energetic, cheerful and the one which seeks excitement. On the other hand, this color is also attributed mascot that is imaginative, artistic, adventurous, intellectual. In addition, in comparison to yellow, turquoise and pink colors, orange color is not negatively correlated with neuroticism. This implies that to some extent if we broaden the survey, the orange lighting can convey the neuroticism personality trait of a mascot.

Turquoise lighting color condition. Overall, there is a positive relationship between conscientiousness and agreeableness personality traits and turquoise lighting.

Blood-red lighting color condition. There is a positive relationship between blood-red and neuroticism personality trait. Thus, if we will choose a blood-red color, we will convey the neuroticism trait. In other words, the mascot triggering the blood-red lighting will be attributed as anxious, highly depressive, angry, vulnerable and the one that has immoderate behavior.

Pink lighting color condition. According to analysis, pink lighting color can convey the agreeableness or conscientiousness personality traits of a mascot. Thus, by presenting this lighting color, the mascot can be attributed as both modest, cooperative, trustworthy which are facets that constitute agreeableness, and orderly, dutiful, discipline which belongs to conscientiousness. Moreover, the negative relationship between pink and neuroticism implies that we can exclude that the mascot which triggers pink color will be attributed as anxious, vulnerable, angry and so on.

7.2 Mascot-Speakers interaction

For mascot-speakers interaction, we found a significant relationship between music and the personality trait on the mascot is presented by specific songs. We can report that there are some music categories that convey the particular personality trait of a mascot. In general, the interpretation of a mascot varies depending on which song this mascot triggered. In the following subsections we will discuss which music categories convey personality traits.

7.2.1 Discussion for the first study

Extraversion Personality Trait. Among all categories, Unpretentious has more consistent positive opinions for mascot being measured as an extravert device. However, there is no noticeable difference between Unpretentious and Contemporary music. Moreover, while assessing mascot's extraversion personality trait, participants clearly distinguished Unpretentious from the Sophisticated category. Thus, participants tended to assess the mascot for which pop, rock&roll, bluegrass songs were played, as a more friendly, sociable, cheerful personality. For these genres having noticeable rhythmic elements and a mainstream style, may lead participants to interpret the behavior of a mascot as a more energetic, gregarious and positive one.

Agreeableness Personality Trait. There is no statistically significant evidence that participants' measurements differed between Sophisticated and Unpretentious music. However, for both of these categories participants attributed the higher scores of Agreeableness for a Mascot rather than for Contemporary. To conclude, there is a significant negative relationship between Contemporary music and the Agreeableness personality trait of a Mascot. The Sophisticated and Unpretentious music can be correlated positively with Agreeableness trait only when we compare each with Contemporary music genres.

Conscientiousness Personality Trait. Overall, the three music categories yield almost similar average scores, which explains the relatively less significant result of the Friedman test in comparison to other personality traits (see Table-6.3). Despite that, participants' measurements regarding mascot conveying conscientiousness were significantly different when they were shown songs from Sophisticated and Contemporary categories. Thus, the genres from a Sophisticated category such as classical, jazz, and contemporary adult portrayed the mascot as being more disciplined, continuous, achievement-striving in comparison to rap and soul genres from Contemporary. Finally, there is a significant negative correlation between Contemporary music and the scores on facets that constitute a Conscientiousness personality trait.

Neuroticism Personality Trait. Among all three music categories, Contemporary showed a positive correlation with the Neuroticism personality trait of a mascot. In comparison to classical, jazz, pop, rock&roll, and other genres, rap and soul describe mascot as being more emotionally unstable, angry, vulnerable, depressive. Participants explained this tendency as the following: mascots high in facets related to the Neuroticism personality captures aggression which is reflected in the music genres that they prefer to play. Participants who listened to Sophisticated and Unpretentious music measured mascot relatively low on Neuroticism.

Openness Personality Trait. Overall, the difference among all music categories is significantly different while assessing the openness personality trait of a mascot. This effect is substantially noticeable in the Sophisticated group which shows a

positive correlation to a current personality trait. According to the participants' opinions, classical, jazz songs contains ensembles of instruments with complex arrangements and they have distinctive tones and performance techniques which leads to measure the mascot as a complex, intelligent and thoughtful, the one who will enjoy non-mainstream music.

7.2.2 Discussion for the second study

Sophisticated music condition. There is a positive correlation between sophisticated music and openness personality trait. In other words, the mascot that trigger speakers to play songs form jazz, classical or contemporary adult genres, will mostly convey openness personality trait. Moreover, the negative relationship between sophisticated and neuroticism implies that when participants listened to the above-mentioned genres, they measured the mascot very low in being anxious, aggressive, impulsive and all other facets represented by neuroticism.

Contemporary music condition. There is a connection between contemporary music and extraversion personality trait. Thus, in order to convey extravert mascot, such as rap and soul music can be helpful.

Unpretentious music condition. There is no positive relationship between any personality traits and Unpretentious music category. We observed only negative correlation between this category and neuroticism, meaning that songs as pop, rock&roll, bluegrass and so on, can be interpreted very low on being aggressive, vulnerable, depressive and so on. The absence of differences between all other personality traits can imply that this music category may convey a mascot with a mix of being sociable, cheerful, trusting, cooperative, disciplined, orderly, artistic, intellectual and other facets belonging to extraversion, agreeable, conscientiousness and openness respectively.

7.3 Mascot-Mascot interaction

The statistical analysis showed that the levels of vibration have a significant effect on the measurement of mascot's personality. The vibration duration gives a clue about approaching mascot. Further, we discuss specific levels that personalities convey.

7.3.1 Discussion for the first study

Extraversion Personality Trait. The mascot with the longest vibration duration, namely 500 milliseconds long, was interpreted as assertive, forceful, energetic, friendly, sociable, cheerful. All of these facets constitute extraversion personality trait. Moreover, Level-4 showed a second-highest, after Level-1, positive

correlation to the mascot being perceived as an extravert. In addition, after experiments, participants commented that the longer their mascot vibrated, the more they got an impression that approaching mascot wants to socialize with them. This made them give higher scores for extraversion facets. Importantly, participants were measuring all 30 facets without knowing which of them belong to the extraversion dimension.

Agreeableness Personality Trait. Level-2 and Level-3 are more separated from all other levels showing a positive correlation for mascot being assessed as agreeable. This may indicate that for the majority of participants in order for mascot being assessed as modest, cooperative, trustworthy, the vibration level that they represent should not be as assertive as we have noticed for extraversion personality trait and not as passive as we will notice for neuroticism trait.

Conscientiousness Personality Trait. Level-3 and Level-4 reveal a positive correlation to the currently described personality trait. Since conscientiousness personality trait is characterized by being goal-oriented (see Appendix Questionnaire), we can assume that participants might expect from conscientious mascot to be a little bit more assertive and forcefull in order to achieve its goals. Thus, it can explain why participants agreed that Level-4 conveys conscientious personality trait.

Neuroticism Personality Trait. The mascot was scored significantly high on being neurotic when participants experienced the vibration with the shortest duration, namely Level-1. This level sows a great separation from all other vibration levels. In addition, we can assume that the longer the duration of the vibration is, the more this mascot represents its desire to communicate with other mascots. Communication may require additional skills such as coping with a stressful situation, and in this kinds of situation, neurotic personality trait may be vulnerable and feel anxiety. It gleans insight into the reason why Level-1 is highly related to a neuroticism personality trait.

Openness Personality Trait. Overall, in comparison to other traits, the results for openness personality did not show very significant differences. The only difference were found between Level-1 and Level-2. Therefore, the mascot with a 200-milliseconds duration of the vibration may be perceived as an openness personality trait, only when it is compared with 100-milliseconds duration. The conclusion that we can draw is that such personality facets as imagination, adventurousness, intellect, liberalism hard to assess based on only vibration levels.

7.3.2 Discussion for the second study

Level-1 vibration condition. When the mascot approaches the participant that holds their own mascot, their mascots start to vibrate. When their mascot vibrated with the lowest level of vibration they interpreted approaching mascot as neurotic. Thus, Level-1 conveys anxious, depressive, vulnerable mascot.

Level-2 vibration condition. Level 2 portrays modest, trusting, cooperative and

straightforward facets which constitute agreeableness personality traits. This, if we want to assign agreeable personality traits to any social device the vibration level that is a good example to convey this personality is Level-2. We can assume that agreement could also tends to co-operate and socialize with others. Since is a mascot comprises modest facet, in order not to disturb other mascots or their owners, it communicate with others in the more restrained way. Thus, we expect the levels of vibration that has neutral duration such as Level-2 and later we will see Level-3. Because the higher is duration of vibration is, the more assertiveness it implies. Therefore, Level-2 does not disturb other owners of a mascot in an assertive manner which portrays the modesty and empathy traits of agreeableness.

Level-3 vibration condition. Level-3 may convey two personality traits: agreeableness and conscientiousness. the reason why we think Level-3 portrays agreeableness personality traits is the same as we discussed for Level-2. regarding conscientiousness personality, it is characterized by being orderly, dutiful, goal-oriented and therefore we would expect the tendency to be more careful with actions. This may explain that the neutral level of vibration conveys conscientiousness personality trait. In fact, some of these assumptions are made in order to better understand the reason behind participants' choices. Whereas, some of the assumptions are the comments that participants made in during video watch. Since our experiments did not include open-ended questionnaire, it can be a good idea to take it into account during future work.

Level-4 vibration condition. According to results Level-4 also conveys two personality dimensions: conscientiousness and extraversion. The possible reason for Level-4 to portray conscientiousness personality trait might be the goal-oriented, achievement-striving and competence characteristics. On the one hand, Level-3 conveys conscientiousness personality trait because of its underliness, dutifulness, and self-discipline characteristics which we discussed above. On the other hand conscientiousness constitutes competence and achievements-striving facets which may be the reason why longer vibration duration conveys conscientiousness personality.

Level-5 vibration condition. Level 4 and level 5 they both portray extraversion personality dimension. The assertiveness and forceful facets of a mascot may be a reason why Level-5 conveys extraversion personality. We can assume that the mascot will force other mascot to vibrate with the longest duration until the owner react to it. The other reason might be the mascot is active, energetic and seeks for excitement, therefore, it tries to involve all other mascots and their owners to be social.

7.4 Mascot-Tablet interaction

Based on analysis, we can claim that some colors of the screen portrays specific personality traits. In the following subsections, we discuss which colors were

more excessively assessed as personality traits. Moreover, we will give intuitive assumptions about why we think participants associated certain colors with particular personality traits. In fact, those assumptions are not bse on the research papers, they just help us to explain participants' decisions in a more intuitive manner.

7.4.1 Discussion for the first study

There is no strong relationship between mascot being assessed high in **extraversion personality** and the background screen colour to the tablet displays. yellow and orange colours can be assessed as an extrovert mascot only when they are compared to pink and blood red colours. however it is hard to emphasise one colour that would convey extraversion personality.

The analysis revealed that blood-red screen color is negatively correlated with the mascot being measured as **agreeableness personality**. This implies that when participants have seen the tablet with blood red screen colour measured mascot as being very low in agreeableness. Moreover pink and turquoise colours convey agreeable personality. This can be explained by the agreeableness personality being kind, warm, generous, forgiving and unselfish and being portrayed by calming colours such as pink and turquoise. Pink colour can be associated with flowers and turquoise colour with sky or ocean for blue side of turquoise and nature for green side. Some participants mentioned that since these two colours remind nature, they decided to measure calming and relaxing colours as the representation of agreeableness personality

We found a strong relationship between turquoise and **conscientiousness personality** dimension. Generally, we can assume that turquoise color can be associated with nature which symbolizes green plants and clear sky. Conscientiousness personality represents achievement-striving and concentration. The calming effect of these colors could effect the decision of participant on measuring conscientiousness higher than other four dimensions.

There is a positive relationship between blood-red and **neuroticism personality trait**. Neuroticism personality is characterized by immoderation, depression, anxiety and etc which makes them unable to approve themselves. We think that since it is hard for neurotic to cope with stressful interpersonal situation, it will try to avoid to be center of attention. It can explain why such dark and dimmed shade of red as blood-red color conveys this personality trait.

Yellow screen color plays a significant role on portraying **openness personality trait**. Openness dimension is characterized by deep imagination, openness to new knowledge, having a wide spectrum of interests and curious. Yellow color may be associated with the sun and being bright. This color is quite visible and attention-grabbing color. Thus, the openness mascot may trigger yellow color in order to be seen by others and communicate with more new social devices.

7.4.2 Discussion for the second study

Now considering each color separately, we can notice which personality traits they convey most. In our second study, **yellow screen color** portrays openness personality trait which makes the results from first study even more consistent. **Orange screen color** shows the least effect on measuring personality trait of our mascot. According to analysis, it is hard to discriminate one personality trait that would be conveyed by orange color. **Turquoise screen color** mostly conveyed conscientiousness and agreeableness personality traits. Whereas, **blood-red screen color** represents neuroticism personality trait which also confirms the results from first study. Generally, for **pink screen color** we have found a relationship with agreeableness personality trait. However, in some sense, it also can be interpreted as conscientiousness personality. Despite that, the pink color was mostly perceived as modest, forgiving, altruistic, unselfish mascot.

Chapter 8
Conclusion

Section 8.1 of the final chapter gives a conclusive overview of the results achieved during conducting this research. In section 8.2, we describe the contribution and our attempts to improve the system compared to related work [Chapter 2] and in section 8.3 we provide certain limitations to our study. Further, in section 8.4, we discuss how the ideas explored in this project can be continued further.

8.1 Overview

In this study both psychological and user-experience approaches helps us to better understand thing to thing interaction.

8.1.1 The birth of the idea

In our study we started with a question: "What interactive objects with a certain behavior can tell us about itself?". Thus, we decided to assign a personality trait to a mascot, assuming that personality may be identification of this social device. We hope that the interaction between a mascot and other inanimate devices might be a descriptive clue for personality of that mascot. Therefore, the actions that mascot is taking might convey the personality of it. From analysis point of view, taking into account all possible types of interaction would cause a huge data set that will be hard to analyze. Thus, we decided to minimize possible actions by using Proxemics theory, which helped us to come up with use-cases such as the interaction between mascot-mascot, mascot-tablet, mascot-lamp, and mascot-speakers. Further, for each interaction type we had to come up with possible actions such as mascot triggering specific song or lighting color and so on. During our study, we have noticed that certain type of behavior, for example,

mascot emitted pink color or sophisticated song and so on, conveys a particular personality trait.

8.1.2 Overview of the results

Now we can review the final results. We analyzed the data from two perspectives and reported them as study-1 and study-2 in chapter 6. In the first study, we observe the personality trait and the variation of all conditions within each personality individually. In our second study, we take a closer look at each condition and the variation of all personality traits within a specific condition. The second study is supplementary for the first study. When during the first study, we see that one condition conveys several personality traits, the second study gives us additional information regarding which of these personality traits conveyed most by this condition.

For **Mascot-Lamp interaction**, we can conclude that both studies showed that there is a positive relationship between blood-red and neuroticism personality. Thus, if the mascot triggers blood-red lighting as a representation of its behavior, it will convey the neuroticism personality trait. Choosing turquoise or pink lighting as a behavior of the mascot will be measured either as a conscientious or agreeable social device. The same tendency is observed for orange color, by showing this color, we may convey either extraversion or openness personality trait. Unfortunately, for mascot-lamp interaction, yellow lighting failed to portray stable personality trait.

For **Mascot-Speakers interaction**, in order to convey extraversion or neuroticism personality traits, contemporary music will be the best choice. For the mascot that attributes an openness personality trait, the good choice will fall on sophisticated music. Or the other way around, by choosing sophisticated music, the personality trait that will be conveyed is an openness. When we choose contemporary music, the mascot will convey an extraversion personality trait. In our first study, we notice that both extraversion and neuroticism are positively related to contemporary music. Having two personalities related to the same music category, our second study revealed that when choosing contemporary music, extraversion personality will be conveyed more.

For **Mascot-Mascot interaction**, extraversion mascot can be presented by showing higher levels of vibration, namely Level-4 and Level-5. If we assign agreeableness personality to our mascot or any other social device, the good choice will be focusing on Level-2 and Level-3. For conscientious mascot, we can take Level-3 and Level-4 as a representational behavior of that personality trait. When we want to convey the neuroticism personality trait, we make a choice for Level-1, the vibration with the lowest duration. And vice versa, as a result of the second study, Level-1 will convey that the mascot is neurotic, Level-2 - agreeable, and Level-5 that the mascot is an extravert. Moreover, by choosing Level-3, we will able to portray either agreeableness or conscientious personality traits. And by

choosing Level-4, both extraversion and conscientiousness personalities can be conveyed.

For **Mascot-Tablet interaction**, in order to convey the conscientiousness personality trait, mascot should be able to trigger a tablet to display turquoise color. Whereas, for a neurotic mascot, the blood-red may be a good and distinctive choice. Finally, when we want to convey an openness personality trait, the mascot should represent yellow color. Further, if we want to focus on colors, yellow screen color is a good choice to convey openness, blood-red portrays neuroticism personality trait. In addition, turquoise and pink screen colors can exhibit either agreeableness or conscientious personality traits. The last two colors may need further study.

Despite the fact that yellow lighting could not convey any personality traits for mascot-lamp interaction, there is a clear positive relationship between yellow screen color and mascot's openness personality trait for mascot-tablet interaction. We can assume that the reason for a different interpretation of the same color in different use-cases is that the lamp emitting yellow light can be perceived as the typical color you get from incandescent bulbs. Meanwhile, the yellow screen color is perceived as a more vivid color framed in a screen. The same observation is made for blood-red color which conveys a neurotic personality trait for both use-cases. However, the mascot triggering the lamp with blood-red lighting is perceived as more angry, anxious, depressive, emotionally unstable and impulsive than the mascot triggering the same color in the tablet. We can assume that by illuminating the whole room with blood-red color people can get a more negative impression about mascot's personality than seeing the same color in a tablet-size screen.

8.2 Contributions and findings

The main contribution is an achieving cooperation among mascot and other interactive objects in a system where each mascot has a unique personality trait. This can, in turn, serve as a contribution for designing social devices in SIoT environment. Moreover, the networthing finding is that there is a relationship between personality trait and behavior of interactive objects. Although this relationship is not as clear and vivid as we observe in human-human interaction, it is a good insight that personality and behavior are interconnected concepts even for inanimate objects. These concepts can help engineers to design their social devices and to serve as an aid for users to better understand interaction between them. For example, when researchers or engineers would like to construct SIoT devices with certain personalities they could use our findings about types of behavior that can convey this personality trait. We hope that behavior that we came up with, particularly four types of interaction shed a light on how behavior of social devices can help people to understand their personality and therefore, the main goals, intentions, and motivation of inanimate object. When engineers

try to configure personality on social device in the context of behaviour and interaction types that we described they can expect actions that we reported in chapter 6. On the other hand if researchers or engineers set up specific commands i.e actions to the social device the users will understand the device's personality as we described in discussion chapter.

Moreover, there is one unexpected phenomenon that we observed during experiments. We know that each participant has its own approach on measuring the personality traits of a mascot. So, before experiment, we believed that while measuring the mascot's personality, participants will rely on their background knowledge of non-verbal clues such as favorite colors or music and so on. However, during the experiments, we noticed that some participants did not focus on factors such as lighting, music and etc as pure independent variable that is affecting their choice. During post-experiment discussions, we noticed that they first associated these factors with someone from their life and then analyze the mascot as they would assess that person. This was an interesting finding showing that some people would prefer to measure the personality of social device by relating it to the real world scenarios and making references to the person from real-world. Of course, this observation is hard to extend to a whole population. However, it was an easter egg in a sense that when people were observing the interaction between social devices, they immediately applied anthropomorphic rules even if they knew that these are inanimate objects.

8.3 Limitations

Unfortunately, the study was based on relatively small (N=25) and homogeneous (e.g. having 70% of participants from formal sciences and age mean of 26) samples which limited the power of their analyses and make it difficult to extrapolate findings to a general population. However, the experiment design was counterbalanced in terms of other important characteristics such as gender, participants' overall music preferences for Mascot-Speakers interaction and the order in which participants watched the videos.

Another limitation could be that the study was held in a laboratory setting where participants only had a limited time to assess the personalities of Mascots. On the one hand, there is a possibility that spending more time (i.e. hours or days) with Mascots could affect participant's opinions on assigning the personality trait to these devices. On the other hand, during these experiments participants reflected their very first impressions while seeing the interaction between devices and their initial reaction while measuring the personality traits of Mascot based on these interactions.

8.4 Future work

In future work, design researchers interested in contributing to our study can focus on finer specifications of factors. These specifications can be either toward new interaction types and behavior or toward improvement of the results from existing interactions. Testing more songs from different genres, or more colors for light and screen may serve as a good example. Another idea might be improving mascot-tablet interaction in addition to screen colors some other functionalities can be added. For example, when mascot approaching tablet it can show some favorite pictures in order to give more information about mascot. In fact, the design of such system should also take into account security aspects for not leaking personal photos.

Another approach might be using the interaction between social devices as a trigger or motivation for people to socialize and communicate more. The behavior of mascots such as trigger lighting or music play or vibrate some other person's mascot when you approach it, can be an icebreaker for people to communicate with each other.

Appendix A
Tables and Figures

	Extraversion					**Agreeableness**					**Conscientiousness**				
	Y	O	T	B	P	Y	O	T	B	P	Y	O	T	B	P
min	2.3	2.3	1.8	1.0	1.7	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5
median	3.7	3.0	2.7	1.7	2.8	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5
max	4.8	4.8	4.2	4.5	3.7	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5
	Neuroticism					**Openness**									
	Y	O	T	B	P	Y	O	T	B	P					
min	D1	D2	D3	D4	D5	E1	E2	E3	E4	E5					
median	D1	D2	D3	D4	D5	E1	E2	E3	E4	E5					
max	D1	D2	D3	D4	D5	E1	E2	E3	E4	E5					

Table A.1: Some Caption. Y is yellow, O is orange ...

	Color	mean	min	Q1	median	Q3	max
E	Yellow	3.626667	2.333333	3.000000	3.666667	4.166667	4.833333
	Orange	3.420000	2.333333	2.666667	3.000000	4.333333	4.833333
	Turquoise	2.793333	1.833333	2.500000	2.666667	3.166667	4.166667
	Blood-Red	2.006667	1.000000	1.500000	1.666667	2.500000	4.500000
	Pink	2.760000	1.666667	2.166667	2.833333	3.166667	3.666667
A	Yellow	3.380000	1.833333	2.333333	3.666667	4.000000	5.000000
	Orange	2.286667	1.000000	1.833333	2.333333	2.666667	3.333333
	Turquoise	3.453333	2.000000	2.833333	3.500000	3.833333	5.000000
	Blood-Red	1.960000	1.000000	1.166667	2.000000	2.500000	3.833333
	Pink	3.993333	2.500000	3.500000	4.000000	4.666667	5.000000
C	Yellow	3.266667	1.333333	2.500000	3.500000	4.000000	4.833333
	Orange	2.533333	1.833333	2.166667	2.500000	3.000000	3.333333
	Turquoise	3.740000	1.666667	3.166667	3.666667	4.166667	5.000000
	Blood-Red	2.493333	1.166667	1.500000	2.166667	3.500000	4.666667
	Pink	3.546667	2.000000	3.000000	3.500000	4.500000	5.000000
N	Yellow	2.226667	1.000000	1.500000	2.166667	3.000000	3.333333
	Orange	2.313333	1.000000	1.833333	2.500000	2.666667	3.500000
	Turquoise	2.153333	1.000000	1.333333	2.000000	3.000000	3.500000
	Blood-Red	4.220000	3.166667	3.833333	4.333333	4.500000	5.000000
	Pink	1.880000	1.000000	1.333333	1.666667	2.166667	3.333333
O	Yellow	3.546667	1.500000	3.000000	3.500000	4.166667	5.000000
	Orange	3.080000	1.666667	2.666667	3.000000	3.666667	4.666667
	Turquoise	2.906667	2.333333	2.500000	2.833333	3.333333	3.666667
	Blood-Red	2.560000	1.166667	1.833333	2.666667	3.166667	4.000000
	Pink	2.826667	1.500000	2.666667	2.833333	3.500000	4.000000

Table A.2: Additional information to the Figure-1 for Mascot-Lamp use-case Study-1

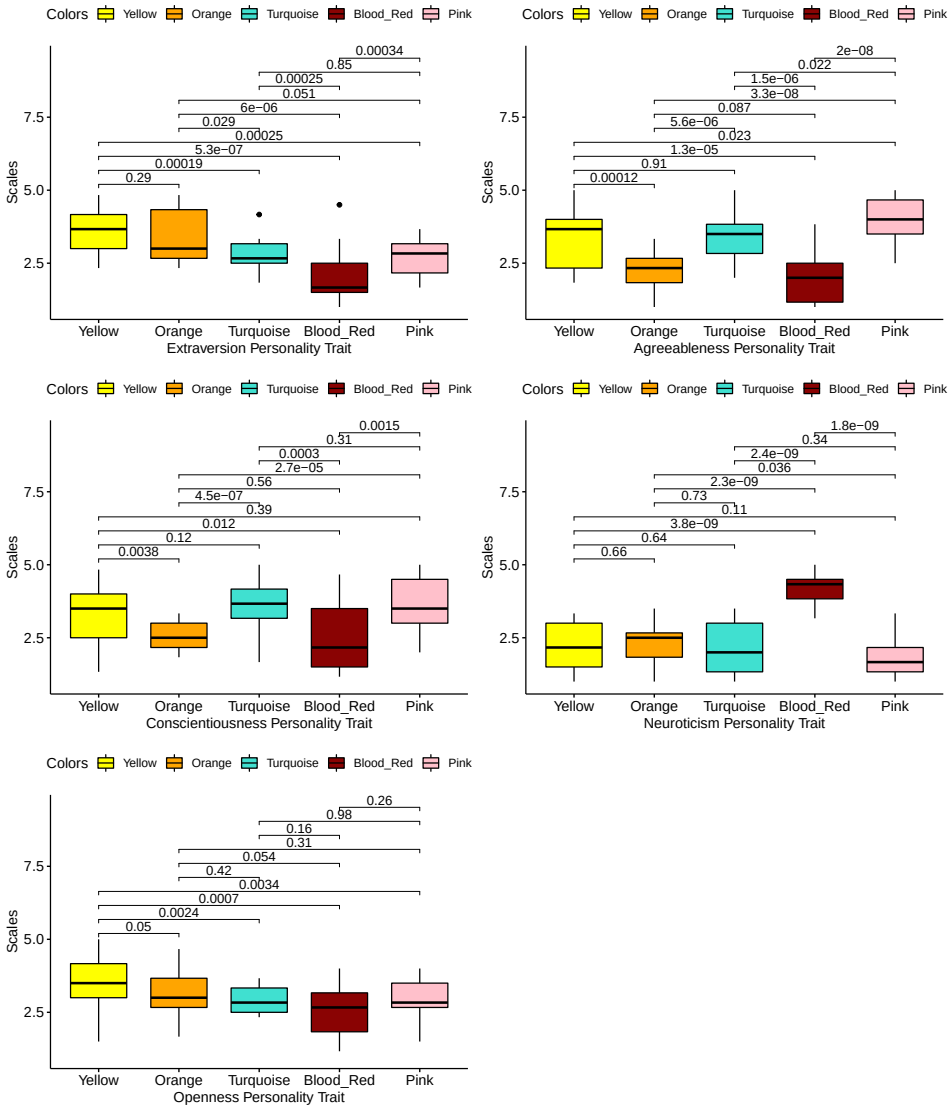

Figure A.1: A boxplot for Mascot-Lamp interaction in Study-1

		mean	min	Q1	median	Q3	max
Yellow	E	3.626667	2.333333	3.000000	3.666667	4.166667	4.833333
	A	3.380000	1.833333	2.333333	3.666667	4.000000	5.000000
	C	3.266667	1.333333	2.500000	3.500000	4.000000	4.833333
	N	2.226667	1.000000	1.500000	2.166667	3.000000	3.333333
	O	3.546667	1.500000	3.000000	3.500000	4.166667	5.000000
Orange	E	3.420000	2.333333	2.666667	3.000000	4.333333	4.833333
	A	2.286667	1.000000	1.833333	2.333333	2.666667	3.333333
	C	2.533333	1.833333	2.166667	2.500000	3.000000	3.333333
	N	2.313333	1.000000	1.833333	2.500000	2.666667	3.500000
	O	3.080000	1.666667	2.666667	3.000000	3.666667	4.666667
Turquoise	E	2.793333	1.833333	2.500000	2.666667	3.166667	4.166667
	A	3.453333	2.000000	2.833333	3.500000	3.833333	5.000000
	C	3.740000	1.666667	3.166667	3.666667	4.166667	5.000000
	N	2.153333	1.000000	1.333333	2.000000	3.000000	3.500000
	O	2.906667	2.333333	2.500000	2.833333	3.333333	3.666667
Blood-Red	E	2.006667	1.000000	1.500000	1.666667	2.500000	4.500000
	A	1.960000	1.000000	1.166667	2.000000	2.500000	3.833333
	C	2.493333	1.166667	1.500000	2.166667	3.500000	4.666667
	N	4.220000	3.166667	3.833333	4.333333	4.500000	5.000000
	O	2.560000	1.166667	1.833333	2.666667	3.166667	4.000000
Pink	E	2.760000	1.666667	2.166667	2.833333	3.166667	3.666667
	A	3.993333	2.500000	3.500000	4.000000	4.666667	5.000000
	C	3.546667	2.000000	3.000000	3.500000	4.500000	5.000000
	N	1.880000	1.000000	1.333333	1.666667	2.166667	3.333333
	O	2.826667	1.500000	2.666667	2.833333	3.500000	4.000000

Table A.3: Additional information to the Figure-2 for Mascot-Lamp use-case Study-2

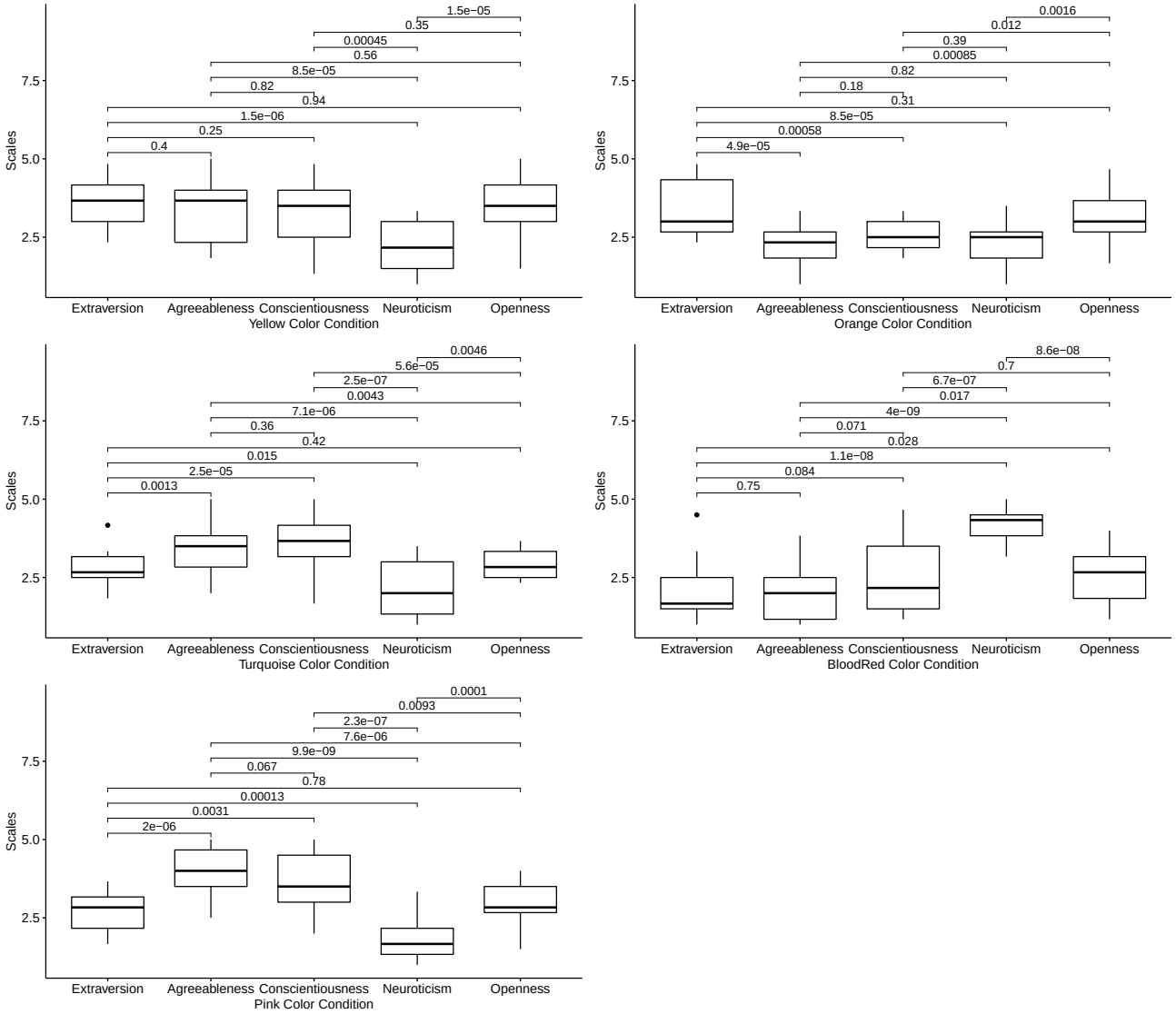

Figure A.2: A boxplot for Mascot-Lamp interaction in Study-2

	Genre Category	mean	min	Q1	median	Q3	max
E	Sophisticated	2.951111	1.388889	2.666667	3.055556	3.333333	3.833333
	Contemporary	4.080000	3.222222	3.666667	3.944444	4.444444	5.000000
	Unpretentious	3.231111	2.222222	3.111111	3.333333	3.444444	4.000000
A	Sophisticated	3.526667	2.944444	3.222222	3.333333	3.722222	4.666667
	Contemporary	2.704444	1.111111	2.444444	2.888889	3.055556	4.277778
	Unpretentious	3.700000	2.555556	3.444444	3.666667	3.888889	4.666667
C	Sophisticated	3.280000	2.444444	3.000000	3.166667	3.500000	4.611111
	Contemporary	2.664444	1.000000	2.111111	2.777778	3.166667	4.055556
	Unpretentious	3.148889	1.888889	3.000000	3.166667	3.444444	4.666667
N	Sophisticated	2.328889	1.000000	2.111111	2.444444	2.666667	3.444444
	Contemporary	3.188889	2.277778	2.666667	3.111111	3.555556	4.555556
	Unpretentious	2.335556	1.333333	1.722222	2.555556	2.833333	3.166667
O	Sophisticated	3.948889	3.111111	3.611111	3.833333	4.222222	4.944444
	Contemporary	2.975556	2.000000	2.722222	2.944444	3.222222	4.000000
	Unpretentious	3.504444	2.555556	3.166667	3.388889	3.833333	4.666667

Table A.4: Additional information to the Figure-3 for Mascot-Speakers use-case Study-1

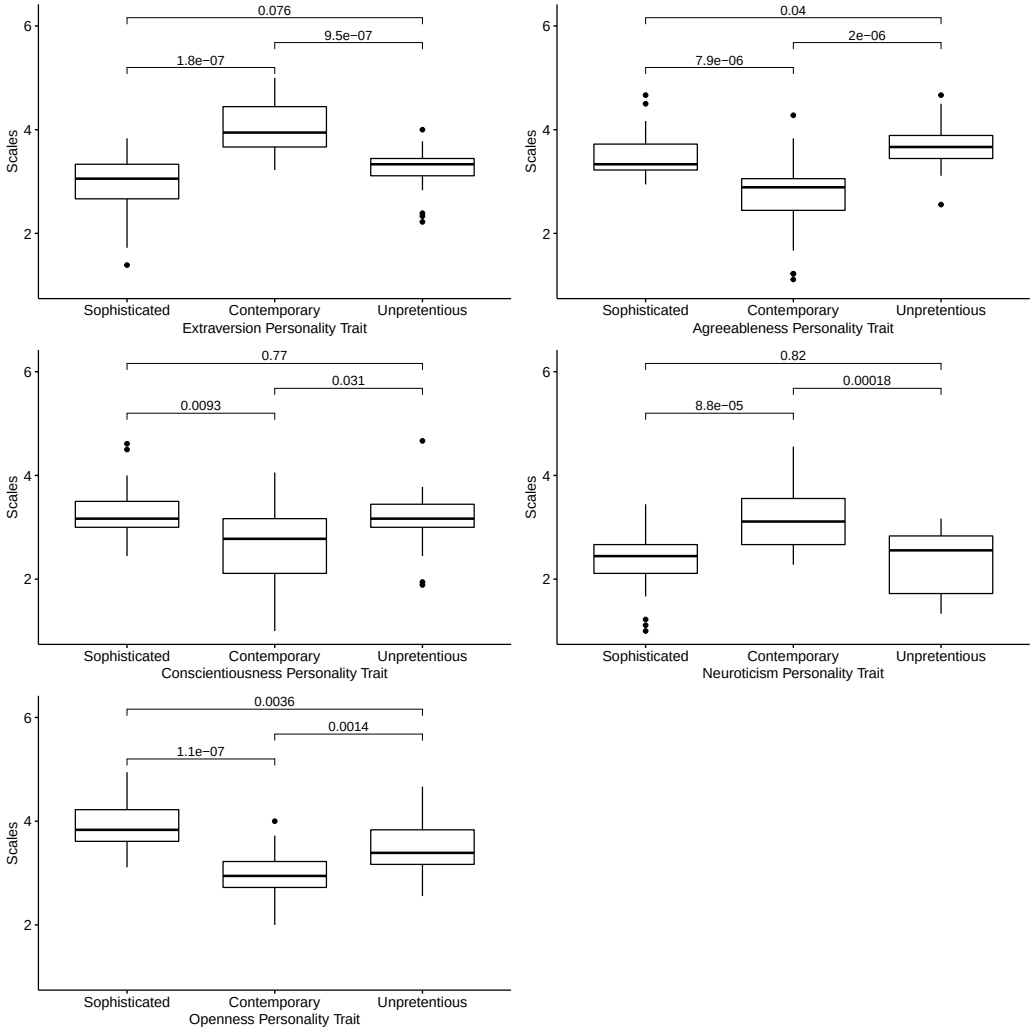

Figure A.3: A boxplot for Mascot-Speakers interaction in Study-1

		mean	min	Q1	median	Q3	max
Sophisticated	E	2.951111	1.388889	2.666667	3.055556	3.333333	3.833333
	A	3.526667	2.944444	3.222222	3.333333	3.722222	4.666667
	C	3.280000	2.444444	3.000000	3.166667	3.500000	4.611111
	N	2.328889	1.000000	2.111111	2.444444	2.666667	3.444444
	O	3.948889	3.111111	3.611111	3.833333	4.222222	4.944444
Contemporary	E	4.080000	3.222222	3.666667	3.944444	4.444444	5.000000
	A	2.704444	1.111111	2.444444	2.888889	3.055556	4.277778
	C	2.664444	1.000000	2.111111	2.777778	3.166667	4.055556
	N	3.188889	2.277778	2.666667	3.111111	3.555556	4.555556
	O	2.975556	2.000000	2.722222	2.944444	3.222222	4.000000
Unpretentious	E	3.231111	2.222222	3.111111	3.333333	3.444444	4.000000
	A	3.700000	2.555556	3.444444	3.666667	3.888889	4.666667
	C	3.148889	1.888889	3.000000	3.166667	3.444444	4.666667
	N	2.335556	1.333333	1.722222	2.555556	2.833333	3.166667
	O	3.504444	2.555556	3.166667	3.388889	3.833333	4.666667

Table A.5: Additional information to the Figure-4 for Mascot-Speakers use-case Study-2

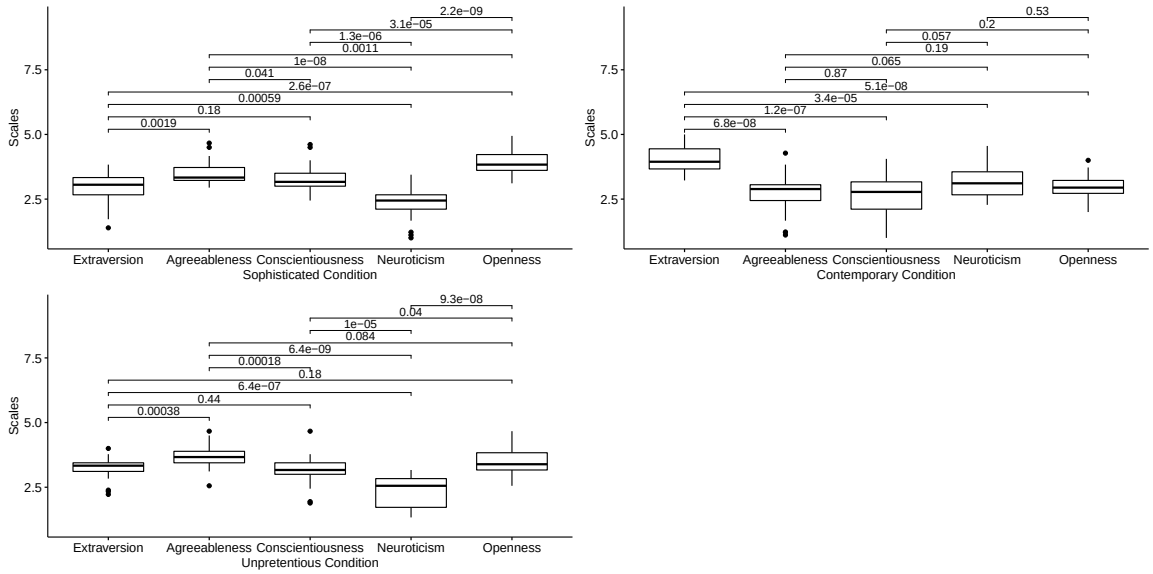

Figure A.4: A boxplot for Mascot-Speakers interaction in Study-2

	Vibration	mean	min	Q1	median	Q3	max
E	Level1	2.166667	1.166667	1.500000	2.000000	2.833333	3.833333
	Level2	2.273333	1.166667	1.500000	2.000000	3.000000	4.000000
	Level3	2.586667	1.333333	1.833333	2.666667	3.500000	4.333333
	Level4	3.226667	2.166667	2.500000	3.000000	3.666667	4.666667
	Level5	3.773333	2.333333	2.833333	4.000000	4.666667	4.666667
A	Level1	2.573333	1.666667	2.000000	2.500000	3.000000	4.000000
	Level2	3.713333	2.000000	3.166667	4.000000	4.333333	4.666667
	Level3	3.800000	2.500000	3.166667	3.500000	4.666667	5.000000
	Level4	2.620000	1.333333	1.833333	2.833333	3.166667	4.000000
	Level5	2.546667	1.333333	1.500000	2.666667	3.333333	3.833333
C	Level1	2.606667	1.666667	2.166667	2.500000	2.833333	3.833333
	Level2	2.673333	1.500000	2.000000	2.666667	3.500000	4.166667
	Level3	3.960000	2.833333	3.333333	3.833333	4.833333	5.000000
	Level4	4.100000	2.166667	3.666667	4.000000	4.666667	5.000000
	Level5	2.740000	1.666667	2.166667	2.833333	3.166667	3.833333
N	Level1	3.606667	2.000000	2.833333	3.666667	4.500000	4.666667
	Level2	2.366667	1.333333	1.666667	2.166667	3.166667	3.666667
	Level3	2.186667	1.333333	1.666667	1.833333	2.500000	4.166667
	Level4	2.126667	1.000000	1.666667	2.166667	2.500000	3.500000
	Level5	2.266667	1.000000	1.666667	2.333333	2.833333	3.333333
O	Level1	2.420000	1.166667	1.666667	2.333333	3.000000	4.166667
	Level2	2.746667	1.833333	2.166667	2.500000	3.166667	4.500000
	Level3	3.186667	1.500000	2.833333	3.333333	3.666667	4.333333
	Level4	2.546667	1.000000	1.666667	2.666667	3.333333	4.500000
	Level5	2.560000	1.333333	1.833333	2.666667	3.333333	4.000000

Table A.6: Additional information to the Figure-5 for Mascot-Mascot use-case Study-1

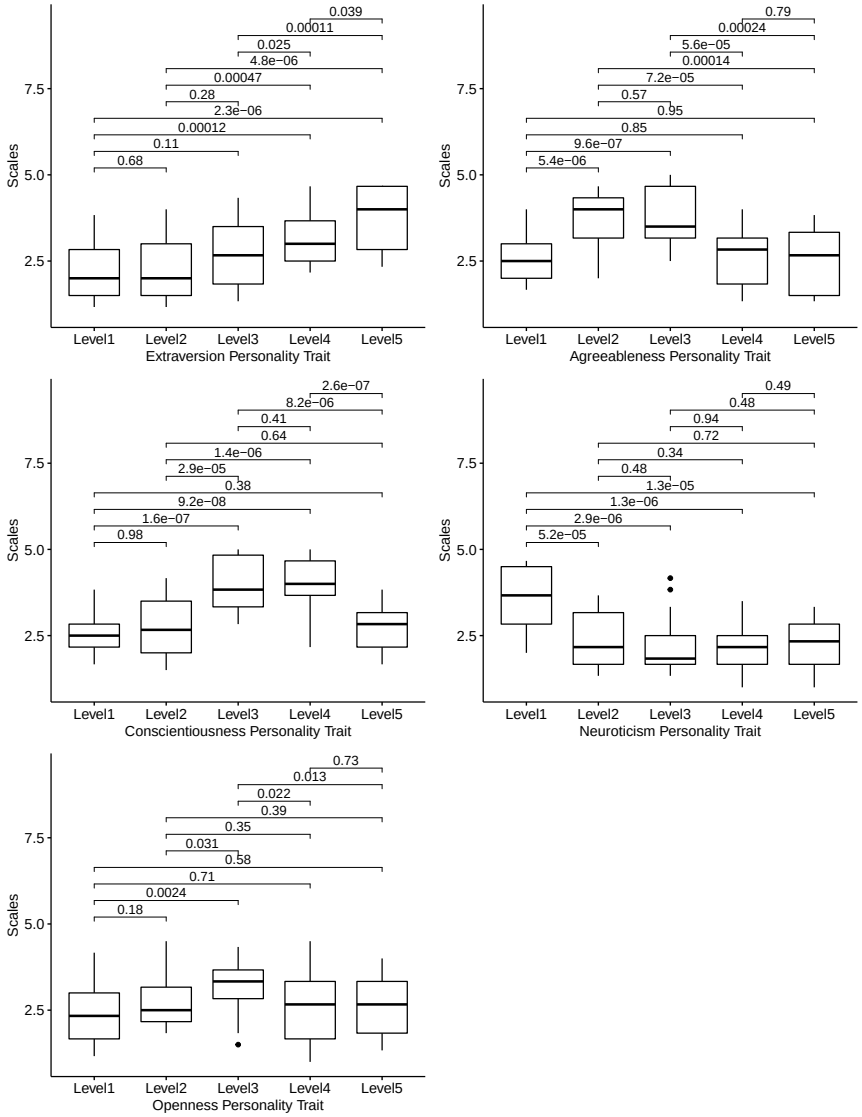

Figure A.5: A boxplot for Mascot-Mascot interaction in Study-1

		mean	min	Q1	median	Q3	max
Level1	E	2.166667	1.166667	1.500000	2.000000	2.833333	3.833333
	A	2.573333	1.666667	2.000000	2.500000	3.000000	4.000000
	C	2.606667	1.666667	2.166667	2.500000	2.833333	3.833333
	N	3.606667	2.000000	2.833333	3.666667	4.500000	4.666667
	O	2.420000	1.166667	1.666667	2.333333	3.000000	4.166667
Level2	E	2.273333	1.166667	1.500000	2.000000	3.000000	4.000000
	A	3.713333	2.000000	3.166667	4.000000	4.333333	4.666667
	C	2.673333	1.500000	2.000000	2.666667	3.500000	4.166667
	N	2.366667	1.333333	1.666667	2.166667	3.166667	3.666667
	O	2.746667	1.833333	2.166667	2.500000	3.166667	4.500000
Level3	E	2.586667	1.333333	1.833333	2.666667	3.500000	4.333333
	A	3.800000	2.500000	3.166667	3.500000	4.666667	5.000000
	C	3.960000	2.833333	3.333333	3.833333	4.833333	5.000000
	N	2.186667	1.333333	1.666667	1.833333	2.500000	4.166667
	O	3.186667	1.500000	2.833333	3.333333	3.666667	4.333333
Level4	E	3.226667	2.166667	2.500000	3.000000	3.666667	4.666667
	A	2.620000	1.333333	1.833333	2.833333	3.166667	4.000000
	C	4.100000	2.166667	3.666667	4.000000	4.666667	5.000000
	N	2.126667	1.000000	1.666667	2.166667	2.500000	3.500000
	O	2.546667	1.000000	1.666667	2.666667	3.333333	4.500000
Level5	E	3.773333	2.333333	2.833333	4.000000	4.666667	4.666667
	A	2.546667	1.333333	1.500000	2.666667	3.333333	3.833333
	C	2.740000	1.666667	2.166667	2.833333	3.166667	3.833333
	N	2.266667	1.000000	1.666667	2.333333	2.833333	3.333333
	O	2.560000	1.333333	1.833333	2.666667	3.333333	4.000000

Table A.7: Additional information to the Figure-6 for Mascot-Mascot use-case Study-2

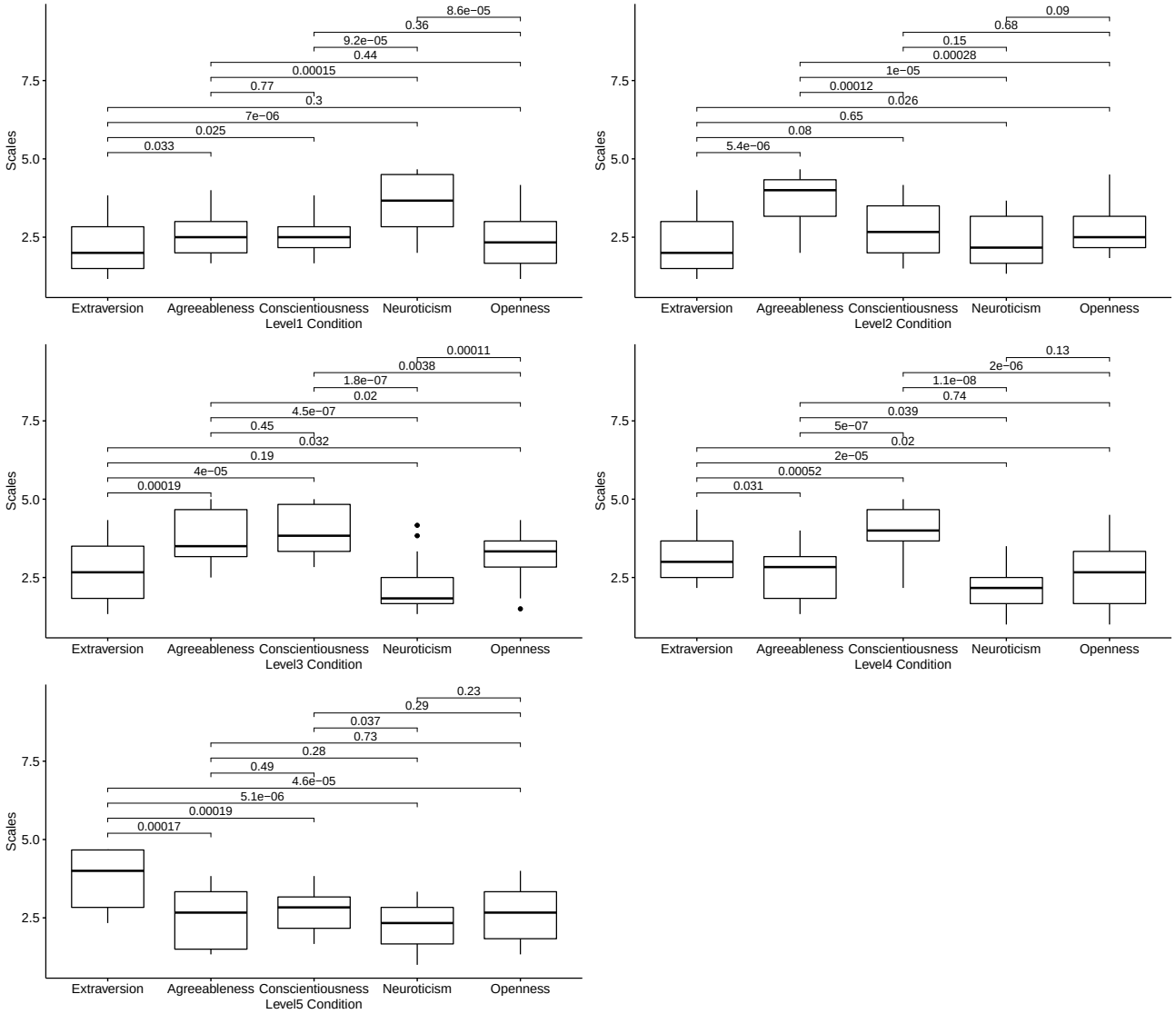

Figure A.6: A boxplot for Mascot-Mascot interaction in Study-2

	Screen Color	mean	min	Q1	median	Q3	max
E	Yellow	3.206667	2.000000	3.000000	3.333333	3.666667	4.000000
	Orange	3.746667	1.666667	2.833333	4.166667	4.666667	5.000000
	Turquoise	2.873333	2.000000	2.333333	2.833333	3.166667	4.333333
	Blood-Red	2.253333	1.166667	1.500000	1.666667	3.166667	4.666667
	Pink	2.626667	1.666667	2.333333	2.500000	2.833333	3.833333
A	Yellow	2.773333	1.500000	2.000000	3.000000	3.333333	3.666667
	Orange	2.440000	1.166667	1.833333	2.333333	2.833333	4.500000
	Turquoise	3.600000	1.833333	3.333333	3.666667	4.000000	4.166667
	Blood-Red	2.006667	1.000000	1.500000	1.833333	2.500000	3.333333
	Pink	3.666667	1.666667	3.000000	3.666667	4.666667	5.000000
C	Yellow	2.686667	1.833333	2.333333	2.666667	3.000000	3.500000
	Orange	3.093333	2.166667	2.500000	2.666667	3.833333	4.500000
	Turquoise	3.986667	2.000000	3.333333	4.166667	4.666667	5.000000
	Blood-Red	2.360000	1.000000	1.500000	2.333333	3.166667	4.333333
	Pink	2.960000	2.000000	2.666667	2.833333	3.000000	4.666667
N	Yellow	2.373333	1.333333	2.166667	2.166667	2.500000	3.666667
	Orange	2.560000	1.500000	2.000000	2.500000	3.000000	4.333333
	Turquoise	2.393333	1.000000	2.000000	2.500000	2.666667	3.500000
	Blood-Red	3.786667	1.500000	3.000000	3.833333	4.666667	5.000000
	Pink	2.320000	1.166667	1.833333	2.333333	2.500000	4.166667
O	Yellow	4.020000	2.500000	3.500000	4.000000	4.666667	5.000000
	Orange	2.800000	1.333333	1.833333	3.000000	3.500000	5.000000
	Turquoise	3.053333	2.000000	2.666667	3.000000	3.333333	4.166667
	Blood-Red	2.586667	1.000000	2.333333	2.666667	3.000000	3.833333
	Pink	2.726667	1.500000	2.500000	2.666667	3.000000	3.833333

Table A.8: Additional information to the Figure-7 for Mascot-Tablet use-case Study-1

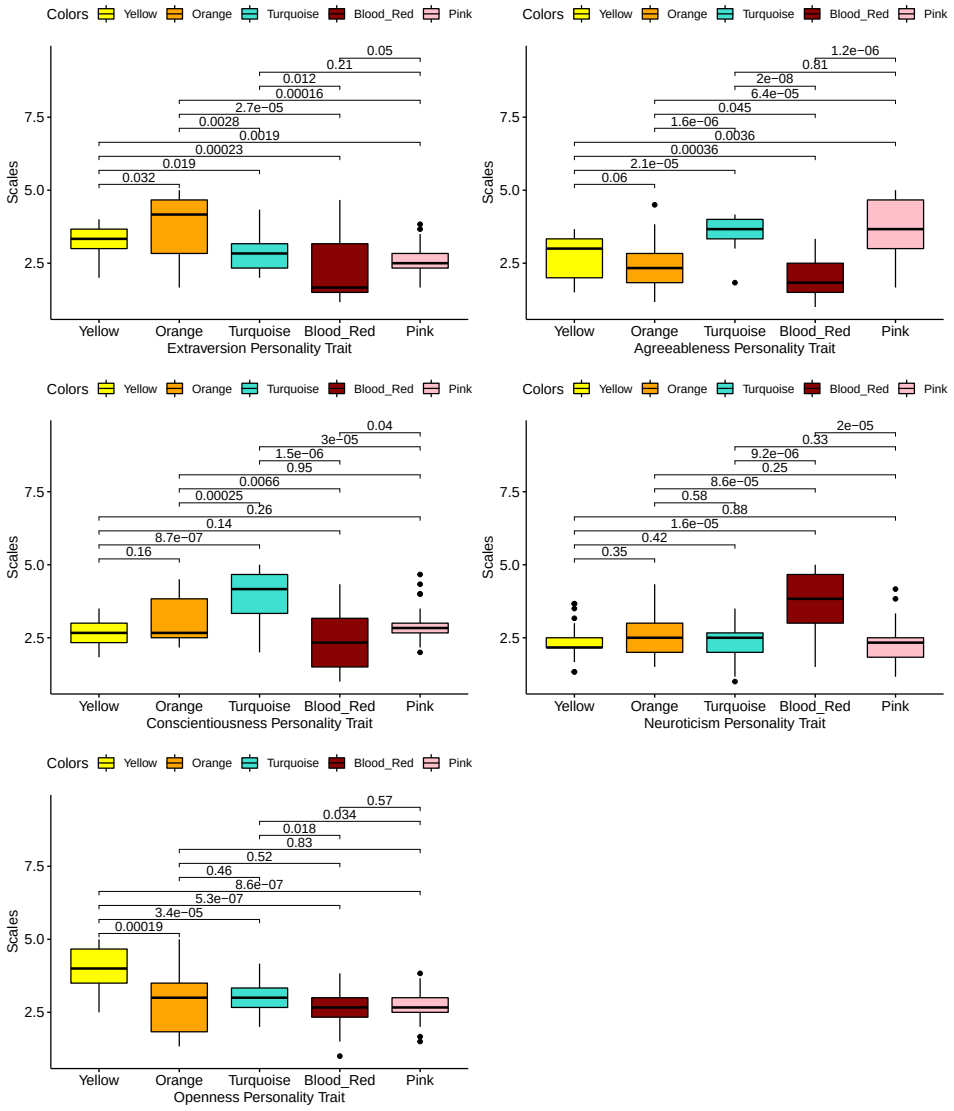

Figure A.7: A boxplot for Mascot-Tablet interaction in Study-1

		mean	min	Q1	median	Q3	max
Yellow	E	3.206667	2.000000	3.000000	3.333333	3.666667	4.000000
	A	2.773333	1.500000	2.000000	3.000000	3.333333	3.666667
	C	2.686667	1.833333	2.333333	2.666667	3.000000	3.500000
	N	2.373333	1.333333	2.166667	2.166667	2.500000	3.666667
	O	4.020000	2.500000	3.500000	4.000000	4.666667	5.000000
Orange	E	3.746667	1.666667	2.833333	4.166667	4.666667	5.000000
	A	2.440000	1.166667	1.833333	2.333333	2.833333	4.500000
	C	3.093333	2.166667	2.500000	2.666667	3.833333	4.500000
	N	2.560000	1.500000	2.000000	2.500000	3.000000	4.333333
	O	2.800000	1.333333	1.833333	3.000000	3.500000	5.000000
Turquoise	E	2.873333	2.000000	2.333333	2.833333	3.166667	4.333333
	A	3.600000	1.833333	3.333333	3.666667	4.000000	4.166667
	C	3.986667	2.000000	3.333333	4.166667	4.666667	5.000000
	N	2.393333	1.000000	2.000000	2.500000	2.666667	3.500000
	O	3.053333	2.000000	2.666667	3.000000	3.333333	4.166667
Blood-Red	E	2.253333	1.166667	1.500000	1.666667	3.166667	4.666667
	A	2.006667	1.000000	1.500000	1.833333	2.500000	3.333333
	C	2.360000	1.000000	1.500000	2.333333	3.166667	4.333333
	N	3.786667	1.500000	3.000000	3.833333	4.666667	5.000000
	O	2.586667	1.000000	2.333333	2.666667	3.000000	3.833333
Pink	E	2.626667	1.666667	2.333333	2.500000	2.833333	3.833333
	A	3.666667	1.666667	3.000000	3.666667	4.666667	5.000000
	C	2.960000	2.000000	2.666667	2.833333	3.000000	4.666667
	N	2.320000	1.166667	1.833333	2.333333	2.500000	4.166667
	O	2.726667	1.500000	2.500000	2.666667	3.000000	3.833333

Table A.9: Additional information to the Figure-8 for Mascot-Tablet use-case Study-2

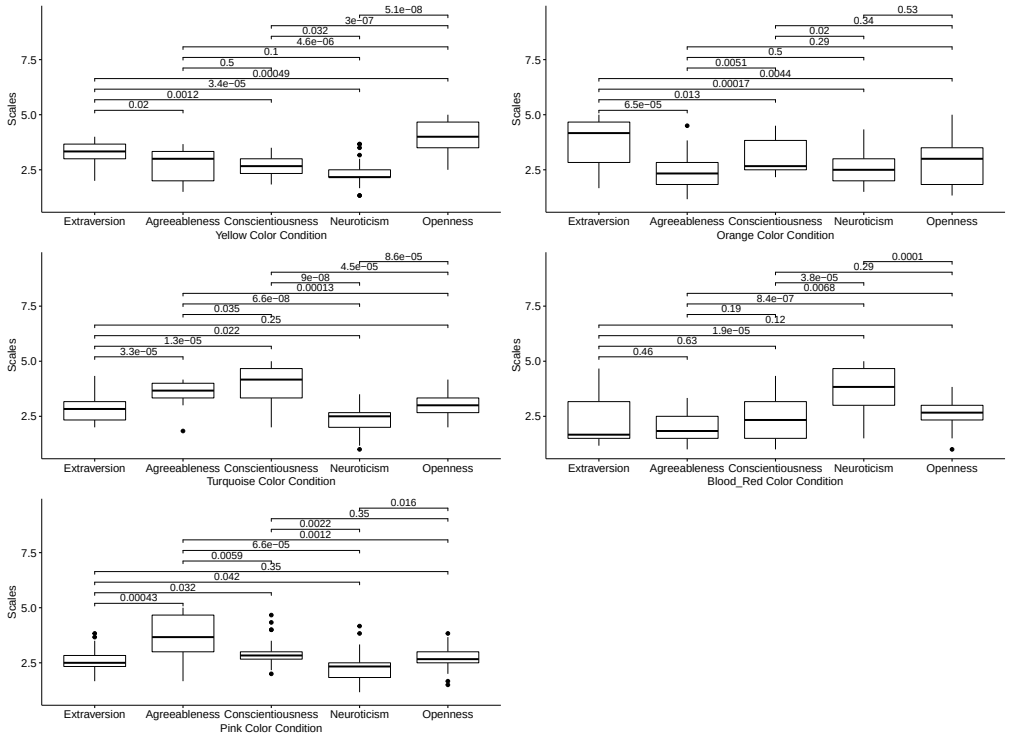

Figure A.8: A boxplot for Mascot-Tablet interaction in Study-2

Appendix B
Questionnaires of the User Study

[1] [2] [3] [4] [5] [6] [7] [8] [9] [10]
[11] [12] [13] [14] [15] [18] [19] [20]
[21] [22] [23] [26] [27] [28] [29] [30] [31]

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