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MASTER THESIS

Understanding Autonomous Device Behavior in a Social Internet of Things environment through Personality Traits.

submitted by
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Abstract

In a Social Internet of Things environment, smart devices autonomously communicate with each other by establishing their own network. While social device interaction increases scalability and enhances network navigability, decisions made by smart devices are not always clear and may not be in line with a user's expectation. Our work aims to find an approach that will bring awareness of automated behaviors while taking the user's context into account.

In our system, a user's smartphone becomes their personal Mascot being able to autonomously connect to four other devices, i.e., another Mascot, a lamp, a tablet, and speakers. While proximity is used to initiate communication between devices, the resulting behavior is influenced by a predefined "personality" of the user's Mascot.

In a user study, we explored different automated behaviors and investigated how users perceived the associated personality according to the Big Five Personality Trait model. Our results indicate that different types of actions, such as playing certain types of music, vibrating at a certain level, changing lighting, and altering screen color, are interpreted as certain personalities. This opens the path to utilizing personality traits as tools to predict and influence automated behaviors in an Internet of Things environment.

Contents

Chapter 1
Introduction

1.1 Motivation

The rapid development of the area of Information Technology led to the emergence of a new paradigm known as "Internet of Things". IoT adds a new dimension by focusing not only on the interaction between humans and devices but also on the devices themselves. However, the concept of IoT does not ensure the effective discovery of the objects and the better reaction to the states of other objects. A new paradigm "Social Internet of Things" (SIoT) introduces more autonomous interaction between "things" by applying the notion of Social Relationship of things rather than explicit users' instructions. However, the ambition of having autonomous interaction of things increases the complexity of a system without having users in mind. Throughout this paper, "things" based on the SIoT concept will be referred to as "social things" or "social devices" for convenience.

Social things interact with each other without making visible to the user their decisions. Thus, it is unrealistic to assume that the autonomous decisions made by social things will always be in line with users' expectations. Given this problem, we are motivated to find and investigate an approach that will take the user's context into account. As a result, the system that achieves the cooperation of social things where things are assigned with unique personalities is proposed. A user being able to configure the personality of the social device will be ensured about the consistent behavior of devices where the services provided by these devices will remain dynamic. We assume that the concept of the personality with predefined actions increases a user's awareness of a system and serves as an interaction mechanism inside the SIoT environment.

The system implemented in this thesis was inspired by the "Autonomous Cooper-

ation of Social Things" paper [29], where authors achieve the interaction between mascot and bench as case studies by representing to cooperation among private and public things. A more detailed description of a system and its contribution is described in Section 2.4. Additionally, authors introduce social things concept where things have unique personalities. However, they do not use personality from a design perspective. In their system, a mascot interacts with a bench that shows only static behavior based on the user's position in space. We plan to apply the personality concept as a design process and bring it to the behavior of social things where they will react to each other dynamically based on the personality of a social device. The use of the personality concept as a design process may help users to create a mental model about the behavior of social devices and their environment. Thus, we envision that the concept of personality with preset actions will influence not only the interaction between social things but also between the user and social things.

1.2 Research Goals

As we mentioned in the previous Section 1.1, from the user perspective, social devices introduced in the paper [29] have static behavior. Users are not able to configure devices or input some information and see the output accordingly. Considering the role of the human in the SIoT environment, in our system, the personality with preset actions serves as an interface for interaction between user and its environment including social devices.

Therefore, as an input, we use the configuration of mascot's personality and proximity information of the user's movements. As an output, we use actions that all social things in the environment display (i.e change of light, vibration, music play, and screen color alteration) based on the personality information that the user configured.

To wrap it up, we extend the system introduced in a paper [29] by adding:

- More case studies such as mascot-lamp, mascot-speakers, mascot-mascot, and mascot-tablet interactions. Thus, the cooperation among private and public things proposed by the previous system [29] is now extended to more interaction types (see Section 3.1)
- Preset actions for each case-study with a changing:
  - Lighting colors such as yellow, orange, turquoise, pink, blood-red lighting color for a mascot-lamp interaction.
  - Music types such as sophisticated, contemporary, unpretentious music for mascot-speakers interaction.
  - Vibrations with five different durations starting from 100 to 500 milliseconds per time for mascot-mascot interaction.

- Background screen colors such as yellow, orange, turquoise, pink, blood-red screen background for mascot-tablet interaction.

Chapter 3 is completely dedicated to the design of a system and the concepts applied in this research in more detail.

Given the extended SIoT system, the main focus lies on how people interpret the interaction between user and social devices. A person holding a mascot changes the state of all devices in the system by his movements. Thus, the question that arises is: "How people will interpret the following actions of things such as lighting color change, music play, vibration duration and screen color alternation in the context of personality traits?" We suppose that the interactions between a mascot and other social devices give a descriptive clue about the personality of this mascot. Therefore, we empirically investigate each action individually and analyze the impact of predefined actions on the measurements of mascot's personality and which personality traits these actions convey (see Chapters 6, 7 and 8). Thus, for each case study, the goal is to settle the question of how people understand devices' actions and measure the personality trait of the mascot based on the interactions between users and these social devices.

1.3 Outline of Thesis

After presenting motivation and research goals (see Chapter 1), in Chapter 2, an overview of scientific publications that are relevant to the thesis is given. The related work chapter also describes current works that inspired us to investigate further and the methodologies that are applied to expand the existing system.

Chapter 3 introduces the papers that aid us to come up with case-studies; identify personality traits that each mascot will be assigned; identify such actions as vibration, music play, lighting, and screen color change based on the personality trait concept.

Chapter 4 describes the implementation details of the system providing the interaction between social things with preset personality. The implementation chapter includes client and server architectures, the overall workload of a system, software, and hardware used to implement the system.

Chapter 5 includes the user study, namely, describes the design of experiments, procedures, tasks, and materials used for the experiments.

Chapter 6 presents the statistical analysis of all four case-studies. The analysis measured from two perspectives framed into two separate sub-studies.

Chapter 7 covers the discussion of statistical results for each case-study.

Chapter 8 gives an overview of the results, contributions, possible limitations of a study, and future works that can extend existing study.

Appendices cover the step-by-step instructions on how to set up the system,

questionnaires used during experiments, and the expanded tables of the results from statistical tests.

Chapter 2
Related Work

This chapter presents the background publications related and applied in our research. Sections 2.1, 2.2, and 2.3 provide an introduction of basic concepts related to the system. Section 2.4 presents a system that inspired us to expand and use in a user study. Starting from section 2.5, we discuss some methodologies that help us to expand the existing system. Each section presents the related publications, gives an example of projects where these concepts were used and describe how we used these concepts in our study.

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" [44]. In this paper, the author touched two issues related to the concept of Ubiquitous Computing such as location and scale.

The traditional computers which existed before the introduction of this paradigm had no idea about their location. The location-aware system has an information about how far or close it is from other objects and may even later be able to adapt its behavior accordingly. An example application that leveraged the location-aware paradigm was introduced by Hupfeld and Berge in their RAUM system [21]. 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 system

presented in our research uses the location information 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 [44]. In the context of our system, 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 smartphone 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 [42]. Thus, in comparison to Ubiquitous technologies, IoT focuses not only on the interaction between humans and devices but also on the devices themselves.

The idea of IoT was first proposed by Kevin Ashton in 1999 [2] by linking the idea of RFID (Radio Frequency Identification) to the topic of the Internet. IoT can be characterized 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 the "Internet of Things: A Literature Review" paper [27], 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 lamps, 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.

Also, 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" to communicate with other objects. ZigBee is widely used, short-range, low-rate wireless network technology, thus, in our system, the communication between mascot and lamp is built with the help of the Zigbee Lighting protocol. Additionally, an inexpensive radio technology Bluetooth Low Energy is also very useful for proximity sensing. In addition to these technologies which are considered as a

pillar for the 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” [11] where the authors are trying to stimulate scientists to a more detailed discussion about the design qualities of the IoT devices. For that, Chung et al conducted the HiddenLocal workshop (HWL) 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 behavior; subtleness of movement; react to the external event; recognize explorative behavior 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 [3], there are many 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 the reaction to the state of other objects is enhanced. Atzori et al [4] 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. 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 a new paradigm to the IoT concept can lead to the following advantages [4, 5]:

- 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 higher scalability and efficiency.

By integrating social networking concepts into the Internet of Things, intelligent things establish a connection with other peers autonomously by exploiting things’ social relationships. An exemplary connection between smart things that we also refer to 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 behavior according to the given information. Therefore, with the help of the advantages provided by social networking principles, the IoT evolves into the concept of the SIoT. Thus, 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 the user's explicit instructions trigger certain functions of a system in order to effects the behavior of objects. This design contradicts the concept of a fully automated system where objects can cooperate with each other beyond the control of a human. The following paper [29], 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 that are able to communicate with others and exchange information autonomously. This approach allows objects to have their own social circle similar to a human social network. This broadcast information calls certain functions that affect the behavior 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 essential for our system helps the objects to know:

- Their goals.
- What to do with the received information.
- 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 the mascot - a small keychain of three colors: 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. In our system, the device that is called mascot is a user's smartphone and as an analogy of the bench, we use the term lamp. The description of all further devices used in our system is given in Section 3.1.

Besides, in the system described in the paper [29], 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 the mascot that is approaching.

The biggest contribution of this paper was to introduce the autonomously cooperative system where mascot and bench represented as private and public things. Moreover, authors also considered proximity-based cooperation: devices blink more often when approaching closer than 30 cm 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, and therefore case-studies. Afterward, we are going to apply the theory of proxemics and the concept of the 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 [20, 19] conceptualized the idea of a personal space bubble by creating a whole system of notation to understand and record how people navigate shared space. He correlated a physical distance to a 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 121 cm is a space bubble which allows your extended family members and close friends to enter this zone.
- **Social distance** varies from 122 to 369 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 [43] 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:

- Provides peripheral information about the tracking status of a user.
- Shows interaction zones.
- Invites the user to interact with the main display.
- 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 the Remote Controls system introduced by Ledo et.al in their [24] 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. The authors of this paper presented the proxemic-aware controls that utilize the spatial relationship between mobile devices owned by a user and appliances surrounding it. With this system, a 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, is a starting point for developing a new type of remote control interface within our increasingly complex world.

Also, Ballendat, Nicolai Marquardt, and Saul Greenberg in their work [7] introduce proxemic-aware interactive media player system, where they consider information regarding nearby people and devices 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 with 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 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. Despite 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 artifacts 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 studies and possible actions.

2.6 Interaction design for SIoT

The following paper [40] 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 behavior was proposed in "Designing the Behaviour of Interactive Objects" paper [41]. The author concluded that to design a more stable and understandable for a user behavior of a device, it is necessary to add an inner logic to which we can refer. Marco et al proposed to apply the concept of metaphor, which represents human stereotypes of personality to visualize the inner logic. Their system was based on a Big Five Personality Traits model, thus, by assigning these personalities to objects, users could describe its behavior more easily. The authors believe that stereotypes and metaphors are simplified descriptions of being and behavior, therefore, making it an ideal method for displaying the sustainable behavior of a smart object. During the research, they used the robotic sofa as a case study and tried to analyze how users perceive the consistency of its behavior. 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. Since only mascots are a major factor affecting the environment (for example, when mascot come close to the lamp, it changes the light color), we decided to assign a personality to dynamic objects, particularly, to each mascot.

This approach may help the user to better understand the mascot's behavior. Knowing which goals and intentions this object follows, may help users to understand the behavior and the reason for certain decisions of a mascot. Thus, the device with an assigned personality can help users who know the definition of that personality to understand the system behavior at least in an intuitive way. This concept may give the system a more understandable and consistent behavior and to the user a better awareness of object functionality. In the following

subsection, we will describe the Personality Model in more detail.

2.7 Definition of personality traits

The personality is important for human relationships, so we assume that it also may be important for device relationships. To assign a personality to each mascot, we first need to define personality in the context of social devices. We can try to intuitively explain the meaning of a person's personality trait, however, it is hard to apply it in the context of SIoT. For that, we need a generally accepted model for the description of each personality which is a Big Five Personality Traits aka OCEAN Model. We expect that describing personality will help to define goals and more targeted actions which in turn will lead the system to more stable behavior. The following book [28] 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: **O**penness to experience, **C**onscientiousness, **E**xtroversion, **A**greeableness, and **N**euroticism. 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;

The dynamic objects are assigned with a set of personality traits each of which is described in the above-mentioned list. Although people usually have a combination of these five traits, we are going to consider only extreme cases and take into account each personality independently.

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 the previous section. In Section 3.3, based on the assigned personalities, we explore the possible actions that social devices show while interacting with each other. In Section 3.3, we identify the vibration levels that convey certain personality traits. In Section 3.4, we associate the music genre with personality traits. Section 3.5 describes colors that convey mascots' personality traits. Section 3.6 gives an overview of a system based on the concepts described in the previous sections of this chapter.

3.1 Identifying case studies and actions

We extended the concept described in the "Autonomous Cooperation of Social Things" paper [29] by applying Proxemics Theory and Personality Traits Model.

Based on the Proxemics theory [20, 19], we classify our devices in the following way: mascot will belong to the intimate, tablet to a personal, the 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. Figure 3.1 shows the visual representation of selected devices based on four distances introduced by the theory of proxemics.

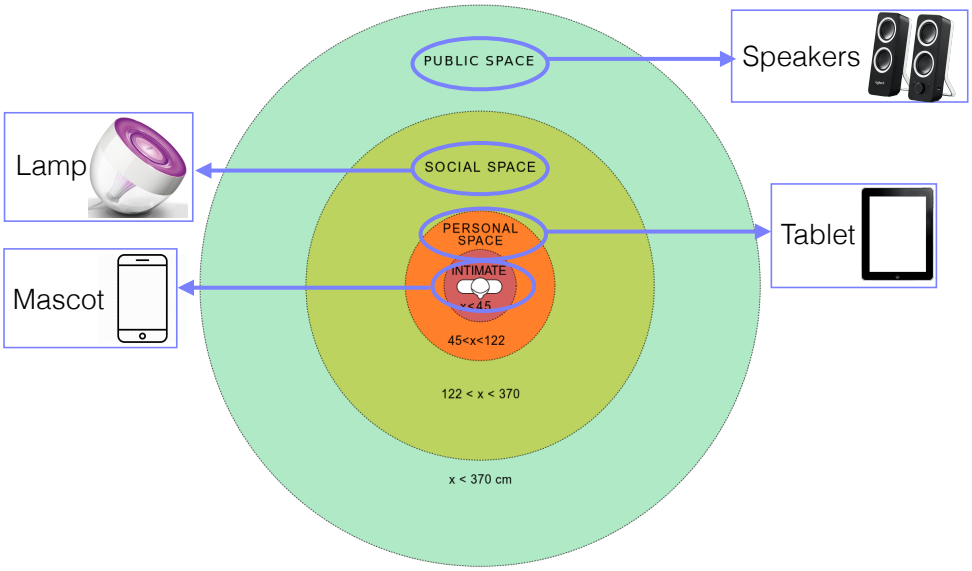


Figure 3.1: Visual representation of Procexics Theory [20, 19] with distances and associated devices selected for this study.

Intimate distance has a very narrow range - up 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 smartphone with a term mascot represented as a ubiquitous personal thing.

Personal distance varied from 45 to 121 cm can be presented by a tablet. In comparison to the vibration where information is only available for owners, the size of the tablet allows displaying information for more members.

Social distance covers from 122 to 370 cm and can be reflected by the lighting of the lamp. Our system contains only one lamp which can be visible for a large number of members, i.e. more than the number of people seeing the change of screen color in the tablet.

Public distance ranging to more than 3.7 meters 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 lamplight 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, conceptualize 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 traits to each mascot. In our system, mascots are dynamic objects, whereas the tablets, lamps and speakers are static devices. The movements of dynamic devices, interacting with all other devices affect the environment (i.e the state of interacted devices). Thus, we assigned a unique personality to each dynamic device that we cover in the following section.

We now can take a closer look at the interaction types of our system 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, it starts to play the genre of music based on the personality of approaching mascot.

Each of these interaction types is 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 actions will be described in Sections 3.3, 3.4, and 3.5.

3.2 Identifying personality traits

In our system, 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 [13]. The NEO-PI-R constitutes five personality traits which we also refer to 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.

In addition, the enhanced scheme of Costa and McCrae (see Table 3.1) helps us in forming a 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,

Personality Traits	Personality Facets
Openness	Fantasy, aesthetics, feelings, actions, ideas, values
Conscientiousness	Competence, order, dutifulness, achievement striving, self-discipline, deliberation
Extraversion	Warmth, gregariousness, assertiveness, highly active, 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 [13, 28]

and vibration level (see Chapter 5). The questionnaire consists of 30 questions including all six facets of all five dimensions based on the NEO-PI-R measured scale [13]. The reason for not giving participants five questions consisting of the personality dimensions as a measurement is the desire to get more detailed feedback from them. Personality dimensions are too broad, and as a result, leads to less powerful predictions of behavior [30]. Moreover, participants may not be familiar with the 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 that 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 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 by 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. To associate the level of vibration with a certain personality trait,

we assume the vibration being conceptualized as a quality of self-expression that can be characterized as assertive behavior. 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 [6, 22, 31, 25] 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 system.

In the following study [6], the 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 [6] shows that neuroticism, extraversion, and conscientiousness factors are the main predictors of assertiveness having a p-value<.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.

	N	**E**	**O**	**A**	**C**
N	1.000				
E	-.423**	1.000			
O	-.047	-.001	1.000		
A	-.253**	.351**	.057	1.000	
C	-.356**	.387**	.091	.0263**	1.000
asseriveness	**-.253****	**.241****	**-.002**	**.064**	**.225****

Table 3.2: Correlation Coefficients between personality traits and assertiveness [6][1]

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 these personality traits the lowest predictor. Also, 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 [22, 31, 25] are also consistent with the results shown in this table. On the one hand, the high level of assertiveness and 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 communication with others. In

[1]The abbreviations for stars: ** p<.01 and * p<.05

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, to conclude 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. To assume which 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 [12] studied the relationship between personality traits and needs and provided PRF (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 [28], openness to experience personality trait is described as more open individuals with 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 an 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 the UN scale shows that open individuals want to understand different areas 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 assume that individuals high in openness personality traits generally behave in a relatively assertive manner (i.e they take the initiative, lead discussions) to broaden their knowledge. By relatively, we mean that the level of assertiveness needs to be less than in the case of the extravert and conscientiousness and more than in case of the 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.

Agreeableness is described as a personality trait that is perceived as sympathetic, kind, warm, generous, helpful, forgiving, friendly, unselfish, and gentle personality [28]. In addition to this definition, having examined 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

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

Table 3.3: Joint Factor Loadings for NEO-PI Factors and PRF Scales [12][2].

level of AG, DO. To summarize, 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 center 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 it 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 these who have a 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 the system are the following:

- L1 is assigned to the mascot with neuroticism personality trait where the vibration has the lowest level of duration (i.e 100 milliseconds per time).

[2]Note. These are varimax-rotated principal components. Decimal points are omitted; loadings above .30 are given in boldface. NEO-PI = NEO Personality Inventory; PRF = Personality Research Form.

- 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 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 favorite music as a badge of social identity to share information about themselves with others [8, 35]. Given that they see music as a tool for revealing one's personality characteristics [34], in our study, we assume 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 [37, 16, 46, 14]. However, the genre labels can be biased and subjective, meaning that the user or participant might have a different understanding of these genres [32]. 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 [33] were first who provided a categorization 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 [32]. The fact that preferences for each dimension 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 [16] studied 30 music styles and revealed eight categories. Schafer and Sedlmeier [37] 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 conceptualizing and measuring music preferences and personality traits.

We, now, take a close look at each dimension of the 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 genres 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 a 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 [36, 9, 15, 18, 23]. 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 to show a 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 the 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 weaker. 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 the above-mentioned studies. Thus, we are planning to make a weak assumption that individuals with 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 the Intense dimension. We believe that the knowledge of the negative relationship between these variables will aid us to eliminate the possibility that people might assign these personality traits to this music genre.

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

- Openness to experience will be linked with the 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 a 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, 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 [45] 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 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 the first scenario and the tablet in the second scenario, the lighting or the screen change 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 [26] found out the effect of color preferences on human behavior which, therefore, may help to determine personality traits. Herman Cerratto in his work [10] characterizes colors by dividing them into their positive and negative aspects. The following table 3.4 is adapted from various research papers [26, 10, 39] and summarizes the characteristics of the colors that we later apply to the design of the system.

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 [1, 38], the black color represents intense anxiety, fears, depression, upset, hostility, and the red color may connote facets that vary from happiness, excitement, intense, stimulating to aggression, hate, hostility. Some of these facets [12] belong to the neuroticism personality trait. Thus, in order to convey the **neuroticism 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 [10] 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 them as turquoise. Based on the reported aspects of these colors (see Table 3.4), we can associate turquoise with a **conscientiousness personality trait**. Especially, the characteristics of turquoise color such as clarity of thought, self-expression, self-sufficiency reported in Table 3.4 match the facets that constitute conscientiousness personality.

Yellow color signifies warmth, creativity, adventures, logic, openness to new ideas, freedom (see Table 3.4). According to Max Lüscher, this color refers to one's desire for development with which emotions and feelings are associated. Since openness personality portrays such facets as imagination, adventurousness, intellect, ideas, and so on [12], we assume that the meaning of yellow color matches these facets. Therefore, we expect a yellow color to convey **openness to an experiences personality trait**.

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: The meaning of colors adapted from the [26, 10, 1, 38] publications.

Even though some characteristics of red color also can connote extraversion personality, there are also some negative aspects of this color such as aggression, fearfully, hostility and so on which may also represent neuroticism personality traits. Thus, we decided to emphasize the negative side of red color by mixing it with black color, to highlight the neurotic personality trait even more. Meanwhile, for extraversion personality trait we decided to pick an 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 [10]. 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 a softer shade of pink can convey this person-

ality trait. Psychologically pink is associated with compassion, understanding, warmth, innocence, and calming aspects. The 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 traits [12]. 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 traits.

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 color is assigned to the mascot with the 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

3.6 Overview of the system based on the applied concepts

In this system, the mascot is a dynamic device that effects the state of other devices and the environment by its location in space. The tablet, smart lamps, and speakers are static devices with a fixed location. Since the mascot has an impact on the state of the interacted devices, the concept of personality is applied to each mascot. Figure 3.2 shows the interaction between social devices in a system.

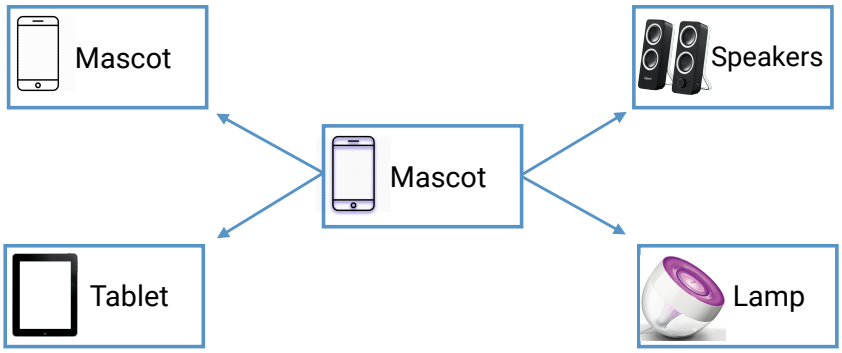


Figure 3.2: The visual representation of the interactions between social devices.

Mascot-mascot interaction.

When a person holding a mascot comes close to another mascot within 45 centimeters, they both start to vibrate with the specific duration of vibration based on the personality of an approaching mascot. Figure 3.3 shows the duration of vibrations in milliseconds associated with specific personality traits.

Mascot-speakers interaction.

When a mascot approaches the speakers within less than half meter, it starts to play a song according to the personality of the approaching mascot. All types of music are associated with the personality traits described in Figure 3.3. Also, since the experiments covered all other interaction types, we tested three songs from each music category. Because of the scale of an experiment and that participants had to fill 30 questions for each song, we kept the list of songs not too long to not overwhelm participants. The list of songs representing these music types are the following:

- Sophisticated:
  - Louis Armstrong - Panama. Released: 1946.
  - Frederic Chopin played by Rousseau - Nocturne In E Flat Major, Op. 9-No.2. Released: 2018.
  - Pink - Walk Me Home. Released: 2019.
- Contemporary:
  - Marvin Gaye - Let's Get It On. Released: 1973.
  - Eminem - Lose Yourself. Released: 2005.
  - Dj Suede - Thankful. Released: 2018.
- Unpretentious:
  - Bob Delevante - Penny Black. Released: 1999.
  - Tennessee River Authority - Sweet Home Alabama. Released: 2013.
  - OneRepublic - Counting Stars. Released: 2015.

Mascot-lamp and mascot-tablet interactions.

When a mascot approaches the lamp or a tablet within 45 centimeters, they change the lighting or screen color according to the personality of the interacted mascot. The associations between colors and personality traits are depicted in Figure 3.3. The corresponding HEX color codes are the following: blood-red -

Neuroticism	L-1 (100 ms)
Agreeableness	L-2 (200 ms)
Openness	L-3 (300 ms)
Conscientiousness	L-4 (400 ms)
Extraversion	L-5 (500 ms)

Neuroticism	Contemporary
Agreeableness	Unpretentious
Openness	Sophisticated
Conscientiousness	Unpretentious
Extraversion	Contemporary

Neuroticism	Blood-Red
Agreeableness	Pink
Openness	Yellow
Conscientiousness	Turquoise
Extraversion	Orange

Figure 3.3: The assignment of all personality traits with corresponding actions.

'#d90001', pink - '#ffbfc8', yellow - '#fdac22', turquoise - '#50ffab', and orange - '#fb4c0c'.

Figure 3.3 is a summary of all five personality traits with associated actions that we assigned to each mascot. The assigned personalities with associated actions are used purely for the implementation part in order to have a consistent system. In this study, we do not compare the executed system with the user's mental model. During a user study, we investigated the impact of predefined actions on the way how people perceive and associate with personality traits.

Chapter 4
Implementation

Section 4.1 assists the end-users to use the system. In Section 4.2 we will take a look at the project structure. Section 4.5 describes how the project can be deployed and configured. Section 4.3 covers system architecture, namely the communication protocols, frameworks, and APIs that are used in the system. Finally, in Section 4.4, we describe the technical requirements and hardware used in the system.

4.1 User Documentation

When a user runs the android application for the first time, it displays the form that a user has to fill in order to configure his phone. For that, the user needs to follow the steps:

- Choose the beacon ID that will help this application to measure the distance between devices.
- Give his mascot a custom name.
- Choose one out of five personalities displayed on the screen.

Figure 4.1 shows the user interface of the mascot application during the device registration.

After pressing the next button, such information as beacon ID, the type, name, and the personality of the device are sent to the server and saved in the database. Starting from here, no further user interaction with the mobile phone is needed, the user can walk around and approaching other devices such as other phones,

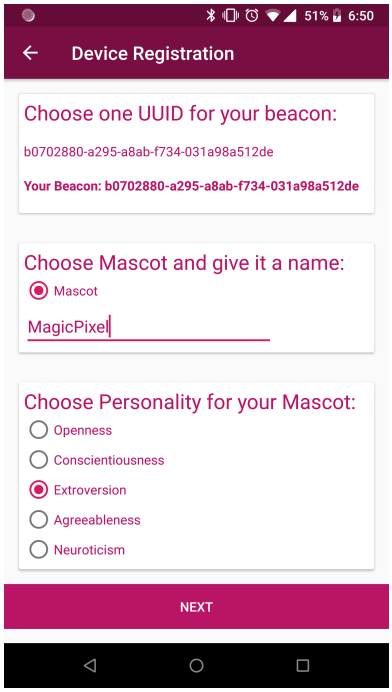


Figure 4.1: The screen capture of the user interface of the device registration page in mascot application.

lamps, speakers, and tablets. The application starts to measure the distance to all other beacons according to the users' movements and sends this information to a server.

4.2 Project Presentation

The project consists of the client-side with two Android applications for mascot i.e. phone and tablet. The server is responsible for coordinating client applications.

The `AutonomousSystemThesis` consists of three directories:

- `MyMascotApp`: The android application registers the phone in the system and measures the distance from the phone and to all beacon tags located in the room.
- `MyTabletApp`: The android application that is registering the tablet in the system and displaying colors according to the personality of approaching mascot
- `server`: allows the management of all devices and beacons, and the coordination of all client applications.

The project structure is demonstrated in Figure 4.2.

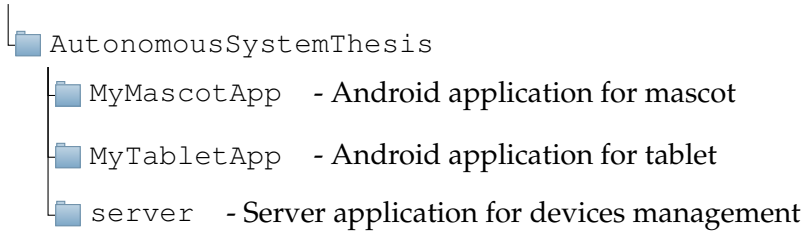


Figure 4.2: The folder structure of the whole system

4.3 System Architecture

For multi-device support used centralized architecture, where all devices inform the server about their state in real-time. Subsequently, the server changes the states of all other devices accordingly. Moreover, the centralized system has a simpler design that excludes any consensus problem. All devices communicate with each other through the server that makes decisions.

4.3.1 Module descriptions

`MyMascotApp` is an Android application that has the following responsibilities:

- The application registers the phone in the system, namely the ID of a beacon that it is attached, mascot custom name, and the personality of a mascot.
- The application measures the distance from the device-phone to all other beacons in the system.
- The application vibrates the phone with the vibration duration that the server sent to it.

`MyTabletApp` is an Android application that has the following functionalities:

- The application registers the tablet in the system, namely ID of a beacon that it is attached to it.
- Every second, the tablet application polls data from the server, where as a response it gets specific color code.
- The application changes the background color of a screen to a color that is retrieved from the server.

`server` is a server application that has the following features:

- Manages a database that consists of three tables (devices, distances, and personality).

- Implements controllers that handle the client requests such as post requests of device registration, distances, and get requests of required data from the database.
- Server checks whether the distance of all devices falls into the predefined distance range of the Proxemics theory.
- When the user reaches the lamp, the server requests Philips Hue API to change color based on the personality retrieved from the database.
- When the user approaches speakers, play audio files concurrently using the Audio File Play utility or `afplay`.

The folder structure of the server application is demonstrated in Figure 4.3.

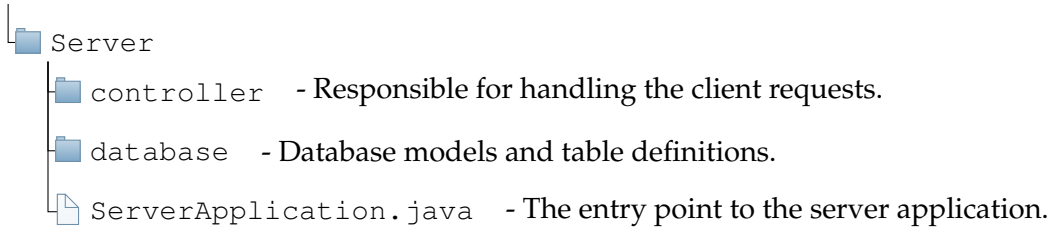


Figure 4.3: The folder structure of the server application

4.3.2 Software stack and protocols

The following programming languages, frameworks, and APIs were used to implement the system.

For client applications:

- Android framework with Java language.
  - NSD API - Network Service Discovery.
- AltBeacon Library.

For the server-side:

- Spring Framework with Java language.
- DNS-SD.
- Philips Hue API.
- Music Playback component.

4.3.3 Database and server

Network requests are handled by controllers using the Spring framework on the server-side. It also allows easy data access to simply connecting and working with the database.

For database management, we use an open-source relational database system known as PostgreSQL.

Database schema and models are defined using Hibernate - an ORM (object relation mapping) framework. Hibernate is also responsible for managing database tables in PostgreSQL. For the detailed instructions on how to set up the database and run the server see Appendix A.1- A.4.

4.3.4 Service discovery

The way android clients discover a server is by using mDNS implementation on Android called NSD API.

NSD API (Network Service Discovery) is an Android implementation of Multicast DNS. In order to make requests the Android applications need to know the IP address and port of services. NSD API helps the client to discover the server. `NSDHelper.java` module allows the client-applications to find an HTTP server in the local network that supports services that clients are interested in. In our case, we specified _socialiot._tcp type of service.

DNS-SD is an implementation of mDNS protocol on macOS. In this project, it is used to register and publish the server information, such as the port number and the service name. Here is an example of how it can be used to set up the `AutonamousThesisProject`:

```
1    dns-sd -R mythesis _socialiot._tcp local 8080
```

In the command specified above, ***mythesis*** is a service name; ***_socialiot._tcp*** is a service type; ***8080*** is a port number with domain type ***local***. The parameter _socialiot._tcp must match, since the client applications using NSD API will start looking for this specific service type.

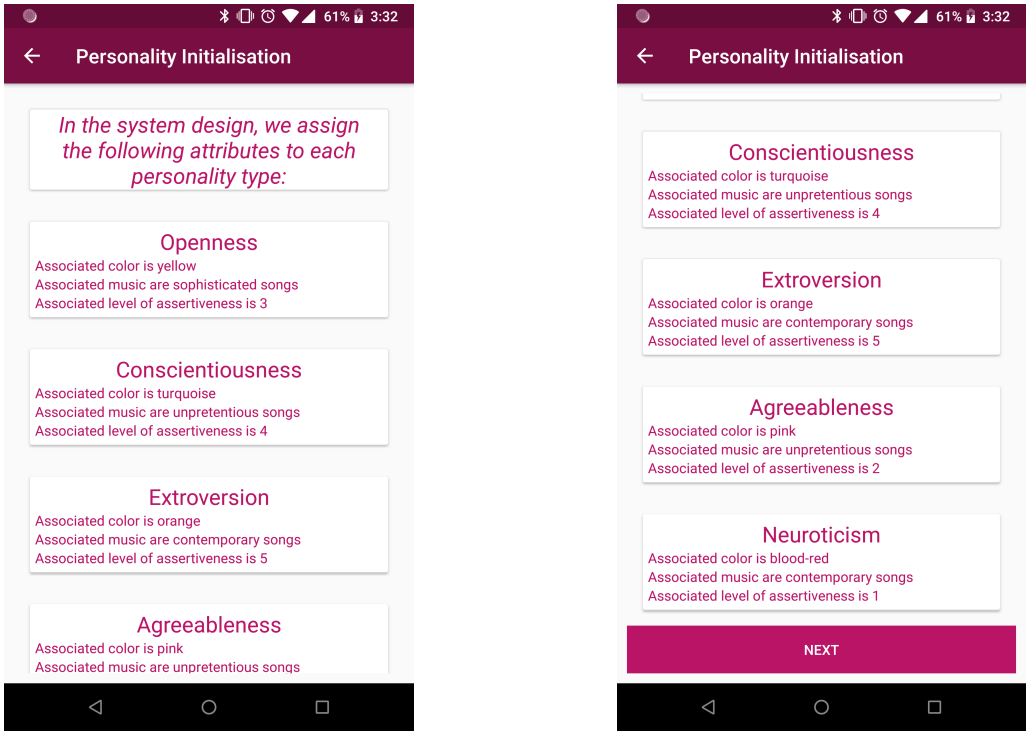
4.3.5 Registering devices in the system

Every user can register its mascot in the system by running `MyMascotApp` and following the instructions on the screen. The detailed description of how to configure the smartphone for the mascot application is given in Section 4.1.

The registration of such devices as the tablet, the lamp, and the speakers must be performed by the developers using `MyTabletApp`. So, the tablet application is the device that registers all social devices with a fixed location. Also, the tablet application registers in the system all five personality traits with their associated

actions such as color, music type, and the vibration level. The registration of all devices and the personality traits can be performed by following the instructions on the screen. Figure 4.4 is the screenshot of the tablet application that shows the information of the data that will be sent to the server about the personality traits and associated actions.

You can also find the step-by-step instructions on how to run both the mascot and the tablet applications in Appendix A.5.



(a) The top of the page.

(b) The bottom of the page.

Figure 4.4: The screen capture of the user interface of the personality registration in tablet application.

4.3.6 Measuring distance between devices

AltBeacon Library is a library that provides APIs to interact with beacon tags. Beacon tags are broadcast-only Bluetooth Low Energy (BLE) radio transmitters which communicate by transmitting their proximity to the Android applications that supports BLE technology. With the help of AltBeacon Library, `MyMascotApp` detects beacon tags nearby and uses this information to measure the distance. The accuracy precision that `MyMascotApp` can measure the distance is around a half meter with a ten-second margin for new positions.

4.3.7 The communication between two mascots

The communication between devices and the workflow of the system is described in Figure 4.5. The figure describes the interaction between two phones and step by step including requests that clients and a server send each other.

After the client application finds the server in a local network, it looks for all nearby beacon tags. When the user types the custom name for his mascot, the personality, and the beacon, the client application registers all this information in the system. The client application starts to measure the distance to all beacon tags that are located near other devices. The distance information is constantly sent to the server, where as soon as mascot approaches the other mascot within 45 cm, the server retrieves the personality information of approaching mascot with the associated vibration duration from a database. Afterward, the server passes the vibration information to the client, which in turn triggers the phone to vibrate with an invoked vibration level.

4.3.8 Working with lights

The interaction between mascot and lamp happens using Philips Hue API.

Philips Hue API helps the server to control the hue system. The workflow of the mascot-lamp interaction is similar to the mascot-mascot interaction (see Figure 4.5) and all other interaction types. The client measures the distance from the Android application to all beacons in the system and constantly sends this information to the server. The only difference is the use of Philips Hue API. When the server encounters that the distance between mascot and lamp fits the Proxemics theory i.e. x<45, it retrieves such parameters as hue, brightness, and saturation from the database and sends them to the Hue bridge through Philips Hue API. With the help of API, it can directly input commands such as changing light color which in turn will trigger the lamp to change its lighting color. All Philips Hue lamps need to be connected to the Philips Hue Bridge via an open standards protocol called ZigBee Light Link which in turn helps devices to communicate with each other via the internet. Figure 4.6 shows the visual representation of the mascot interacting with the lamp.

The important note for the implementation part is that all devices such as Philips Hue Bridge, server, phones, and tablet have to be connected to the same network.

4.4 Technical Requirements and Hardware

The system comprises of the following devices: the phone with an attached beacon tag, the lamp with a beacon tag, the tablet with a beacon tag, and speakers with a beacon tag. Using the beacon tags that are located right next to devices,

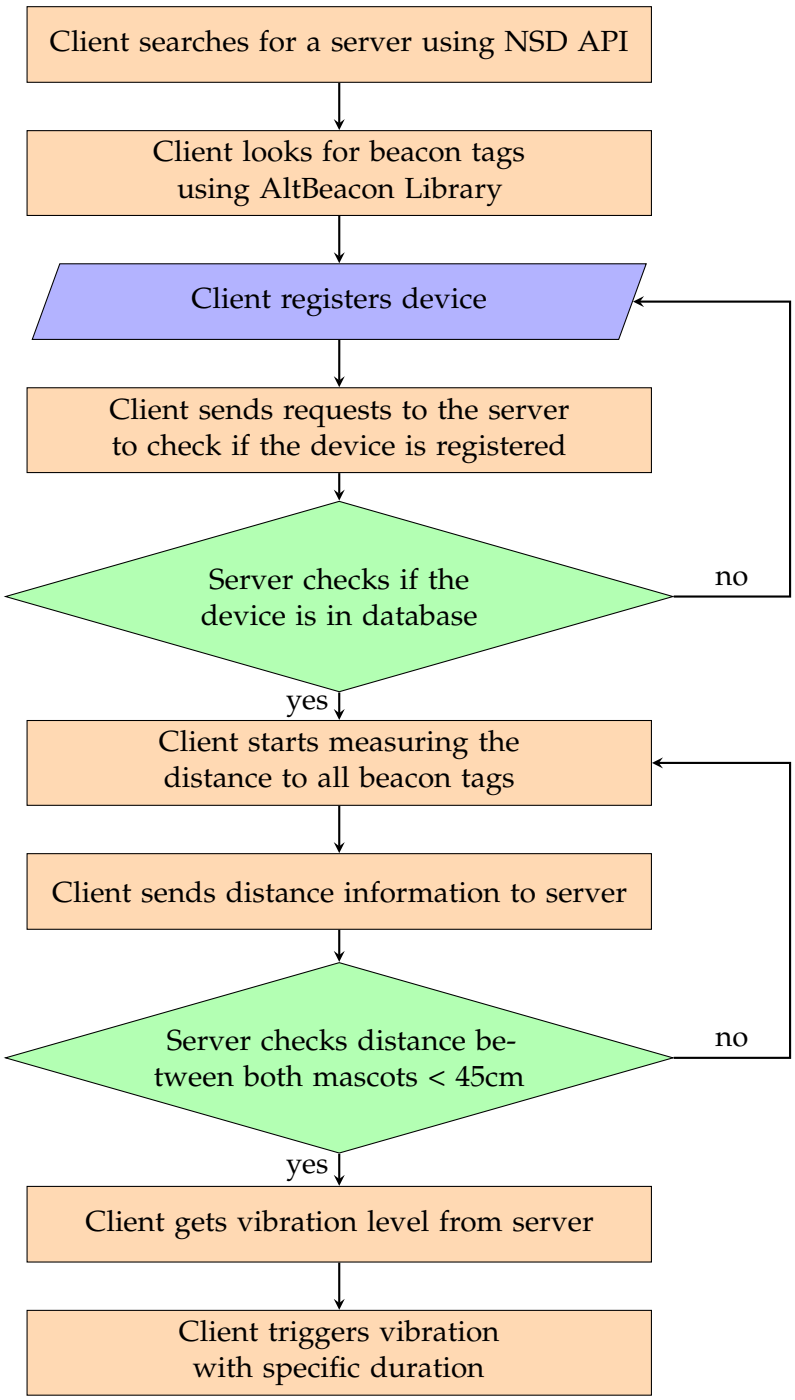


Figure 4.5: The interaction between two phones and a server with the libraries and APIs that it is using.

Android applications measure the distance from themselves to all other devices. Additionally, the following prerequisites have to be met:

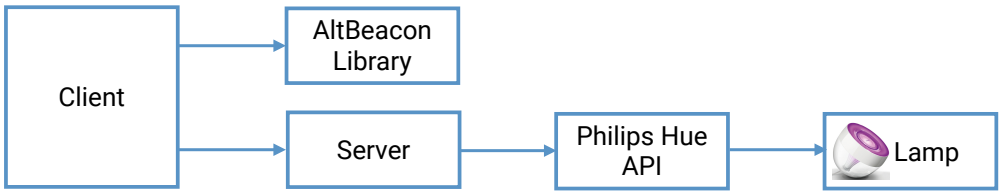


Figure 4.6: Visual representation of mascot-lamp interaction.

- Philips Hue lamps to be connected to the local network.
- The android application with the location and the Bluetooth permissions granted.
- The android application the operating system in order to use Bluetooth BLE must be higher than 6+.
- The server must be running on macOS to use `afplay` utility.

4.5 Configuration

The `AutonomousSystemThesis` can be configured in the following way:

To run the server, we pass the following arguments in the terminal:

```
1 mvn spring-boot:run -e -X -Dspring-boot.run.arguments=–hueUsername=<hue_username>,–
    hueIPAddress=<hue_ip_address>,–musicFolderPath=<music_folder_path>
```

The Spring Boot Maven Plugin is used to run spring boot applications and generate build information.

Here, *<hue_ip_address>* is an IP address assigned to our Philips Hue bridge. Since you will have your smart lamps, you need to discover the IP address of your bridge. The quickest way to discover it is to visit this website [3] which will display the internal IP address of your bridge. The username can be obtained by visiting the following website:

`https://<bridgeIPaddress>/debug/clip.html`

where *<bridge ip address>* is the internal IP address of your bridge. The step-by-step instructions on how to get username and IP address of the Philips Hue bridge is described in Appendix A.3. The more detailed guideline on how to discover the IP address and username of your bridge you can find in the official Philips Hue Documentation[4].

[3] `https://discovery.meethue.com`
[4] `https://developers.meethue.com/develop/get-started-2/`

The <*music_folder_path*> is the path to all songs played when mascot approaches the speakers. This path can be configurable and depends on where the project is saved.

The fully documented configuration of the database, server, and client applications are described in Appendix A.

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 the social sciences and 70% from formal sciences. Moreover, the participants had 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).

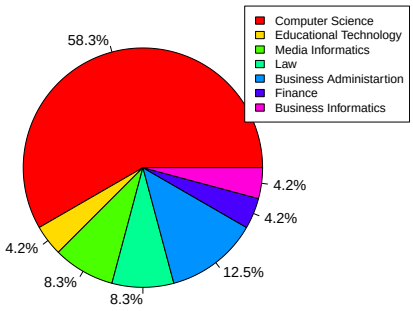


Figure 5.1: Participants' majors obtained from Demographics questionnaires

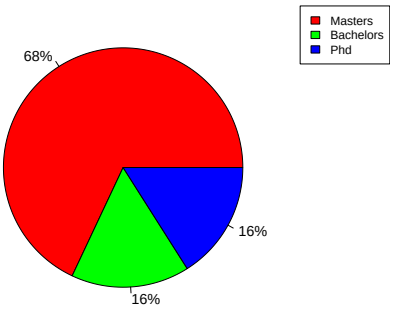


Figure 5.2: Participants' education level obtained from Demographics questionnaires

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).

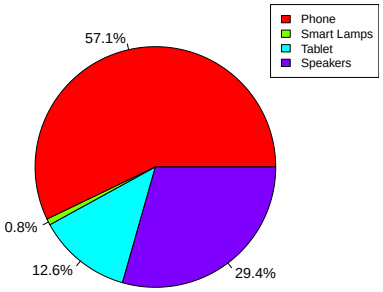


Figure 5.3: Participants' use of devices obtained from Demographics questionnaires.

Overall, the experience level with the 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 was a 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 a tablet and smart lamps.

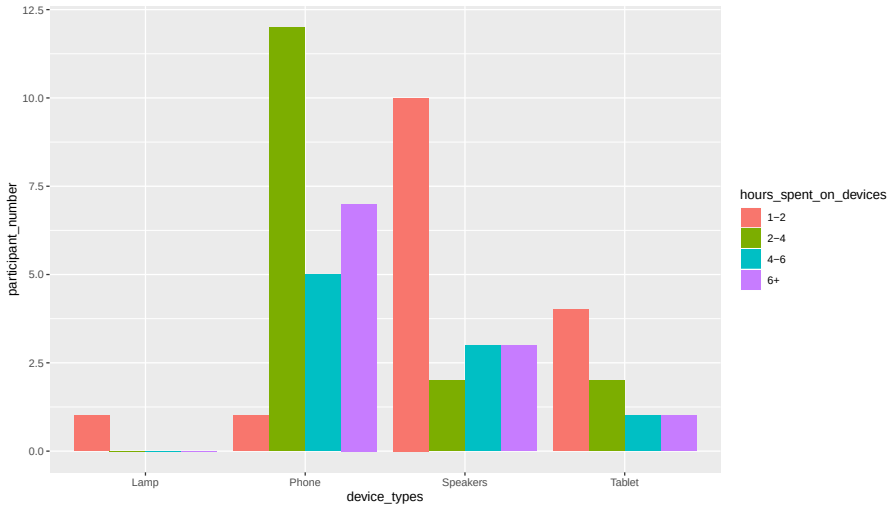


Figure 5.4: Participants' device use in hours obtained from Demographics questionnaires.

In addition, Table 5.1 describes the participants' preference for the music genres. The more fluent the participant would be with the music, the more rapid becomes the assessment of genre-specific features [17]. Moreover, if the majority of participants prefer to listen to or like a certain genre of music, it may result in biased opinions. The mascot that triggers genre that they prefer may give participants a more positive impression about their personality. Thus, the main reason for gathering data regarding participants' music preferences was to see whether the liking factor affects the study or not.

According to the One-Sample t-test with $p>.05$, 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, the following aspects were described to the participants:

- The implemented system introducing the devices used in this study.
- The key idea of a study.
- The purpose of the experiment.
- The goal of the participants during the experiment.

	t-value	df	mean	p-value	95 percent confidence interval	
					lower	upper
Country	1	24	.04	.32	-.04	.12
Pop	3.7	24	.36	.001	.15	.57
Hip-hop	1.8	24	.12	.08	-.02	.26
Rap	1	24	.04	.33	-.04	.12
Jazz	2.4	24	.2	.022	.03	.37
Classic	3.1	24	.28	.005	.09	.47
Rock&Roll	1	24	.04	.32	-.04	.12

Table 5.1: T-test for participants' familiarity with music genres used in our study[5].

- The number of phases and the overall duration of the experiment.

In general, we have 4 phases for each interaction type such as mascot-mascot, mascot-lamps, mascot-tablet, and mascot-speakers. The order of all phases was counterbalanced by using Latin Square. Each phase consists of 5 videos with a duration of 20 seconds, except for mascot-speakers interactions where we have 9 videos with duration 40 seconds long. Moreover, for each participant, there was 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 of 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 smartphone 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 the 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 to assess the personality of a mascot based on the video that they have seen and the vibration that they have felt.

[5]Note: Decimal points are omitted.

Figure 5.5 shows the screenshots of the videos that participants watched during each phase of the experiment. The pictures at the top represent the mascot-mascot and the mascot-lamp interaction and the pictures at the bottom display the mascot-tablet and mascot-speakers interactions.

Figure 5.5: The snapshots of videos from each case-study presented to the participants[6].

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 not to affect the opinion of the participants. Giving personal questions up-front, respondents could 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 an hour and a half, depending on the speed of participants 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 the devices, but instead, we showed participants videos containing the interaction between social devices. The main reason for that was the distraction of participants on various factors.

[6]During the experiments, the faces in the videos were not hidden, for this document we hide faces with a nice smiley icon.

From an implementation perspective, the application using BLE - low-energy Bluetooth technology measures the distance between objects with high accuracy and precision. It can measure the distance from the smartphone to the beacon tag with a margin error of 0.5 meters which is a very good result[7]. However, the step of a 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 might distract them by focusing on their behavior rather than on the assessment of the mascot's personality, we decided to use videos in our experiments. Moreover, these limitations are present in other applications that use BLE for calculating the distance.

Another factor that affects the study might be the vibration level during the mascot-mascot interaction. In this study, we focus only on the duration of the vibration varying from 100 to 500 milliseconds per time. Whenever a user interacts with the other mascot, the smartphone starts to vibrate with a particular duration. Restricting participants to interact with the mascots with a specific number of times, might also shift their focus, i.e instead of paying attention to the mascot's behavior, they will try to control their behavior. Thus, to eliminate possible distracting factors, we decided to film all interactions between a user and social devices, and show these videos to the participants.

Another design decision was instead of showing one video with all interaction types, we split it into five short videos for mascot-lamp, mascot-table, mascot-mascot, and into nine short videos for mascot-speakers interaction. Despite the fact that the system supports multidimensional device interactions i.e multiple mascots can interact with a lamp, a tablet, speakers, and other mascots at the same time, we decided to split interaction types into four phases. The main goal was to help participants to focus on one interaction and make it easier for them to evaluate the personality of mascot based on a specific interaction type.

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 for displaying all videos.
- Tablet to fill the questionnaire in the google forms.
- Nexus One smartphone 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

[7] https://altbeacon.github.io/android-beacon-library/distance-calculations.html

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, and two CSV files for demographic questionnaire).

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 the mascot-lamp phase, each participant watches 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 and can 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 this study, the independent variables (IVs) are factors that are triggered due to the behavior of a mascot. For each case-study, we have a different number of IVs aka factors which are the followings:

- For mascot-lamp case-study, there are five variables: turquoise, blood-red, yellow, orange, and pink lighting colors.
- For mascot-mascot case-study, five vibration levels: 100, 200, 300, 400, and 500 milliseconds per time.
- For mascot-speakers case-study, there are nine songs categorized into three variables: Sophisticated, Contemporary, and Unpretentious music categories.
- For mascot-tablet case-study, there are five variables: yellow, orange, turquoise, blood-red and pink background screen colors.

We do not compare case-studies with each other, where one interaction type has a more effect on the measurements of the personality trait of mascots than the other type. 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 questions that we asked are the following:

- Is the perception, namely, the measurements of the mascot's personality affected by these factors?
- When they are affected, which personality traits does each factor convey?

5.6 Measures

As measurements of the experiments, we used questionnaires that were given after each video watch. Overall, there were 24 questionnaires with five questionnaires in three phases and nine questionnaires for the mascot-speakers interaction phase. Each questionnaire consists of 30 questions portraying six facets of each personality based on the NEO-PIP survey. The questionnaire items were answered using a Likert-scale i.e. 'Very inaccurate', 'Inaccurate', 'Neutral', 'Accurate', 'Very accurate' rates.

Chapter 6
Results

This chapter presents the statistical analysis where the results for each case-study, such as mascot-speakers, mascot-lamp, mascot-mascot, and mascot-tablet are reported in separate sections. Each section consists of two subsections describing tests for two studies: the within personality traits study and the within conditions such as types of music, lighting colors, vibration levels, or screen colors.

Since the gathered data are ordinal and the outcome is not normally distributed, the analysis of all case-studies is focused on the non-parametric tests. Specifically, since each case-study consists of more than two compared groups (i.e. each described in Sections 6.1, 6.2, 6.3, and 6.4) and data is compared against a within-subject factor (i.e. each participant tested all conditions), the Friedman tests followed by the Wilcoxon Signed-rank tests are used for statistical analysis.

For each study, the Wilcoxon tests compare 10 groups with each other except from a study one for the mascot-speakers interaction where it compares 6 groups. Since there are a large number of statistical tests, some of the results may have $p<.05$ purely by chance. Thus, in order to control the family-wise error rate, the Bonferroni correction is used. This adjustment method will divide all p-values in 10 and 6 according to the number of compared groups.

In addition, in each subsection, the results of Wilcoxon tests after Bonferroni correction are displayed graphically using box plots. The complete tables of these tests can be found in appendices (see Appendix C).

6.1 The analysis of the mascot-speakers interaction

This section describes the mascot-speakers case-study, where is analyzed the effect of music on the measurement of the mascots' personality traits. As discussed

in Section 3.4, the choice of the music genre is based on the MUSIC pattern. For statistical analysis, all songs that were used in the experiments are distributed into the following categories:

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

In addition, the raw data consists of 30 personality facets for each music condition (see Section 3.2). During analysis, all facets are grouped into five personality traits. Thus, each personality trait consists of the mean scores given for six personality facets. The analysis of the mascot-speakers interaction is performed by two studies.

In the first study, we compare three types of music within each personality trait to find the effects of each music on participant's measurements of mascot's personality. In the second study, the second iteration on the same dataset is performed by comparing five personality traits within each music category.

Figure 6.1 depicts both studies for mascot-speakers interaction where vertical arrows represent the first study i.e. analysis of the within personality trait and horizontal arrows represent the analysis of the within condition study. In the first study, we determine the effect of music on the measurements of personality traits. Thus, we compare all music types with each other within a specific personality trait. It results in music that is significantly different and rated higher in comparison to all other music types. Since we compare all conditions within each personality separately (see vertical arrows in Figure 6.1), one music may be associated with multiple personality traits. We aim to conclude with one music condition being associated with a specific personality trait. In the second study, we compare all personality traits within each music type (see horizontal arrows in Figure 6.1) which helps us to find personality trait that is conveyed by specific music most.

In addition, we apply the same statistical tests for each case-study (see Sections 6.2, 6.3, and 6.4).

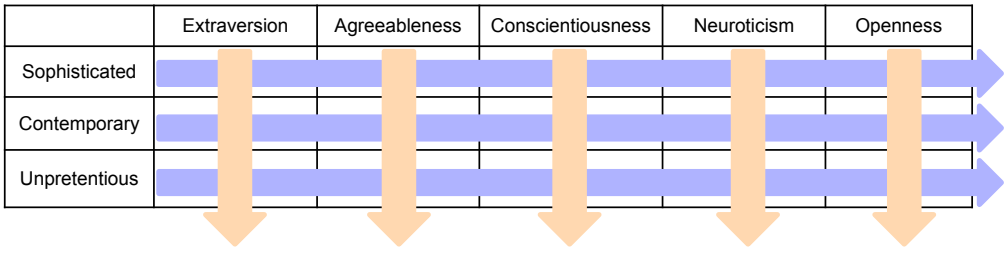


Figure 6.1: Visual representation of compared groups in study-1 for vertical arrows and study-2 for horizontal arrows in case of mascot-speakers interaction.

In this chapter, the abbreviations for all tables (i.e. Tables 6.2 - 6.16,) and figures (i.e. Figures 6.2 - 6.9) are described in the footnotes [1] [2] [3] [4] [5].

6.1.1 The analysis of the 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. Compared factors are sophisticated, contemporary, and unpretentious music.

Extraversion. The Friedman tests show the significant effect of all predefined music categories on the ratings of extraversion personality with p<.01, df=2 (see Table 6.1). The Wilcoxon tests revealed that the significant difference is concentrated on contemporary music compared to all other categories with p_{adj}<.01 (see Figure 6.2). According to Table 6.2, the contemporary category has the highest median with med = 3.9.

Agreeableness. All three categories significantly influenced participants' measurements of mascot's agreeableness personality trait with p<.01, df=2 (see Table 6.1). The main difference fault in the following groups: sophisticated and contemporary; contemporary and unpretentious with p<.01. According to Figure 6.2, the boxplot distinguishes most of the contemporary samples from the other two categories having very low ratings to convey the agreeableness personality trait.

Conscientiousness. There is a significant difference in all music categories within conscientiousness personality trait with p<.05, df=2 (see Table 6.1. Scores for mascot being measured as conscientiousness personality trait increased sharply during playing sophisticated and unpretentious (med = 3.2) music in comparison to scores for contemporary music (med = 2.8) The Wilcoxon test confirms the statistically significant difference between the following groups: sophisticated and contemporary (p_{adj}<.01); unpretentious and contemporary (p_{adj}<.05).

Neuroticism. Overall, all three categories have an effect on the measurement of mascot's neuroticism personality with p<.01, df=2 (see Table 6.1). Table 6.2 shows that the scores given for contemporary music while assessing neuroticism personality traits are the highest with med = 3.1 compared to the other two categories. Moreover, there are two significant differences between groups: sophisticated and contemporary; contemporary and unpretentious music with p_{adj}<.01 (see Figure 6.2).

Openness. Table 6.1 reveals a substantial difference between all three music types

[1] The abbreviations for stars: ** p_{adj}<.01 and * p_{adj}<.05

[2] The abbreviations for personality traits: ^{E} extraversion, ^{A} agreeableness, ^{C} conscientiousness, ^{N} neuroticism and ^{O} openness personality trait

[3] The abbreviations for music types: ^{S} sophisticated, ^{C} contemporary, ^{U} unpretentious music

[4] The abbreviations for vibrations: ^{L1} vibration level-1, ^{L2} level-2, ^{L3} level-3, ^{L4} level-4 and ^{L5} level-5

[5] The abbreviations for colors: ^{Y} yellow, ^{O} orange, ^{T} turquoise, ^{B} blood-red and ^{P} pink color

within an openness personality trait. Particularly, there is a good separation of the sophisticated with med = 3.8 and max = 4.9 from other music categories (see Table 6.2). There is a large difference between sophisticated and contemporary, and sophisticated and unpretentious with p_{adj}<.01 (see Figure 6.2).

Personality traits	χ^2	**df**	**p**
Extraversion	21.4	2	p<.01
Agreeableness	29.0	2	p<.01
Conscientiousness	6.5	2	p<.05
Neuroticism	15.1	2	p<.01
Openness	25.8	2	p<.01

Table 6.1: The results of the Friedman test for five personality traits in the case of mascot-speakers interaction.

	E			**A**			**C**			**N**			**O**		
	S	C	U	S	C	U	S	C	U	S	C	U	S	C	U
Min	1.4	3.2	2.2	2.9	1.1	2.5	2.4	1.0	1.9	1.0	2.3	1.3	3.1	2.0	2.5
Med	3.1	3.9	3.3	3.3	2.9	3.7	3.2	2.8	3.2	2.4	3.1	2.5	3.8	2.9	3.4
Max	3.8	5.0	4.0	4.7	4.3	4.7	4.6	4.0	4.7	3.4	4.5	3.2	4.9	4.0	4.7

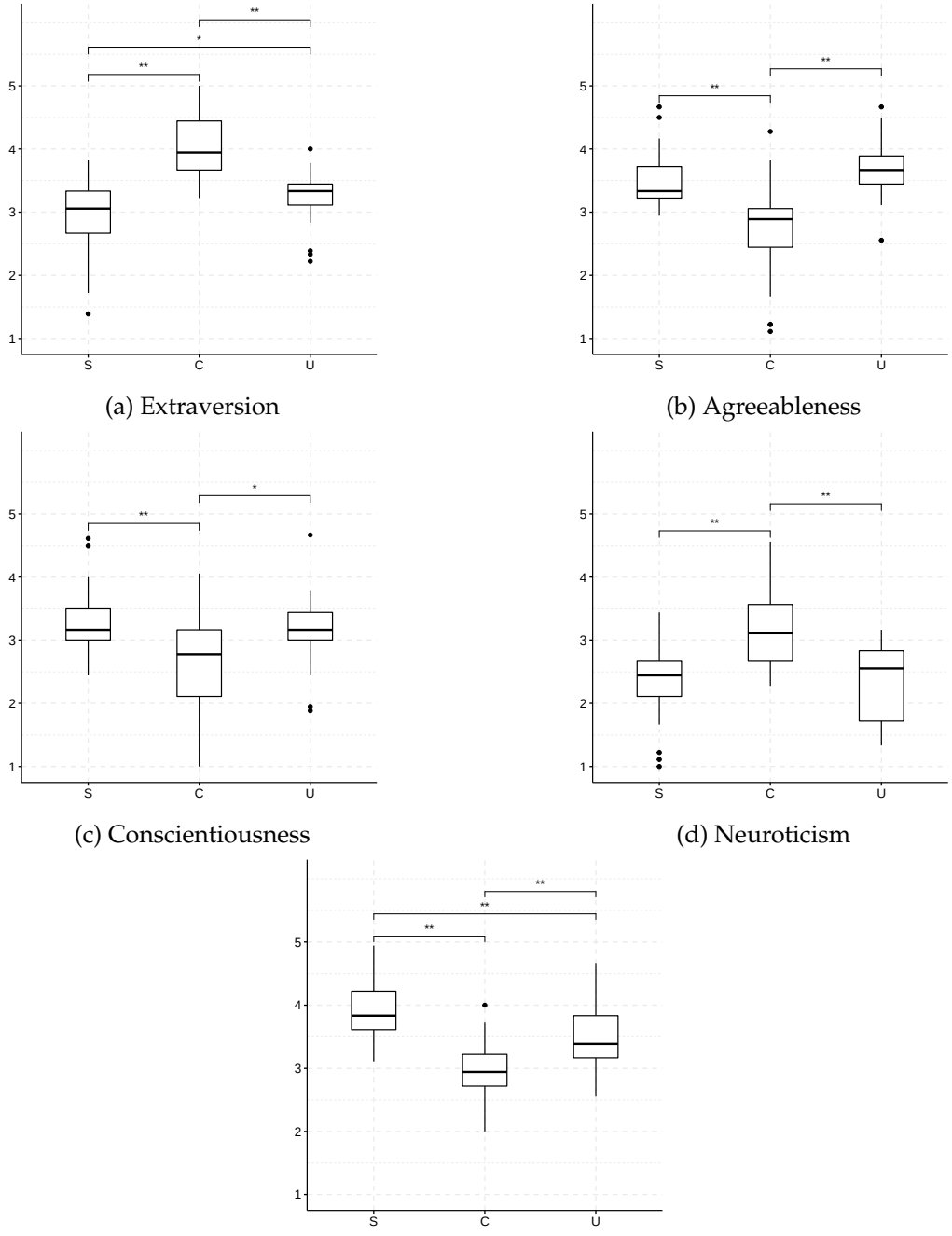
Table 6.2: A summary table of the median, minimum, and maximum rates given for each personality trait.

6.1.2 The analysis of the within music category study

In this study, we analyze the effect of each music category, particularly on how each personality trait is assessed differently within one music condition. Compared groups are extraversion, agreeableness, conscientiousness, neuroticism, and openness personality traits.

Sophisticated. On average, sophisticated music has a significant effect on all five personality traits with p<.01, df=2 (see Table 6.3). When sophisticated is played, in comparison to all the personality traits, openness is rated very high with med = 3.8, and neuroticism is rated very low with med = 2.4 (see Table 6.4). According to Figure 6.3, openness to experience shows a significant difference from all other personality traits in the group.

Contemporary. The Friedman test shows a significant difference between the ratings of all personality traits and contemporary music with p<.01, df=2 (see Table 6.3). According to Figure 6.3, for mascot triggering contemporary music, there is a clear separation of extraversion samples from all other personality traits with p_{adj}<.01. The median value for extraversion is very high being med = 3.9 compared to all other personality traits (med $\approx$ 3).



(a) Extraversion

(b) Agreeableness

(c) Conscientiousness

(d) Neuroticism

(e) Openness

Figure 6.2: A boxplot for the mascot-speakers interaction in study-1. Stars represent the significance of p_{adj} after Bonferroni correction.

Unpretentious music substantially affects the measurements of all personality traits with p<.01, df=4 (see Table 6.3). Based on Wilcoxon tests, neuroticism personality trait is rated very low when unpretentious music was played with

p_{adj}<.01 (see Figure 6.3). The median values of all other personality traits slightly differ from each other, condensed around 'neutral' rating which is med $\approx$ 3 (see Table 6.4).

Music categories	χ^2	**df**	**p**
Sophisticated	66.6	4	p<.01
Contemporary	44.4	4	p<.01
Unpretentious	57.4	4	p<.01

Table 6.3: The results of the Friedman test for all music categories in the case of mascot-speakers interaction.

	Sophisticated					**Contemporary**					**Unpretentious**				
	E	A	C	N	O	E	A	C	N	O	E	A	C	N	O
Min	1.4	2.9	2.4	1.0	3.1	3.2	1.1	1.0	2.3	2.0	2.2	2.5	1.9	1.3	2.5
Med	3.0	3.3	3.2	2.4	3.8	3.9	2.9	2.8	3.1	2.9	3.3	3.7	3.2	2.5	3.4
Max	3.8	4.7	4.6	3.4	4.9	5.0	4.3	4.0	4.5	4.0	4.0	4.7	4.7	3.2	4.7

Table 6.4: A summary table of the median, minimum, and maximum rates given for each music category.

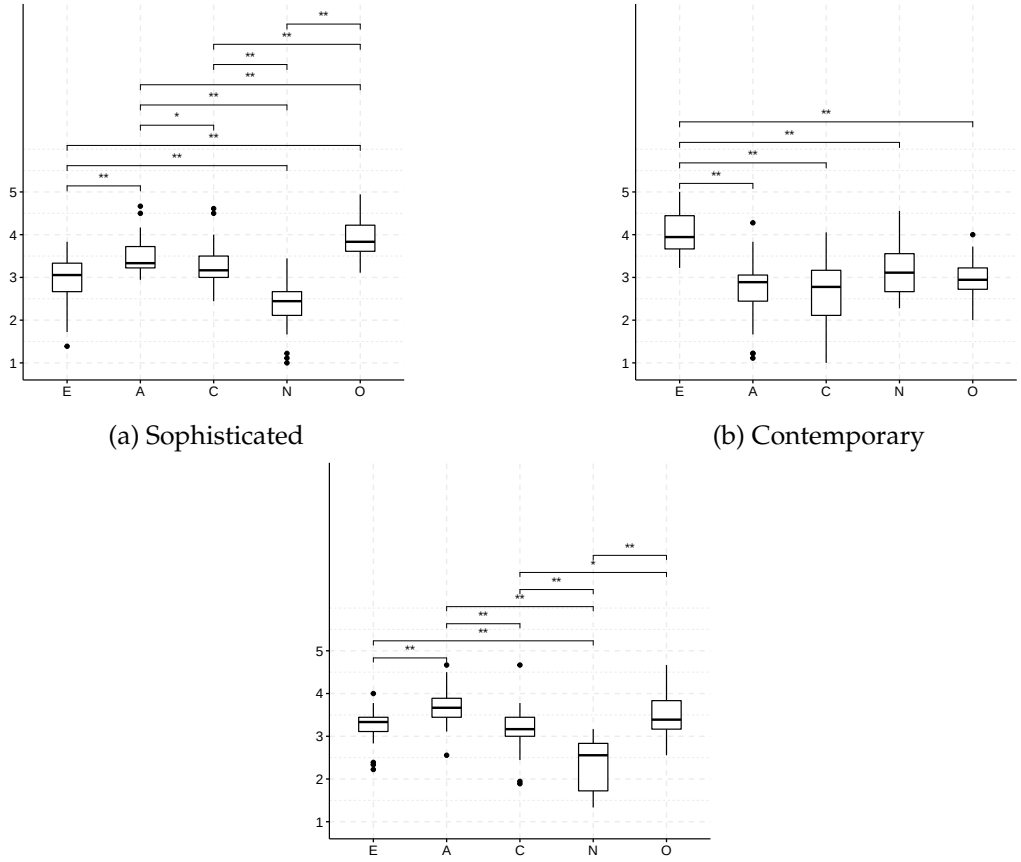
6.2 The analysis of the mascot-lamp interaction

This section investigates the effect of the lighting color on the measurement of the mascots' personality traits. Subsection 6.2.1 describes the results for the within personality study and subsection 6.2.2 for the within the lighting color study.

6.2.1 The analysis of the within personality trait study

In the first study, that compared factors are orange, turquoise, yellow, blood-red, and pink lighting colors.

Extraversion. According to Table 6.5, all lighting colors significantly influenced the measurements of extraversion personality with p<.01, df=4. Figure 6.4 shows where exactly this effect is concentrated reporting six groups of colors with p_{adj}<.01. Yellow showed a significant difference compared to turquoise, blood-red and pink lighting colors being rated very high on conveying extraversion personality trait. In contrast, the mascot interacting with blood-red lighting was rated very low on being an extravert. This is also reported in Table 6.6, the blood-red color having the lowest median (med = 1.7, max = 4.5, min = 1.0) and yellow having the highest value (med = 3.7, max = 4.8, min = 2.3) for extraversion personality.



(a) Sophisticated

(b) Contemporary

(c) Unpretentious

Figure 6.3: A boxplot for the mascot-speakers interaction in study-2. Stars represent the significance of p_{adj} after Bonferroni correction.

Agreeableness. There is a significant impact of lighting colors and the participants' measurements of agreeableness personality with p<.01 (see Table 6.5) According to Figure 6.4, in comparison to all other colors, mascots triggering blood-red and orange lighting are rated very low to have an agreeableness personality (p_{adj}<.01). Moreover, Table 6.6 shows that compared to all other colors, blood-red has the smallest median with med = 2.0. The median values, in descending order, for pink, turquoise, and yellow lights are approximately similar with med = 4.0, med = 3.5, and med = 3.7 respectively.

Conscientiousness. The Friedman test shows a statistically significant effect of all predefined lighting colors on the ratings of conscientiousness personality (see Table 6.5). The Wilcoxon tests show that effect is noticeable when we compare mascot that triggers blood-red and orange with ones that triggered turquoise, yellow, pink colors (see Figure 6.4). In fact, the mascot interacting blood-red and orange were assessed as being very low on the conscientious personality trait. Table 6.6 indicates that blood-red has the lowest median (med = 2.2), whereas

turquoise, pink and yellow have relatively similar high medians (med = 3.7, med = 3.5, med = 3.5 respectively). The latest values show that the mascot triggering these colors is rated high on having orderly, dutiful, disciplined, and other facets that constitute conscientiousness personality.

Neuroticism. Overall, there is an impact of the predefined colors on the ratings of the neuroticism personality with p<.01 reported in Table 6.5. The blood-red color showed a significant difference in rating neuroticism comparing to all other colors with p_{adj}<.01 (see Figure 6.4). Moreover, blood-red presents the highest values with med = 4.3, max = 5.0, min = 3.2 (see Table 6.6).

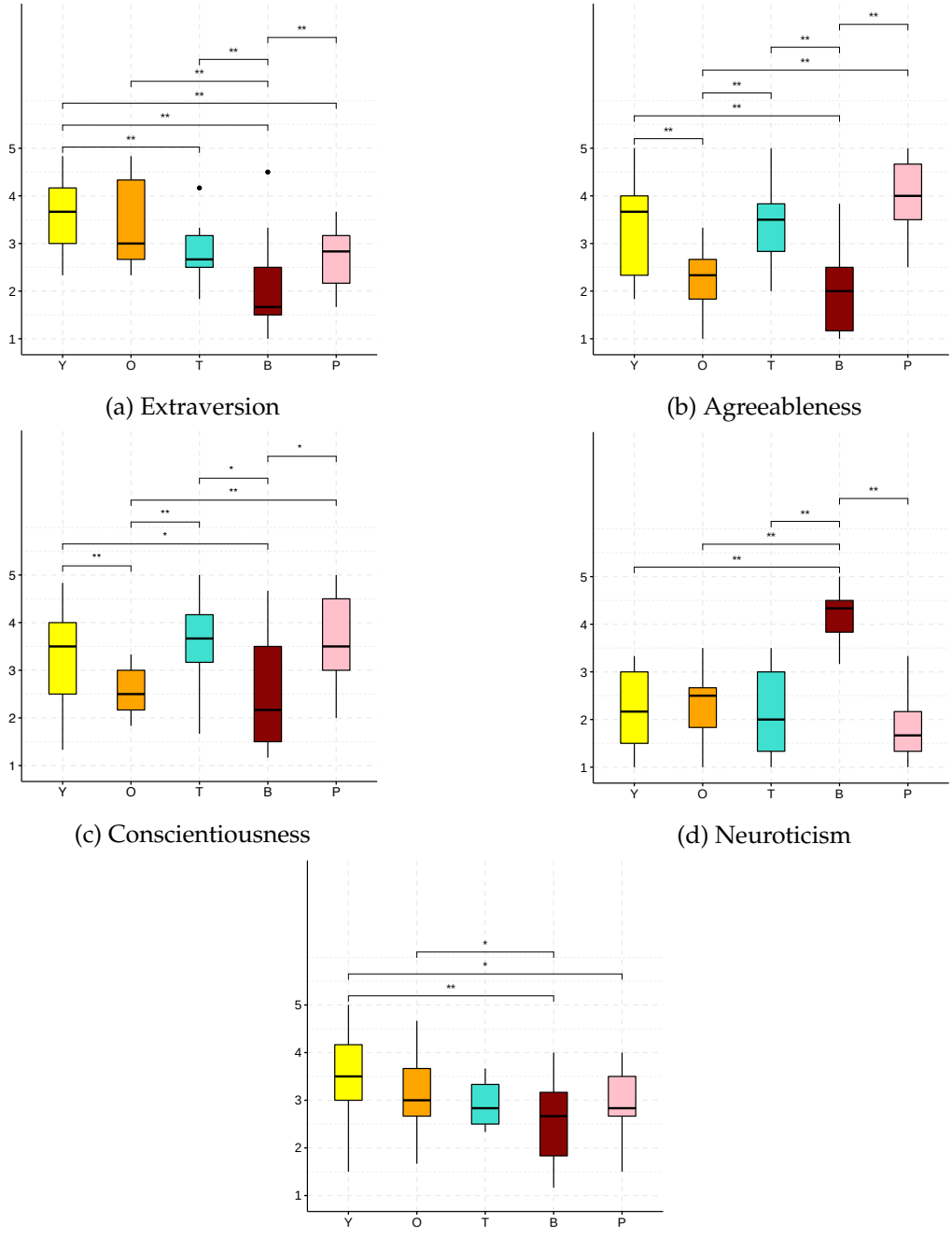
Openness. There is a significant difference of all colors within openness personality with p<.01 (see Table 6.5). The main differences are concentrated between the following groups: yellow and pink; yellow and blood-red; blood-red and orange with p_{adj}<.01 (see Figure 6.4). Table 6.6 shows the similarity of the median values for all colors concentrating around neutral attitude for mascot being measured as openness which is represented by med $\approx$ 3.

Personality traits	χ^2	**df**	**p**
Extraversion	40.0	4	p<.01
Agreeableness	56.4	4	p<.01
Conscientiousness	25.8	4	p<.01
Neuroticism	52.4	4	p<.01
Openness	18.2	4	p<.01

Table 6.5: The results of the Friedman test for all personality traits for the first study in the case of mascot-lamp interaction.

	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	1.8	1.0	2.0	1.0	2.5	1.3	1.8	1.7	1.2	2.0
Med	3.7	3.0	2.7	1.7	2.8	3.7	2.3	3.5	2.0	4.0	3.5	2.5	3.7	2.2	3.5
Max	4.8	4.8	4.2	4.5	3.7	5.0	3.3	5.0	3.8	5.0	4.8	3.3	5.0	4.7	5.0
	Neuroticism					**Openness**									
	Y	O	T	B	P	Y	O	T	B	P					
Min	1.0	1.0	1.0	3.2	1.0	1.5	1.7	2.3	1.2	1.5					
Med	2.1	2.5	2.0	4.3	1.7	3.5	3.0	2.8	2.7	2.8					
Max	3.3	3.5	3.5	5.0	3.3	5.0	4.7	3.7	4.0	4.0					

Table 6.6: A summary table of the median, minimum, and maximum rates given for each personality trait.



(a) Extraversion

(b) Agreeableness

(c) Conscientiousness

(d) Neuroticism

(e) Openness

Figure 6.4: A boxplot for the mascot-lamp interaction in study-1. Stars represent the significance of p_{adj} after Bonferroni correction.

6.2.2 The analysis of the within lighting color study

The second study considers the effect of the lighting color on how each personality trait is assessed within one color condition. Compared groups are five personality traits such as extraversion, agreeableness, conscientiousness, neuroticism, and openness.

Yellow. The Friedman test shows a significant difference in the ratings of each personality trait within yellow lighting color with $p<.01$, df=4 (see Table 6.7). When mascot triggers yellow light, the difference is concentrated on neuroticism which is rated very low compared to other personality traits. According to Figure 6.5, 80% of scores given for extraversion, agreeableness, conscientiousness, and openness are higher than all scores given for neurotic personality. Also, the similarity of the median values for all personality traits except neuroticism (med = 3.7, med = 3.7, med = 3.5, med = 3.5) reveals a small effect of yellow color on these four personality traits (see Table 6.8).

Orange. There is a statistically substantial difference between personality trait measurements within orange color with $p<.01$, df=4 (see Table 6.7). When orange color is triggered, the mascot with extraversion and openness traits show distinguishable ratings in comparison to all other personalities with $p<.05$ (see Figure 6.5). Moreover, tests did not show any significant differences between extraversion (med = 3.0, max = 4.8, min = 2.3) and openness (med = 3.0, max = 4.7, min = 1.7) within orange color (see Table 6.8). However, the median values of extraversion and openness are higher compared to the values of all other personality traits.

Turquoise. Overall, all personality traits are measured differently when the light was transformed to turquoise color with $p<0.01$, df=4 (see Table 6.7). Wilcoxon test reveals that when the turquoise is displayed, the agreeableness and conscientiousness personality traits are substantially distinguishable from other personality traits with $p<.05$ (see Figure 6.5). Both of them are measured high when mascot triggers turquoise color. However, these two personalities are not distinguishable from each other within turquoise color. Despite that fact, the median value of conscientiousness (med = 3.7) is slightly higher than for agreeableness (med = 3.5) (see Table 6.8).

Blood-red lighting color reveals a significant difference in measurements of all personality traits with $p<.01$, df=4 (see Table 6.7). According to Figure 6.5, there is an excellent separation of neuroticism boxplot from all other personality traits. Table 6.8 shows a very high median value for neuroticism compared to other personality traits with med = 4.3, max = 5.0 and min = 3.2.

Pink. There is a significant difference in ratings of the mascots' personality when the pink light is triggered having $p<.01$, df=4 (see Table 6.7). According to Figure 6.5, pink light shows a significant effect on the agreeableness and conscientiousness with $p_{adj}<.01$ comparing to extraversion, neuroticism, and openness personality traits. Based on the medians reported in Table 6.8, agreeableness has

the highest (med = 4.0) in contrast to neuroticism which has the lowest value (med = 1.7).

Color conditions	χ^2	**df**	**p**
Yellow	23.6	4	p<.01
Orange	38.2	4	p<.01
Turquoise	37.1	4	p<.01
Blood-red	45.5	4	p<.01
Pink	60.1	4	p<.01

Table 6.7: The results of the Friedman test for five color conditions in the case of mascot-lamp interaction.

	Yellow					**Orange**					**Turquoise**				
	E	A	C	N	O	E	A	C	N	O	E	A	C	N	O
Min	2.3	1.8	1.3	1.0	1.5	2.3	1.0	1.8	1.0	1.7	1.8	2.0	1.7	1.0	2.3
Med	3.7	3.7	3.5	2.2	3.5	3.0	2.3	2.5	2.5	3.0	2.7	3.5	3.7	2.0	2.8
Max	4.8	5.0	4.8	3.3	5.0	4.8	3.3	3.3	3.5	4.7	4.2	5.0	5.0	3.5	3.7
	Blood-red					**Pink**									
	E	A	C	N	O	E	A	C	N	O					
Min	1.0	1.0	1.2	3.2	1.2	1.7	2.5	2.0	1.0	1.5					
Med	1.7	2.0	2.2	4.3	2.7	2.8	4.0	3.5	1.7	2.8					
Max	4.5	3.8	4.7	5.0	4.0	3.7	5.0	5.0	3.3	4.0					

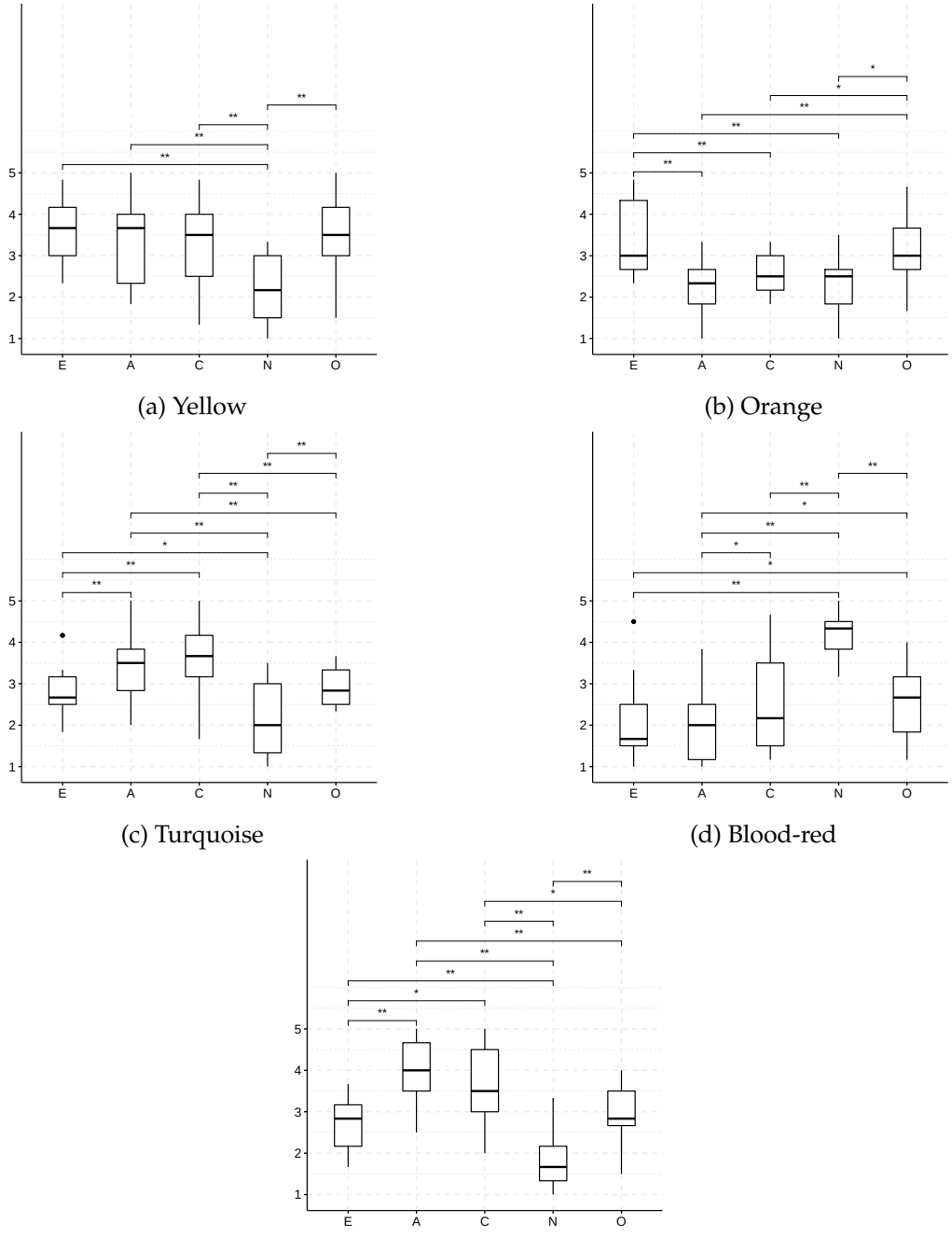
Table 6.8: A summary table of the median, minimum, and maximum rates given for each color condition.

6.3 The analysis of the 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, the statistical tests are conducted for the within personality trait study and in Subsection 6.3.2 for the within vibration level. Besides, 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 The analysis of the within personality trait study

In the first study, compared factors are five levels of vibration starting from level-1 to level-5.



(a) Yellow

(b) Orange

(c) Turquoise

(d) Blood-red

(e) Pink

Figure 6.5: A boxplot for the mascot-lamp interaction in study-2. Stars represent the significance of p_{adj} after Bonferroni correction.

Extraversion. The Friedman test shows a significant difference between all levels of vibration in the ratings of an extraversion personality trait with p<.01 (see Table 6.9). In comparison to all other levels, level-5 shows a significant difference

in the measurements of the extraversion personality with p<.05 (see Figure 6.6). This level is highly scored as the behavior of an extravert mascot with med = 4.0 (see Table 6.10).

Agreeableness. All vibration levels substantially affect the measurements of an agreeableness personality trait with p<.01, df=4 (see Table 6.9). Both level-2 and level-3 revealed a significant effect for mascot being assessed as agreeable with p_{adj}<.05 (see Figure 6.6). Overall, the majority of votes given for level-2 (med = 4.0, max = 4.7, min = 2.0) and level-3 (med = 3.5, max = 5.0, min = 2.5) are higher than most votes given for other vibration levels (see Table 6.10).

Conscientiousness. There is a significant impact of all vibration levels on the assessment of conscientiousness personality trait with p<.01, df=4 (see Table 6.9). The analysis revealed a strong difference of levels three and four from scores given for other vibrations with p_{adj}<.01 (see Figure 6.6). Moreover, the median values for level-3 (med = 3.8) and level-4 (med = 4.0) are high enough to show a strong impact of these levels to measure mascot as conscientious (see Table 6.10).

Neuroticism. There is a significant difference in measurements of each level of vibration within neuroticism personality trait with p<.01, df=4 (see Table 6.9). Especially, this difference is concentrated on the ratings for level-1 with med = 3.7 in comparison to other levels having med < 2.5 (see Table 6.10). According to Figure 6.6, for a neuroticism personality trait, there is a good separation of samples for level-1 from all other vibration levels with p_{adj}<.05.

Openness. Table 6.9 reveals a difference between all five vibration levels within openness personality trait with p<.05, df=4 (see Table 6.9). The Wilcoxon test revealed a significant difference between levels one and two, during the measurements of the openness personality trait with p<.05 (see Figure 6.6). The median values for levels five, four, two, and one imply the overall similarity of votes concentrated on the 'neutral' scale with med < 2.7 (see Table 6.10).

Personality traits	χ^2	**df**	**p**
Extraversion	30.8	4	p<.01
Agreeableness	19.8	4	p<.01
Conscientiousness	43.2	4	p<.01
Neuroticism	28.2	4	p<.01
Openness	11.2	4	p<.05

Table 6.9: The results of the Friedman test for all personality traits in the case of mascot-mascot interaction.

6.3.2 The analysis of the within vibration level study

The second study analyzes each vibration level individually and the difference of each personality trait within a specific vibration level. Compared groups

	Extraversion					Agreeableness					Conscientiousness				
	L1	L2	L3	L4	L5	L1	L2	L3	L4	L5	L1	L2	L3	L4	L5
Min	1.2	1.7	1.3	2.2	2.3	1.7	2.0	2.5	1.3	1.3	1.7	1.5	2.8	2.2	1.7
Med	2.0	2.0	2.7	3.0	4.0	2.5	4.0	3.5	2.8	2.7	2.5	2.7	3.8	4.0	2.8
Max	3.8	4.0	4.3	4.7	4.7	4.0	4.7	5.0	4.0	3.8	3.8	4.2	5.0	5.0	3.8
	Neuroticism					**Openness**									
	L1	L2	L3	L4	L5	L1	L2	L3	L4	L5					
Min	2.0	1.3	1.3	1.0	1.0	1.1	1.8	1.5	1.0	1.3					
Med	3.7	2.1	1.8	2.2	2.3	2.3	2.5	3.3	2.7	2.7					
Max	4.7	3.7	4.2	3.5	3.3	4.2	4.5	4.3	4.5	4.0					

Table 6.10: A summary table of the median, minimum, and maximum rates given for each personality trait.

are extraversion, agreeableness, conscientiousness, neuroticism, and openness personality traits.

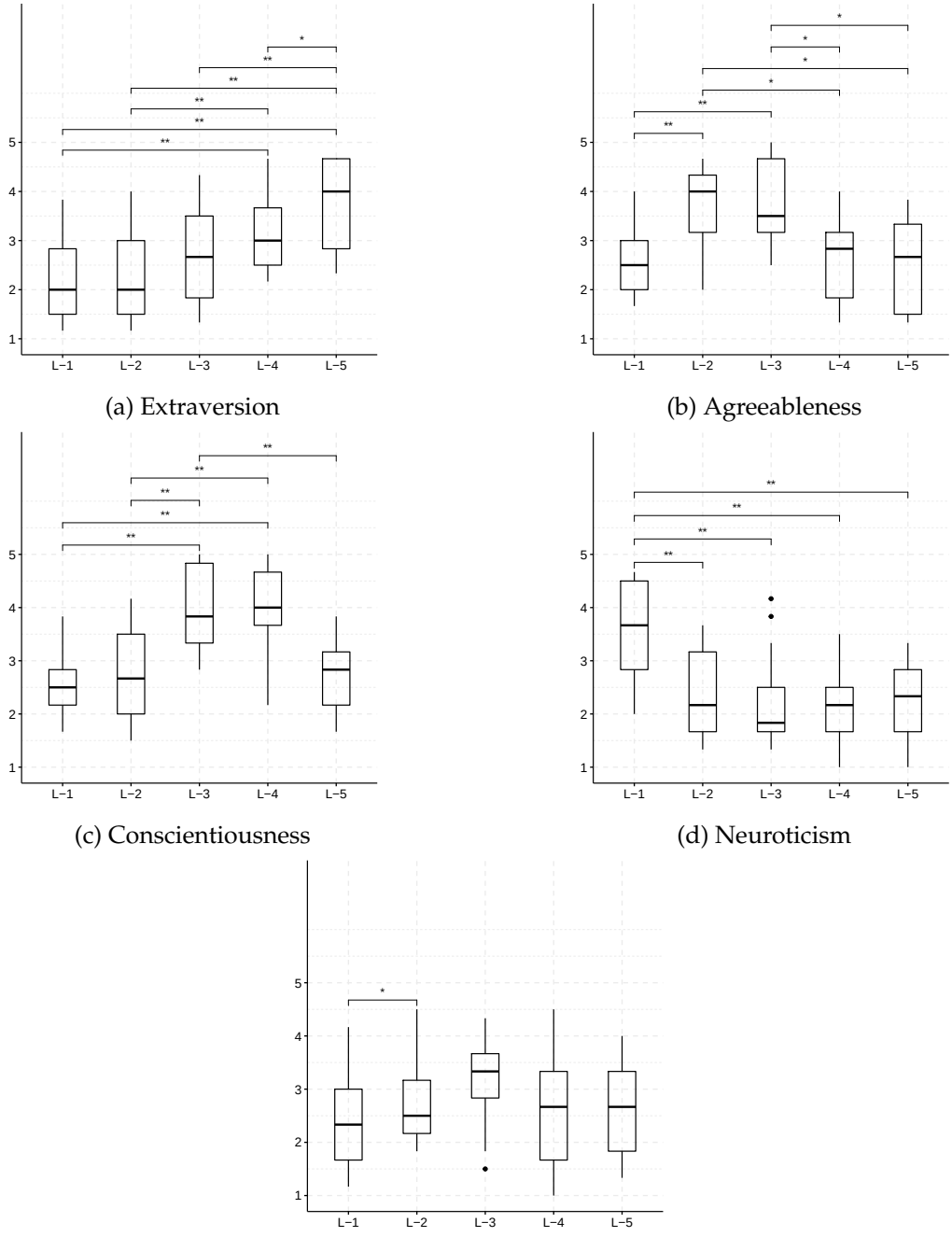
Level-1. The Friedman test shows a significant difference between the ratings of all personality traits and vibration level one with $p<.01$, df=4 (see Table 6.11). This difference especially is concentrated on neuroticism which distinguished it from all other personality traits with $p_{adj}<.05$ (see Figure 6.7). In comparison to neuroticism (med = 3.7), the median rates are given for extraversion, agreeableness, conscientiousness, and openness personality traits are relatively similar being 2.0, 2.5, 2.5, 2.3 respectively (see Table 6.12).

Level-2. On average, level-2 has a significant effect on the ratings of all five personality traits with $p<.01$, df=4 (see Table 6.11). Based on Wilcoxon tests, there are four groups of personality traits being effected by vibration level-2 with $p_{adj}<.05$ (see Figure 6.7). Agreeableness is the most distinguishable being rated higher (med = 4.0) than all other personality traits (med < 2.8) (see Table 6.12).

Level-3 has a substantial impact on the measurements of a personality trait with $p<.01$, df=4 (see Table 6.11). Level-3 effects the ratings of two personality traits: agreeableness and conscientiousness with $p_{adj}<.05$ (see Figure 6.7).

Level-4. There is a statistically significant difference between the measurements of all personality traits within level-4 with $p<.01$, df=4 (see Table 6.11). Level-4 has an impact on the ratings of two personality traits with the highest scores (max = 4.7 and max = 5.0) such as conscientiousness and extraversion with a very significant $p_{adj}<.01$ (see Figure 6.7).

Level-5. Overall, all personality traits show different results when each mascot vibrating 500 milliseconds per time (i.e. level-5) with $p<.01$, df=4 (see Table 6.11). Level-5 distinguishes extraversion from all other personality traits having the highest ratings with $p_{adj}<.05$ (see Figure 6.7). The median values for all other personality traits are lower than the neutral scale (med < 3.0) in comparison to neuroticism with med = 4.0 (see Table 6.12).



(a) Extraversion

(b) Agreeableness

(c) Conscientiousness

(d) Neuroticism

(e) Openness

Figure 6.6: A boxplot for the mascot-mascot interaction in study-1. Stars represent the significance of p_{adj} after Bonferroni correction.

Vibration levels	χ^2	df	p
Level-1	24.0	4	p<.01
Level-2	24.5	4	p<.01
Level-3	35.2	4	p<.01
Level-4	46.6	4	p<.01
Level-5	24.1	4	p<.01

Table 6.11: The results of the Friedman test for all vibration levels in the case of mascot-mascot interaction.

	Level-1					**Level-2**					**Level-3**				
	E	A	C	N	O	E	A	C	N	O	E	A	C	N	O
Min	1.2	1.7	1.7	2.0	1.2	1.2	2.0	1.5	1.3	1.8	1.3	2.5	2.8	1.3	1.5
Med	2.0	2.5	2.5	3.7	2.3	2.0	4.0	2.7	2.2	2.5	2.7	3.5	3.8	1.8	3.3
Max	3.8	4.0	3.8	4.7	4.2	4.0	4.7	4.2	3.7	4.5	4.3	5.0	5.0	4.2	4.3
	Level-4					**Level-5**									
	E	A	C	N	O	E	A	C	N	O					
Min	2.2	1.3	2.2	1.0	1.0	2.3	1.3	1.7	1.0	1.3					
Med	3.0	2.8	4.0	2.2	2.7	4.0	2.7	2.8	2.3	2.7					
Max	4.7	4.0	5.0	3.5	4.5	4.7	3.8	3.8	3.3	4.0					

Table 6.12: A summary table of the median, minimum, and maximum rates given for each vibration level.

6.4 The analysis of the mascot-tablet interaction

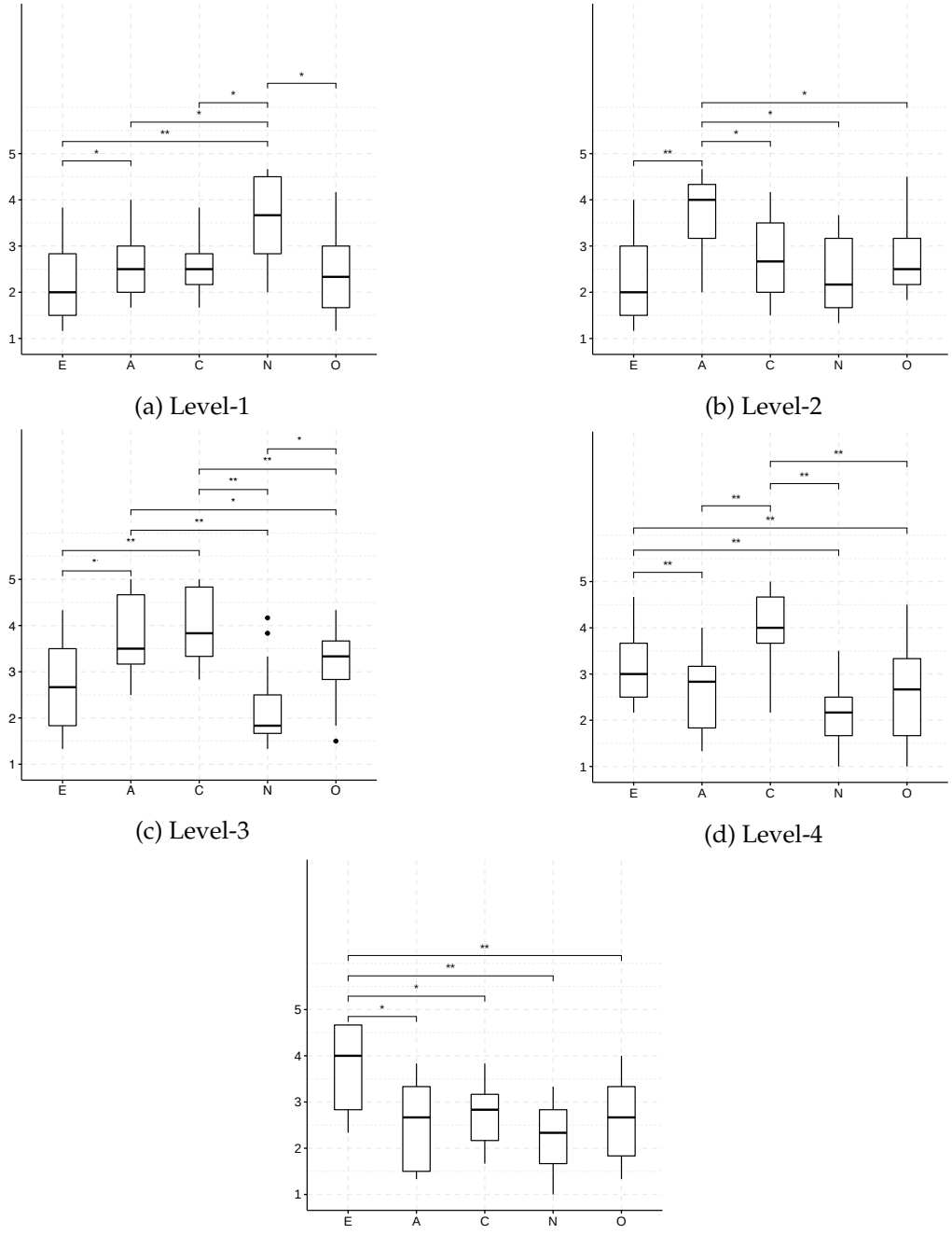
The section describes the impact of the screen color of a tablet on the assessment of the personality trait that mascot conveys. Subsection 6.4.1 shows the analysis of the within personality study and Subsection 6.4.2 of within condition study (i.e. color).

6.4.1 The analysis of the within personality trait study

The first study is focused on each personality by comparing the scores given for each color within that personality trait. Compared factors are yellow, orange, turquoise, blood-red, and pink screen colors.

Extraversion. For the measurements of extraversion personality, the most significant difference was observed when yellow and orange were compared to blood-red and pink colors with p_{adj}<.05 (see Figure 6.8). Moreover, in comparison to other colors most samples for orange are concentrated around an 'accurate' score (med = 4.2, max = 5.0) (see Table 6.14).

Agreeableness. The change in tablet's screen color significantly influenced the



(a) Level-1

(b) Level-2

(c) Level-3

(d) Level-4

(e) Level-5

Figure 6.7: A boxplot for the mascot-mascot interaction in study-2. Stars represent the significance of p_{adj} after Bonferroni correction.

participants' ratings of an agreeableness personality trait with p<.01, df=4 (see Table 6.13). Figure 6.8) shows good separation of turquoise and pink colors from all others implying that there is a difference in ratings of the agreeableness

personality traits having p_{adj}<.01. However, there is no strong difference between turquoise and pink colors having the same value med = 3.7 (see Table 6.14).

Conscientiousness. There is a significant difference in the rating of conscientiousness personality trait when comparing screen colors with p<.01, df=4 (see Table 6.13). According to Figure 6.8, there is a distinguishable impact of the tablet displaying turquoise color on the measurements of the mascot as conscientiousness with p_{adj}<.05. The median values for yellow (med = 2.7), pink (med = 2.8) and orange (med = 2.7) colors are concentrated around the 'neutral' scale, whereas turquoise (med = 4.2) is concentrated near 'accurate' scale (see Table 6.14).

Neuroticism. All predefined screen colors substantially affect the measurements of the neuroticism personality trait with p<.01, df=4 (see Table 6.13). According to Figure 6.8, there is a great separation of blood-red samples from all other screen colors with p_{adj}<.05. The ratings for the blood-red are higher with med = 3.8 compared to all other colors with M $\leq$ 2.5 (see Table 6.14).

Openness. Table 6.13 shows the different effects based on all colors within openness personality trait with p<.01, df=4 (see Table 6.13). According to the Wilcoxon tests, during the measurements of a mascot's openness to experience personality traits, the yellow is significantly different from all other screen colors with p_{adj}<.05 (see Figure 6.8). In comparison to all other colors (M $\leq$ 3.0), most of the samples of yellow color are discriminated from all others concentrating around an 'accurate scale with a med = 4.0 (see Table 6.14).

Personality traits	χ^2	**df**	**p**
Extraversion	28.8	4	p<.01
Agreeableness	52.9	4	p<.01
Conscientiousness	32.9	4	p<.01
Neuroticism	30.5	4	p<.01
Openness	37.7	4	p<.01

Table 6.13: The results of the Friedman test for all personality traits in the case of mascot-tablet interaction.

6.4.2 The analysis of the within screen color study

The second study is focused on each color by comparing the different measurements of five personality traits within each screen color. Compared groups are extraversion, agreeableness, conscientiousness, neuroticism, and openness personality traits.

Yellow. The Friedman test showed a significant difference in the ratings each personality trait within yellow lighting color with p<.01, df=4 (see Table 6.15). When mascot triggers yellow background color, tests reveal openness to be rated

	Extraversion					Agreeableness					Conscientiousness				
	Y	O	T	B	P	Y	O	T	B	P	Y	O	T	B	P
Min	2.0	1.7	2.0	1.2	1.7	1.5	1.2	1.8	1.0	1.7	1.8	2.2	2.0	1.0	2.0
Med	3.3	4.2	2.8	1.7	2.5	3.0	2.3	3.7	1.8	3.7	2.7	2.7	4.2	2.3	2.8
Max	4.0	5.0	4.3	4.7	3.8	3.7	4.5	4.2	3.3	5.0	3.5	4.5	5.0	4.3	4.7
	Neuroticism					**Openness**									
	Y	O	T	B	P	Y	O	T	B	P					
Min	1.3	1.5	1.0	1.5	1.2	2.5	1.3	2.0	1.0	1.5					
Med	2.2	2.5	2.5	3.8	2.3	4.0	3.0	3.0	2.7	2.7					
Max	3.7	4.3	3.5	5.0	4.2	5.0	5.0	4.2	3.8	3.8					

Table 6.14: A summary table of the median, minimum, and maximum rates given for each personality trait.

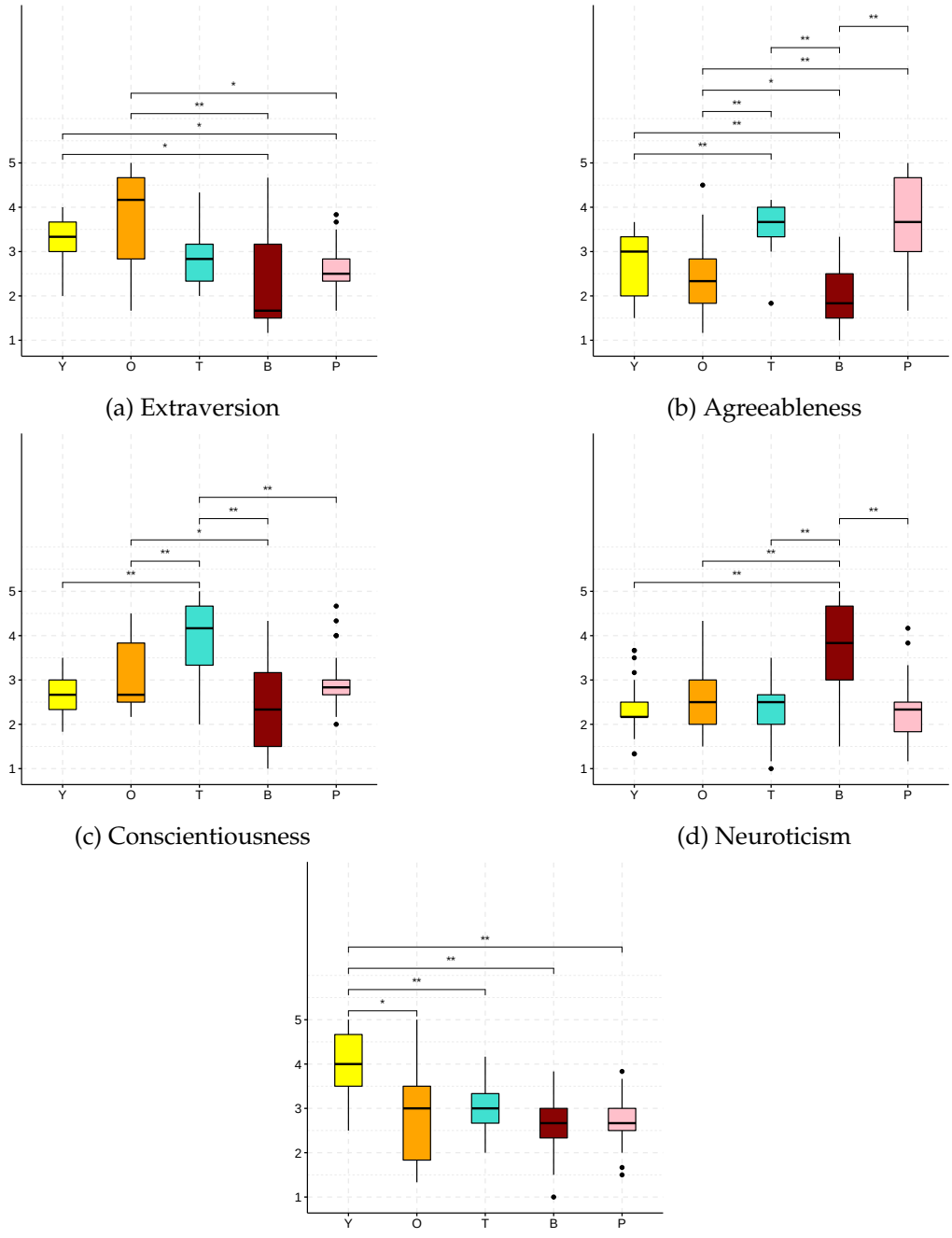
very high with p<.01 (see Figure 6.8).

Orange. There is a statistically substantial difference between personality trait measurements within orange color with p<.01, df=4 (see Table 6.7). The Wilcoxon tests show the following three groups having significantly different ratings when orange color is triggered: extraversion and agreeableness; extraversion and neuroticism; agreeableness and conscientiousness personality traits (see Figure 6.8). The extraversion seems to have the highest average ratings with median = 4.2 (see Appendix C)

Turquoise. Overall, all personality traits show different results when the light was transformed to turquoise color with p<.01, df=4 (see Table 6.7). Particularly, the measurements of conscientiousness and agreeableness personality traits are the most conveyed by turquoise colors with a p_{adj}<.05 (see Table 6.9). The median value for conscientiousness (med = 4.2) is higher than for agreeableness (med = 3.7) and all other personality traits (med $\leq$ 3.0) (see Table 6.15).

Blood-red lighting color reveals a significant difference in the measurements of all personality traits with p<.01, df=4 (see Table 6.7). Especially, there is a significant difference in ratings of neuroticism being higher than for all other personality traits with p_{adj}<.01. The box plots display a great separation of neuroticism samples from all other personality traits (see Figure 6.8).

Pink. There is a significant difference in the rating mascots' personality when the pink light is triggered with p<.01, df=4 (see Table 6.7). Particularly, there is a substantial impact of pink on the scores given for agreeableness personality with p_{adj}<.05. However, we could not find any difference in the ratings of pink color when we compare agreeableness and conscientiousness personality traits (p_{adj}>.05 see Figure 6.9).



(a) Extraversion

(b) Agreeableness

(c) Conscientiousness

(d) Neuroticism

(e) Openness

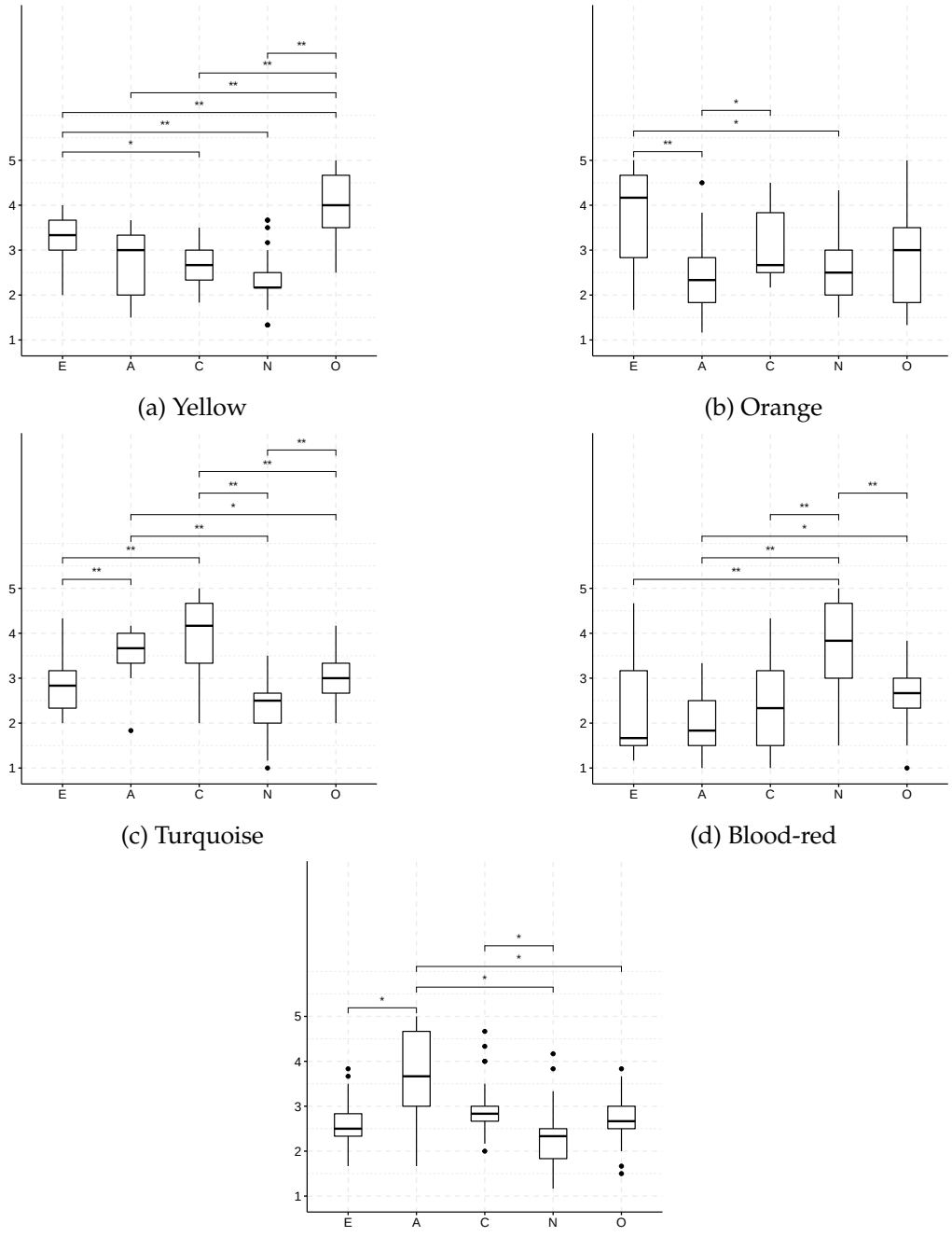
Figure 6.8: A boxplot for the mascot-tablet interaction in study-1. Stars represent the significance of p_{adj} after Bonferroni correction.

Color conditions	χ^2	**df**	**p**
Yellow	38.1	4	p<.01
Orange	20.0	4	p<.01
Turquoise	46.2	4	p<.01
Blood-Red	30.0	4	p<.01
Pink	21.7	4	p<.01

Table 6.15: The results of the Friedman test for all color conditions in the case of mascot-tablet interaction.

	Yellow					**Orange**					**Turquoise**				
	E	A	C	N	O	E	A	C	N	O	E	A	C	N	O
Min	2.0	1.5	1.8	1.3	2.5	1.7	1.2	2.2	1.5	1.3	2.0	1.8	2.0	1.0	2.0
Med	3.3	3.0	2.7	2.2	4.0	4.2	2.3	2.7	2.5	3.0	2.8	3.7	4.2	2.5	3.0
Max	4.0	3.7	3.5	3.7	5.0	5.0	4.5	4.5	4.3	5.0	4.3	4.2	5.0	3.5	4.2
	Blood-red					**Pink**									
	E	A	C	N	O	E	A	C	N	O					
Min	1.2	1.0	1.0	1.5	1.0	1.7	1.7	2.0	1.2	1.5					
Med	1.7	1.8	2.3	3.8	2.7	2.5	3.7	2.8	2.3	2.7					
Max	4.7	3.3	4.3	5.0	3.8	3.8	5.0	4.7	4.2	3.8					

Table 6.16: A summary table of the median, minimum, and maximum rates given for each color condition.



(a) Yellow

(b) Orange

(c) Turquoise

(d) Blood-red

(e) Pink

Figure 6.9: A boxplot for the mascot-tablet interaction in study-2. Stars represent the significance of p_{adj} after Bonferroni correction.

Chapter 7
Discussions

This chapter covers the discussion of the results obtained from the statistical tests. In this study, the behavior of a mascot is conceptualized into four interaction types which are referred to as case-studies. Sections 7.1, 7.2, 7.3, and 7.4 discuss each interaction type for the within the personality and the within condition studies.

7.1 Mascot-speakers interaction

The empirical evidence for mascot-speakers case-study shows that the type of music influences the participants' interpretation of the personality trait. The mascot triggering sophisticated, contemporary, or unpretentious song can be associated with a specific personality trait.

The discussion of the first study.

On the one hand, the interaction between mascot and contemporary was interpreted to be more extravert which is characterized as being more friendly, sociable, cheerful, and so on. On the other hand, this type of interaction also was rated very high on conveying neuroticism personality trait which is described as being more emotionally unstable, angry, vulnerable, depressive, and so on. The mascot triggering sophisticated music was perceived to be more open to new experiences. Such songs as classical, jazz and a contemporary adult were interpreted as more artistic intelligent, thoughtful, and other facets representing openness personality trait (see Table 3.1). Agreeableness and conscientiousness personality traits were associated with sophisticated and unpretentious compared to contemporary music. However, this study does not provide statistical

evidence for these two personality traits to be conveyed by a specific music type.

The discussion of the second study.

The within music condition study revealed that mascot interacting with sophisticated music was perceived to be more open to new experiences. In addition, the first study associated contemporary with both extraversion and neuroticism personality traits. By comparing the ratings of all personality traits within contemporary music, the second study revealed that this music condition conveys an extraversion personality trait most.

7.2 Mascot-lamp interaction

The study shows that the change in color of the lamp has an impact on the way how participants interpret the personality of a mascot. This shows that the lamp that mascot interacts with was not only interpreted as an artificial light source but also gave clues about mascot's personality trait.

The discussion of the first study.

Participants associated mascot triggering blood-red lighting with neuroticism personality trait which is characterized as to be highly anxious, angry, depressive, self-conscientious, impulsive, and vulnerable (see Table 3.1). Extraversion personality was rated very high to be conveyed with yellow lighting only compared to turquoise, blood-red, and pink. With agreeableness and conscientiousness, participants rated mascots interacting with pink, yellow, turquoise lighting to be more associated with these personality traits. However, for all personality traits except neuroticism, it is hard to distinguish a specific color that conveys these personality traits.

The discussion of the second study.

The mascot triggering the blood-red lighting is interpreted to be more neurotic i.e. such as an anxious, highly depressive, angry, vulnerable, and that has an immoderate behavior (see Table 3.1). The second study confirms that how the personality of a mascot was measured, except for neuroticism, all other personality traits cannot be conveyed by a single color. For example, both turquoise and pink lights convey agreeableness and conscientiousness personality traits. Also, the orange color was interpreted to be more extravert and open to new experiences.

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 discussion of the first study.

Participants experiencing 500 milliseconds vibration duration interpreted the approaching mascot as more energetic, assertive, forceful, energetic, friendly, sociable, cheerful which constitutes extraversion personality trait (see Table 3.1). The mascot interacting with level-2 and level-3 was perceived to be more agreeable which is described as being modest, cooperative, trustworthy, and so on. Mascot interacting with level-3 and level-4 vibration are interpreted as conscientiousness. The participants experiencing 100-millisecond vibration aka level-1 interpreted approaching mascot as neurotic which is characterized by being anxious, angry, depressive, and so on (see Table 3.1).

The discussion of the second study.

Participants experiencing the vibration with the shortest duration perceived approaching mascot (i.e. the mascot that triggered their device) as neurotic. The mascot causing 200 milliseconds per time interpreted as agreeable. The mascot making participant's phone to vibrate with the duration of 500 milliseconds conveys extraversion personality trait.

7.4 Mascot-tablet interaction

The empirical evidence revealed that, overall, the change of background color effects which personality trait will be perceived by this interaction.

The discussion of the first study.

For the within personality study, turquoise which is distinguished from all other colors represents conscientiousness personality trait. Also, blood-red color is associated with neuroticism personality that is characterized by having immoderate behavior, being aggressive, depressive, and so on (see Table 3.1). Openness personality is best conveyed by a yellow screen color.

The discussion of the second study.

The analysis of the within color condition shows that the yellow background portrays an openness personality trait which makes the results from the first study consistent with the second study. Also, a blood-red screen is significantly associated with neuroticism personality. The first study revealed a conscientiousness

personality being conveyed by turquoise color. However, when all personality traits were compared within turquoise color, the ratings of conscientiousness personality traits did not distinguish from the scores given for agreeableness personality. Thus, according to the second study, turquoise color failed to be associated only with conscientiousness personality.

7.5 Overview of the discussion

During this study, for each interaction type, there are actions such as music play, vibration, lighting, and screen color change that can be associated with specific personality traits. The representation of all types of behavior and associated personality traits are the following:

⇒ **Music type in mascot-speakers interaction.**

Extraversion: contemporary songs.

Openness: sophisticated songs.

⇒ **Lighting color in mascot-lamp interaction.**

Neuroticism: blood-red.

⇒ **Vibration level in mascot-mascot interaction.**

Neuroticism: level-1 (100 ms).

Agreeableness: level-2 (200 ms).

Extraversion: level-5 (500 ms).

⇒ **Screen color in mascot-tablet interaction.**

Neuroticism: blood-red.

Openness: yellow.

Chapter 8
Conclusion

Section 8.1 of the final chapter gives a conclusive overview of the results achieved during this study. Section 8.2 describes the contribution, Section 8.3 provides certain limitations, and Section 8.4 covers the ideas explored in this project can be continued further.

8.1 Overview

In this study, both psychological and user-experience approaches help us to better understand thing-to-thing interaction. The interaction between a mascot and other inanimate devices gave a descriptive clue about the personality of a social device. In this study, we explore how people interpret the interaction between user and social devices. The preset behaviors such as playing music, vibrating with a certain duration, changing lighting colors, and altering screen color were investigated to find an association with the concept of personality trait.

8.1.1 Overview of the results

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 - specific color, music type, and vibration level. The second study is supplementary for the first study. Thus, the second study results in a specific personality trait that is conveyed most by this condition.

The following guideline to associate predefined actions with a specific personality trait is introduced:

- For the **Mascot-speakers interaction**, in order to convey an extraversion personality trait, contemporary music will be the best choice. For the mascot that attributes an openness personality trait, the good choice will fall on sophisticated music.
- For **Mascot-lamp interaction**, if the mascot triggers blood-red lighting as a representation of its behavior, it will convey the neuroticism personality trait.
- For **Mascot-mascot interaction**, the extraversion mascot can be presented by showing the highest level of vibration, namely level-5 with 500 milliseconds duration. The best representation of an agreeableness personality trait will be level-2 vibrating 200 milliseconds per time. When the neuroticism is chosen, the behavior that conveys this personality trait most is the vibration level-1.
- For **Mascot-tablet interaction**, in order to convey the openness personality trait, the most associated behavior is choosing a yellow screen. For neuroticism personality trait, the blood-red is a good and distinctive choice.

In addition, a social device interacting with the same color in the various environment was interpreted differently. For example, the yellow screen conveyed openness for mascot-tablet interaction, whereas, for mascot-lamp, it failed to convey any personality trait. One reason might be 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 on a screen. The same observation is made for blood-red color which conveys a neurotic personality trait for both interaction types. However, the mascot triggering the blood-red lighting is perceived as more aggressive than the one triggering the same color in the tablet. By illuminating the whole room with blood-red color people may get a more negative impression about mascot's personality than seeing the same color in a tablet-size screen. The above-mentioned explanations are assumptions and can be investigated in further studies.

8.2 Contributions and findings

The main contribution is achieving cooperation among mascots and other interactive objects in a system where each mascot has a unique personality trait. This can, in turn, serve as a contribution to designing social devices in the SIoT environment. Thus, the system that produces four types of interactions with predefined actions was implemented.

We also empirically investigated how people interpret the behavior, particularly such signals as lighting color change, music play, vibration, and screen color alternation. The important finding was the relationship between personality traits

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 traits and behavior are interconnected concepts even for inanimate objects.

Finally, we used personality based on the Big Five Personality Trait Model as an interaction between people and social devices, where personality was conveyed by the predefined actions. This shed a light on using the personality model as a tool to predict and influence automated behaviors in the context of the Internet of Things environment.

8.3 Limitations

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 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 social devices could affect the participant's opinions on the measurements of the personality trait of devices. On the other hand, during these experiments participants reflected their very first impressions while seeing the interaction between a user and devices and their initial reaction while measuring the personality traits of mascots based on these interactions.

Also, during the study, some signals especially some colors in the mascot-lamp interaction was hard to associate with specific personality traits. However, this study gave us insight that personality traits and the behavior of social devices are two interrelated concepts. In addition, for the preset actions and signals that were associated with personality traits, the guideline was introduced.

The limitation regarding the implementation was to have a centralized system that gives control to the server instead of the social devices themselves.

8.4 Future work

From the implementation perspective, a distributed system for communication between social devices can be designed. Thus, the realization of a protocol that helps all devices in a system to come to a common agreement can also be performed.

Another idea might be improving mascot-tablet interaction in addition to screen colors some other functionalities can be added. For example, when a mascot approaches a tablet, it can show some favorite pictures to give more information about the itself. In fact, the design of such a system should also take into account security aspects for not leaking personal photos.

Also, the interaction between social devices can be used as a trigger or motivation for people to socialize and communicate more. The behavior of mascots such as a light change or a music play or vibration can be an icebreaker for people to communicate with each other.

Appendix A
System setup

A.1 Setting up the server.

To set up the Spring server fo the first time perform the following instructions:

- Install JDK version 1.8.
- Install Maven.
  We used "brew" package manager on the macOS:

```
1        brew install maven
```

A.2 Setting up the database

To set up the server for the first time perform the following steps:

- Download pgAdmin tool EDB installer from the link in the footnote [8].
  You can choose the alternative methods on how to install the postgres.
- When installing the database, specify the superusername and the password
  - Default port is *5432*
  - Default hostname is *localhost*

[8] https://www.enterprisedb.com/downloads/postgres-postgresql-downloads

- When connected to the postgresql server in pgAdmin, create a new database with *autonomousSystem* name. The database name must match to the name specified in `application.properties` file of a server. When you choose a custom name for a database, specify it in a server configuration file.
- Specify the database username and password in `application.properties`.

A.3 Setting up the Philips Hue bridge

To set up the Philips Hue bridge for the first time perform the the following steps:

- Visit the following website to get the internal ip address of the Philips Hue bridge:

  `https://discovery.meethue.com`

- Visit the following website by using the above-mentioned ip address:

  `https://<bridgeipaddress>/debug/clip.html`

- Create a randomly generated username for your philips hue bridge by:
  - changing the URL to api/
  - inserting a Body such as "devicetype":"hueApp"
  - pressing the POST button to create a new device
- The response that you will get is depicted in Figure A.1.
- Press the round button on your hue bridge device and then press the POST button again on the website.
- As a response you will get a username that Philips Hue bridge created for you.

A.4 Starting the server

To run the server for the first time perform the following steps:

- Start the server from `AutonomousSystemThesis/server` folder with the following command and the hibernate will generate all necessary tables for the system:

```
1  mvn spring-boot:run -e -X -Dspring-boot.run.arguments=–
       hueUsername=<hue_username>,–hueIPAddress=<hue_ip_address>,–
       musicFolderPath=<music_folder_path>
```

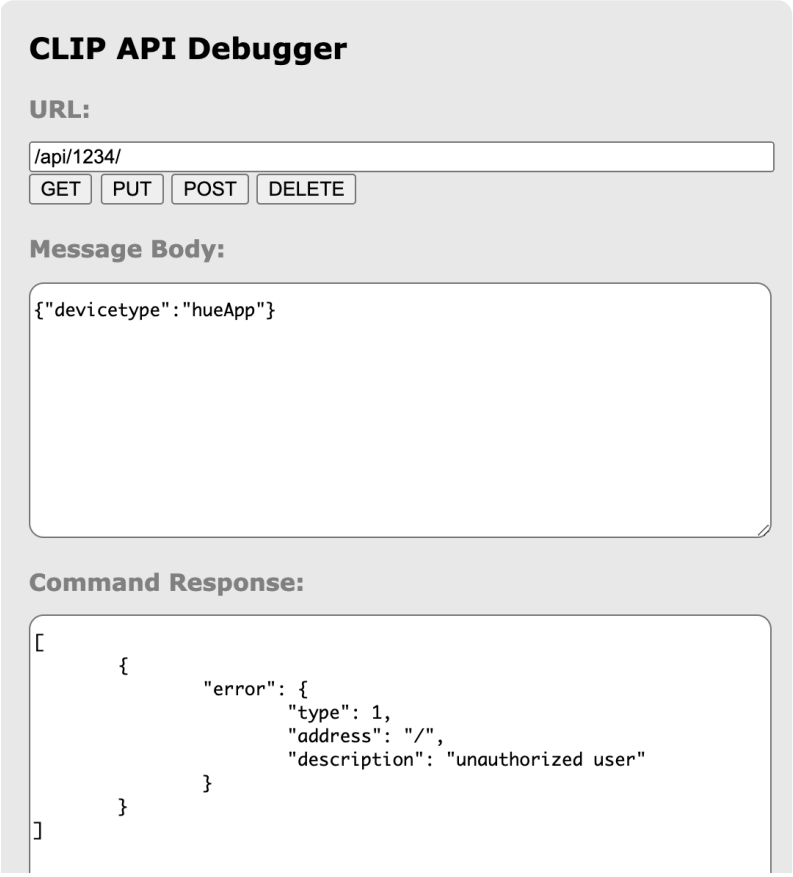


Figure A.1: The screen capture of the response with unauthorised user while setting up Philips Hue bridge.

- Start the server broadcast with the following command:

```
1        dns-sd -R mythesis _socialiot._tcp local 8080
```

When running the server for the second time, you do not need to perform steps for setting up the database.

A.5 Setting up the client applications

To set up the client application for the first time perform the following steps:

- Turn on the Bluetooth and the location on your tablet.
- Start the tablet application by running `MyTabletApp`.
- Grant the required permission for the tablet application.

- Register a tablet, a lamp, and the speakers in the system by following the instructions on the screen.
- Turn on the Bluetooth and the location on your smartphone.
- Start the mascot application by running `MyMascotApp`.
- Grant the required permission for the mascot application.
- Register your mascot in the system by following the instructions on the screen.

Appendix B
Questionnaires for the user study

Questionnare

Please fill this form after the video watch to reflect your opinion

The scales mean that the statement which describes the behavior of the Mascot that you have just saw in the video is Very Inaccurate, Inaccurate, Neutral, Accurate and Very Accurate.

I can describe the behavior of a Mascot that I have seen in this video with the following words:

1. Friendly and warm:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
2. Gregarious and sociable:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
3. Assertive and forceful:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
4. Highly active and energetic:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
5. Seeks for excitement:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
6. Cheerful and Positive:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
7. Trusting and forgiving:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
8. Straightforward:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
9. Altruistic:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
10. Cooperative:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
11. Modest:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
12. Sympathetic:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
13. High sense of Self-efficacy:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
14. Orderly:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
15. Dutiful:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
16. Achievement-striving:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
17. Self-disciplined:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
18. Deliberating and Continuous:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
19. Anxious:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
20. Angry and hostile:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
21. High level of Depression:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
22. Self-conscious:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
23. Immoderate behavior:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
24. Vulnerable:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
25. Imaginative:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
26. Artistic interests:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
27. Emotional:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
28. Adventurous:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
29. Intellectual:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate
30. Liberal:	○ Very Inaccurate ○ Inaccurate ○ Neutral ○ Accurate ○ Very Accurate

Figure B.1: The questionnaires given for each video during the experiments.

About you

1. How old are you? _____

2. Please indicate your gender. ☐ Male ☐ Female

3. What is your current level of study?

☐ Bachelors

☐ Masters

☐ Doctorate / Phd

☐ Other, please specify _____

(if you are student, please state your major as well):

_____

4. How often do you use the following devices per day?

Phone:	☐ +6 hours	☐ 6-4 hours	☐ 4-2 hours	☐ 2-1 hours	☐ 0 hours
Smart Lamps:	☐ +6 hours	☐ 6-4 hours	☐ 4-2 hours	☐ 2-1 hours	☐ 0 hours
Tablet:	☐ +6 hours	☐ 6-4 hours	☐ 4-2 hours	☐ 2-1 hours	☐ 0 hours
Speakers:	☐ +6 hours	☐ 6-4 hours	☐ 4-2 hours	☐ 2-1 hours	☐ 0 hours

5. How often do you listen to music per day?

☐ +6 hours ☐ 6-4 hours ☐ 4-2 hours ☐ 2-1 hours ☐ 0 hours

(Please also specify the genre of the music that you like and/or listening to):

_____

Figure B.2: Demographics questionnaire used during the experiments.

Appendix C
Tables and Figures

	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

Table C.1: The statistically significant comparisons in the first study of each group individually using the Wilcoxon signed-rank test (z, p values) and Bonferroni correction (p_{adj}) while measuring Five Personality Traits for Mascot-Speakers interaction. In addition reporting effect sizes which are large (r>0.500).

	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
	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

Table C.2: The statistically significant comparisons in the second study of each group individually using the Wilcoxon signed-rank test (z, p values) and Bonferroni correction (p_{adj}) while measuring Five Personality Traits for mascot-speakers interaction. In addition reporting effect sizes which are large (r>0.500).

	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

Table C.3: The statistically significant comparisons in the first study of each group individually using the Wilcoxon signed-rank test (z, p values) and Bonferroni correction (p_{adj}) while measuring Five Personality Traits for mascot-lamp interaction. In addition reporting effect sizes which are large (r>0.500).

	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
Blood Red	E	N	-4.3464	p<0.01	0.869	p<0.01
	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

Table C.4: The statistically significant comparisons in the second study of each group individually using the Wilcoxon signed-rank test (z, p values) and Bonferroni correction (p_{adj}) while measuring Five Personality Traits for mascot-lamp interaction. In addition reporting effect sizes which are large (r>0.500).

	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
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

Table C.5: The statistically significant comparisons in the first study of each group individually using the Wilcoxon signed-rank test (z, p values) and Bonferroni correction (p_{adj}) while measuring Five Personality Traits for mascot-mascot interaction. In addition reporting effect sizes which are large (r>0.500).

	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
	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

Table C.6: The statistically significant comparisons in the second study of each group individually using the Wilcoxon signed-rank test (z, p values) and Bonferroni correction (p_{adj}) while measuring Five Personality Traits for mascot-mascot interaction. In addition reporting effect sizes which are large (r>0.500).

	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
	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

Table C.7: The statistically significant comparisons in the first study of each group individually using the Wilcoxon signed-rank test (z, p values) and Bonferroni correction (p_{adj}) while measuring Five Personality Traits for mascot-tablet interaction. In addition reporting effect sizes which are large (r>0.500).

	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
	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

Table C.8: The statistically significant comparisons in the second study of each group individually using the Wilcoxon signed-rank test (z, p values) and Bonferroni correction (p_{adj}) while measuring Five Personality Traits for mascot-tablet interaction. In addition reporting effect sizes which are large (r>0.500).

Bibliography

[1] Rose H Alschuler and LaBerta A Hattwick. 1943. Easel painting as an index of personality in preschool children. *American Journal of Orthopsychiatry* 13, 4 (1943), 616.

[2] Kevin Ashton and others. 2009. That 'internet of things' thing. *RFID journal* 22, 7 (2009), 97–114.

[3] Luigi Atzori, Antonio Iera, and Giacomo Morabito. 2010. The internet of things: A survey. *Computer networks* 54, 15 (2010), 2787–2805.

[4] Luigi Atzori, Antonio Iera, and Giacomo Morabito. 2011. Siot: Giving a social structure to the internet of things. *IEEE communications letters* 15, 11 (2011), 1193–1195.

[5] Luigi Atzori, Antonio Iera, Giacomo Morabito, and Michele Nitti. 2012. The social internet of things (siot)–when social networks meet the internet of things: Concept, architecture and network characterization. *Computer networks* 56, 16 (2012), 3594–3608.

[6] Mandana Bagherian and Adis Kraskian Mojambari. 2016. The relationship between Big Five personality traits and assertiveness. (2016).

[7] Till Ballendat, Nicolai Marquardt, and Saul Greenberg. 2010. Proxemic interaction: designing for a proximity and orientation-aware environment. In *ACM International Conference on Interactive Tabletops and Surfaces*. 121–130.

[8] Diana Boer, Ronald Fischer, Micha Strack, Michael H Bond, Eva Lo, and Jason Lam. 2011. How shared preferences in music create bonds between people: Values as the missing link. *Personality and Social Psychology Bulletin* 37, 9 (2011), 1159–1171.

[9] Arielle Bonneville-Roussy, Peter J Rentfrow, Man K Xu, and Jeff Potter. 2013. Music through the ages: Trends in musical engagement and preferences from adolescence through middle adulthood. *Journal of personality and social psychology* 105, 4 (2013), 703.

[10] Herman Cerrato. 2012. The meaning of colors. *The Graphic Designer* (2012).

[11] David Chung, Mathias Funk, Rung-Huei Liang, and Lin-Lin Chen. 2018. Explorations on reciprocal interplay in things ecology. In *Proceedings of the 2018 ACM Conference Companion Publication on Designing Interactive Systems*. 51–56.

[12] Paul T Costa Jr and Robert R McCrae. 1988. From catalog to classification: Murray's needs and the five-factor model. *Journal of personality and social psychology* 55, 2 (1988), 258.

[13] Paul T Costa Jr and Robert R McCrae. 2008. *The Revised NEO Personality Inventory (NEO-PI-R).* Sage Publications, Inc.

[14] Peter Gregory Dunn, Boris de Ruyter, and Don G Bouwhuis. 2012. Toward a better understanding of the relation between music preference, listening behavior, and personality. *Psychology of Music* 40, 4 (2012), 411–428.

[15] Kai R Fricke and Philipp Y Herzberg. 2017. Personality and self-reported preference for music genres and attributes in a German-speaking sample. *Journal of Research in Personality* 68 (2017), 114–123.

[16] Darren George, Kelly Stickle, Faith Rachid, and Alayne Wopnford. 2007. The association between types of music enjoyed and cognitive, behavioral, and personality factors of those who listen. *Psychomusicology: A Journal of Research in Music Cognition* 19, 2 (2007), 32.

[17] Robert O Gjerdingen and David Perrott. 2008. Scanning the dial: The rapid recognition of music genres. *Journal of New Music Research* 37, 2 (2008), 93–100.

[18] David M Greenberg, Michal Kosinski, David J Stillwell, Brian L Monteiro, Daniel J Levitin, and Peter J Rentfrow. 2016. The song is you: Preferences for musical attribute dimensions reflect personality. *Social Psychological and Personality Science* 7, 6 (2016), 597–605.

[19] Edward T Hall. 1963. A system for the notation of proxemic behavior. *American anthropologist* 65, 5 (1963), 1003–1026.

[20] Edward Twitchell Hall. 1966. *The hidden dimension*. Vol. 609. Garden City, NY: Doubleday.

[21] Felix Hupfeld and Michael Beigl. 2000. Spatially aware local communication in the RAUM system. In *International Workshop on Interactive Distributed Multimedia Systems and Telecommunication Services*. Springer, 285–296.

[22] Laura K Kirst. 2011. Investigating the relationship between assertiveness and personality characteristics. (2011).

[23] Alexandra Langmeyer, Angelika Guglhör-Rudan, and Christian Tarnai. 2012. What do music preferences reveal about personality? *Journal of individual differences* (2012).

[24] David Ledo, Saul Greenberg, Nicolai Marquardt, and Sebastian Boring. 2015. Proxemic-aware controls: Designing remote controls for ubiquitous computing ecologies. In *Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services*. 187–198.

[25] Esther R Lefevre and Malcolm L West. 1981. Assertiveness: Correlations with self-esteem locus of control, interpersonal anxiety, fear of disapproval, and depression. *Psychiatric Journal of the University of Ottawa* (1981).

[26] Max Lüscher. 1971. *The Luscher color test*. Simon and Schuster.

[27] Somayya Madakam, Vihar Lake, Vihar Lake, Vihar Lake, and others. 2015. Internet of Things (IoT): A literature review. *Journal of Computer and Communications* 3, 05 (2015), 164.

[28] Gerald Matthews, Ian J Deary, and Martha C Whiteman. 2003. *Personality traits*. Cambridge University Press.

[29] Miyo Okada, Atsuro Ueki, Niclas Jonasson, Masato Yamanouchi, Cristian Norlin, Hideki Sunahara, Joakim Formo, Mikael Anneroth, and Masa Inakage. 2016. Autonomous cooperation of social things: Designing a system for things with unique personalities in IoT. In *Proceedings of the 6th International Conference on the Internet of Things*. 35–42.

[30] Sampo V Paunonen and Michael C Ashton. 2001. Big five factors and facets and the prediction of behavior. *Journal of personality and social psychology* 81, 3 (2001), 524.

[31] Nerella V Ramanaiah and William M Deniston. 1993. NEO personality inventory profiles of assertive and nonassertive persons. *Psychological reports* 73, 1 (1993), 336–338.

[32] Peter J Rentfrow, Lewis R Goldberg, and Daniel J Levitin. 2011. The structure of musical preferences: a five-factor model. *Journal of personality and social psychology* 100, 6 (2011), 1139.

[33] Peter J Rentfrow and Samuel D Gosling. 2003. The do re mi's of everyday life: the structure and personality correlates of music preferences. *Journal of personality and social psychology* 84, 6 (2003), 1236.

[34] Peter J Rentfrow and Samuel D Gosling. 2006. Message in a ballad: The role of music preferences in interpersonal perception. *Psychological science* 17, 3 (2006), 236–242.

[35] Peter J Rentfrow and Samuel D Gosling. 2007. The content and validity of music-genre stereotypes among college students. *Psychology of music* 35, 2 (2007), 306–326.

[36] Thomas Schäfer and Claudia Mehlhorn. 2017. Can personality traits predict musical style preferences? A meta-analysis. *Personality and Individual Differences* 116 (2017), 265–273.

[37] Thomas Schäfer and Peter Sedlmeier. 2009. From the functions of music to music preference. *Psychology of Music* 37, 3 (2009), 279–300.

[38] K Warner Schaie. 1961. Scaling the association between colors and mood-tones. *The american journal of psychology* 74, 2 (1961), 266–273.

[39] Klaus Warner Schaie and Robert Heiss. 1964. Color and personality. (1964).

[40] Alessandro Soro, Margot Brereton, and Paul Roe. 2018. *Social Internet of Things*. Springer.

[41] Marco Spadafora, Victor Chahuneau, Nikolas Martelaro, David Sirkin, and Wendy Ju. 2016. Designing the behavior of interactive objects. In *Proceedings of the TEI'16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction*. 70–77.

[42] Lu Tan and Neng Wang. 2010. Future internet: The internet of things. In *2010 3rd international conference on advanced computer theory and engineering (ICACTE)*, Vol. 5. IEEE, V5–376.

[43] Jo Vermeulen, Kris Luyten, Karin Coninx, Nicolai Marquardt, and Jon Bird. 2015. Proxemic flow: Dynamic peripheral floor visualizations for revealing and mediating large surface interactions. In *IFIP Conference on Human-Computer Interaction*. Springer, 264–281.

[44] Mark Weiser. 1999. The computer for the 21st century. *ACM SIGMOBILE mobile computing and communications review* 3, 3 (1999), 3–11.

[45] Marvin Zuckerman, D Michael Kuhlman, and Curt Camac. 1988. What lies beyond E and N? Factor analyses of scales believed to measure basic dimensions of personality. *Journal of personality and social psychology* 54, 1 (1988), 96.

[46] Richard L Zweigenhaft. 2008. A do re mi encore: A closer look at the personality correlates of music preferences. *Journal of individual differences* 29, 1 (2008), 45–55.