# MULTIFACETED ANALYSIS OF OLDER ADULTS' AND CARETAKERS' ATTITUDES TOWARD SOCIAL ROBOTS

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Begüm Çonka
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We certify that we have read this thesis and that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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# ABSTRACT

## MULTIFACETED ANALYSIS OF OLDER ADULTS' AND CARETAKERS' ATTITUDES TOWARD SOCIAL ROBOTS

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The global aging population is increasing drastically, bringing crucial concerns regarding the lives of older adults. Though older people generally prefer staying at their own homes while aging, it's necessary to find solutions that will enhance their well-being and life quality since they experience many psychological and physical problems. This thesis focused on social robots' role in enriching older adults' environments, thus improving their healthspan by enhancing their psychological and physiological health. Therefore, aim of this thesis was to understand older adults' and caretakers' attitudes toward social robots. Semi-structured interviews were conducted with older adults (N=18) and caretakers (N=12). In the interviews, photos and videos of the three social robots with different abilities, appearances, and human-likeness levels were shown. These robots are the pet-like robot Aibo, the toy-like robot Paro, and the humanoid robot Pepper. Then, participants were asked to answer open-ended questions to explore their feelings about the robots, their preferences regarding meeting and interacting with them, and whether they would want to have these robots in their homes. Results were analyzed using sentiment analysis, which is a Natural Language Processing (NLP) method, and a qualitative analysis method, thematic analysis (TA). Sentiment analysis results demonstrate a differentiation in caretakers' attitudes toward social robots. They perceived Paro negatively but responded positively to Aibo and Pepper. On the other hand, older adults seem to have similar attitudes toward the three robots. Three experts working in the field of human-robot interaction conducted the TA separately. Combining their analysis, a new model was created, and when all experts confirmed this model, four overarching themes emerged: I) Perceived and expected roles of the robot, II) Physical characteristics and design features of the robot, III) Factors influencing acceptance of the robot, and

IV) Disadvantages of the robot. Themes and sub-themes under the overarching themes differed partly between older adults and caretakers and across Aibo, Paro, and Pepper. The findings of this thesis contribute to the literature by comparing the attitudes toward three different social robots in Turkish culture with the adoption of a multifaceted design approach.



*Keywords:* Social robots, healthy aging, elderly care, human-robot interaction.

# ÖZET

# YAŞLILARIN VE BAKICILARIN SOSYAL ROBOTLARA YÖNELİK TUTUMLARININ ÇOK YÖNLÜ ANALİZİ

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Yaşlanan nüfus küresel bir şekilde hızla artmakta ve bu durum yaşlıların hayatlarıyla ilgili önemli endişeleri beraberinde getirmektedir. Yaşlılar yaşlanma süreçlerinde genellikle kendi evlerinde kalmayı tercih etseler de psikolojik ve fiziksel birçok sorun yaşadıkları için onların refahını ve yaşam kalitesini arttıracak çözümler bulmak gerekmektedir. Bu yüzden, bu tez sosyal robotların yaşlıların çevrelerini zenginleştirmedeki, dolayısıyla psikolojik ve fizyolojik sağlığa katkılarıyla sağlık sürelerini iyileştirmedeki rolüne odaklandı. Bu bağlamda, bu tezde yaşlıların ve bakıcıların sosyal robotlara karşı tutumlarını anlamak amaçlandı. Yaşlılar (N=18) ve bakıcılar (N=12) ile yarı yapılandırılmış görüşmeler gerçekleştirildi. Bu görüşmelerde katılımcılara farklı yeteneklere, görünüşlere ve insana benzeme düzeylerine sahip üç sosyal robotun fotoğraf ve videoları gösterildi. Bu robotlar evcil hayvan benzeri robot Aibo, oyuncak benzeri robot Paro ve insansı robot Pepper'dır. Daha sonra katılımcılardan onların robotlara ilişkin duygularını, onlarla tanışma ve etkileşime geçme konusundaki tercihlerini, evlerinde bu robotların olmasını isteyip istemeyeceklerini keşfetmeye yönelik açık uçlu soruları yanıtlamalarını istendi. Sonuçlar bir Doğal Dil İşleme metodu olan duygu analizi ve nitel analiz yöntemi olan tema analizi kullanılarak incelendi. Duygu analizi sonuçları bakıcıların sosyal robotlara karşı tutumlarında farklılık olduğunu göstermektedir. Bakıcılar Paro'yu olumsuz algılarken Aibo ve Pepper'a olumlu yanıtlar verdiler. Öte yandan, yaşlıların üç robota karşı benzer tutumlar sergiledikleri görüldü. Tema analizini insan-robot etkileşimi alanında çalışan üç uzman ayrı ayrı yürüttü. Onların analizleri birleştirilerek yeni bir model oluşturuldu ve bu model tüm uzmanlar tarafından doğrulandığında, dört kapsayıcı tema ortaya çıktı: I) Robotun algılanan ve beklenen rolleri, II) Robotun fiziksel

ve tasarım özellikleri, III) Robotun kabul edilmesini etkileyen faktörler ve IV) Robotun dezavantajları. Ana temaların altındaki tema ve alt temalar, yaşlılar ile bakıcılar arasında ve Aibo, Paro ve Pepper arasında kısmen farklılık gösterdi. Bu çalışmanın bulguları çok yönlü analiz yaklaşımının benimsenmesiyle üç farklı sosyal robota yönelik tutumları Türk kültüründe karşılaştırarak literatüre katkı sağlamaktadır.

*Anahtar sözcükler*: Sosyal robotlar, sağlıklı yaşlanma, yaşlı bakımı, insan-robot etkileşimi.

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# Chapter 1

# Introduction

The world's aging population is growing sharply. We know that the percentage of the older adult population (people over 60 years old) will reach 24% by 2030 from 10% in 2000 [1]. When we look at the situation in Türkiye, we see that the population of people over the age of 65 increased by 21.4% from 2018 to 2023, reaching 8 million 722 thousand 806 [2]. This increase brings some concerns. For instance, along with increased life expectancy, it might cause an increased need for caregivers [3] who assist older adults in performing daily activities, keeping them safe, and maintaining social connections. However, finding employees caring for older adults will be challenging, and not everyone's economic situation will allow them to hire a caregiver. At the same time, the relatives of older adults may not have the time to take care of them all the time. Moreover, older adults prefer to stay in their own homes for the maximum duration possible [4], "age in place" [5], and live independently. In this case, placing older adults in rehabilitation centers is not the best solution for them either.

Therefore, it is necessary to find effective solutions to improve older adults' lives and environments and create safe spaces for them. To achieve this, it is first essential to examine what healthy aging is, the problems that older people experience during the healthy aging process, environmental enrichment for healthy aging, and the role of social robots in this regard.

This thesis begins with an introduction that explains healthy aging, environmental enrichment, social connectedness in older adults, the role of social robots in this context, and the purpose of the current study. Subsequently, there is the methods section, which includes information about the participants, the study procedure, the measures used in the study, and the analysis methods. Then, there is the results section obtained from sentiment analysis and thematic analysis methods, followed by a detailed discussion section explaining what the study's findings tell us.

## 1.1 Healthy Aging

The term "older adults" does not have a universally fixed definition across the world. There are different age threshold which differ between organizations and countries. For instance, United Nations define an older adult as a person over 60 years old [6], while it is 65 years for other sources [7]. According to the Turkish Statistical Institute [2], an older adult is defined as someone who is 65 years old or older.

It is important to understand the healthy aging process that we want older adults to experience. According to the World Health Organization (WHO), healthy aging is "the process of developing and maintaining the functional ability that enables wellbeing in older age." [8] Functional ability comprises an individual's intrinsic capacity, including mental and physical abilities, pertinent environmental factors composed of home, community, and relationships, and how those factors interact [8].

Furthermore, "healthy ageing is about creating the environments and opportunities that enable people to be and do what they value throughout their lives." [8] Environments impact many areas of our lives: our behavior, the health risks we encounter, and the quality of our lives. Moreover, environments hold the social care we need in itself [8].

By considering the individual, their environment, and the interactions between these two, it becomes clear that the healthy aging process is complex. It encompasses various factors, from a person's mental abilities to their surroundings and the relationships they develop within those surroundings.

To unravel this complexity, a study investigating healthy aging from older adults' perspectives [9] can be examined. According to this study, healthy aging can be approached by focusing on these groups of dimensions: biological, psychological, spiritual, and social. The biological dimension is related to the habits and behaviors (e.g., not smoking, healthy eating, and performing physical activities) adopted by older adults. These can be essential to maintain a healthy lifestyle in which older adults can preserve the protective factors against some diseases. In the psychological dimension, older adults mentioned the importance of optimism and happiness [9]. Both are related to many factors, such as the quality of life, social relationships, and connections with family and society. Speaking of social relationships, from the older adults' perspective, it was found to be closely tied to healthy aging [9]. It's crucial to sustain activities with close ones, including family and friends, at a later age. Finally, the spiritual dimension is related to faith and spirituality [9]. These and religiosity might help older people deal with various problems. Therefore, it is vital to ensure that older adults age healthily, considering all the dimensions mentioned above.

Since this thesis emphasizes enriching older adults' environments to contribute to their healthy aging processes, now, environmental enrichment, which plays a vital role in living organisms' lives by referring to enhancing the conditions in their environments will be explored.

## 1.2 Environmental Enrichment

Environmental enrichment (EE) is a valuable experimental design investigating the environment's role in living organisms' health [10] [11]. It can help us find ways to create complex environments that make organisms live as healthy as

possible throughout their lives and while aging. This design aims to stimulate organisms' physical, mental, or social states. A study investigating EE's impacts on improving healthspan demonstrated its various contributions, including psychological and physiological ones [10] (See Figure 1.1).

Laboratory experiments are being conducted with mice to achieve this. In these experiments, EE housing conditions comprise larger cages, toys, running mazes, etc. [10]. On the other hand, there are standard housing conditions with smaller cages and without additional stuff such as toys. Generally, these two conditions are compared to see how enriching the environment improves health.

It is essential to discriminate healthspan and lifespan to understand EE's effects better. Lifespan is the time between the birth and death of an organism [10]. On the other hand, healthspan refers to the time frame in which an organism maintains good health [10]. Rowe and Kahn first highlighted the healthspan by emphasizing the necessity for people to have all their functions throughout their lives [10]. Thus, according to Queen and colleagues [10], it is essential to extend healthspan without prolonging lifespan to prevent the adverse effects of aging.

EE experiments have shown many valuable findings on age-related diseases. Various studies examine the effects of EE on animal models of CNS disorders [11]. In one study investigating the impact of a stimulating environment on mice with Alzheimer's disease, researchers have found that the mice in EE conditions performed better in memory tests compared to the mice in standard cages, even though there is not a decrease in beta-amyloid (A beta) deposition [12] whose accumulation is closely tied to Alzheimer's disease [13].

In another study, EE's effects on the healthspan of mice have been examined [14]. It was found that EE results in an improvement in metabolism, behavior, and body composition (e.g., a reduction in fat mass). The study also reported that EE increases brain-derived neurotrophic factor (BDNF) [14], which decreases the risk for neurodegenerative diseases. Thus, we can say that, with EE, healthy aging was promoted in mice.

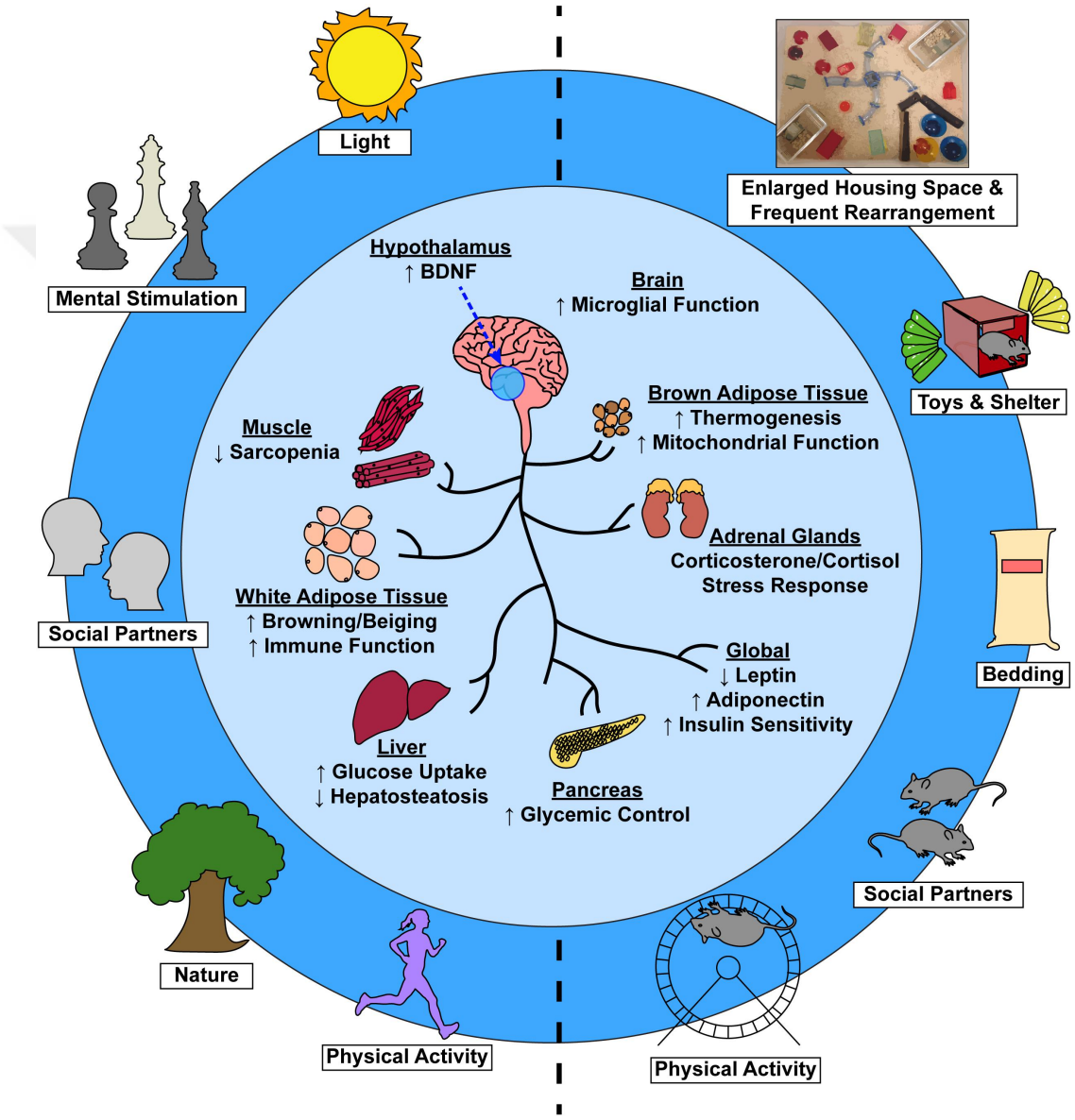


Figure 1.1: **Environmental factors induce systemic physiological change via a brain-body connection.** Complex EE stimuli in laboratory animals (right) and analogous stimuli in humans (left) contribute to not only improved psychological health, but to numerous tissue-specific and global physiological benefits as well (center). Reproduced from [10]

While EE reduces the risk of neurodegenerative disorders, can improve memory and cognitive abilities when these diseases are present, and thus promotes healthy aging, it is also associated with anxiety, depression, and sociability. One study compared the behavior of mice in enriched environments and standard conditions and found that EE mice showed less anxiety-related behavior than mice with standard conditions [15]. Furthermore, a reduced freezing time within the stress model, along with no change in corticosterone level, which is associated with stress response, was observed in EE mice [15].

Moreover, sustaining social bonds is vital for both laboratory animals and humans [10]. In humans, older adults might experience social isolation, which I will discuss further in the following section, that might cause a decrease in their well-being. A study with mice placed either grouped or isolated in a standard or enriched environment for two months examined not only their cognitive functioning and social interaction ability but also the medial prefrontal cortex and hippocampus for synaptic protein levels, myelination, neuroinflammation, BDNF and NOD-like receptor protein three inflammasome signaling pathways [16]. The findings of this study reveal that isolated mice demonstrated declines in spatial and social memory [16]. However, these problems in the memory were weakened when the isolated mice were in enriched environments (with a running wheel and toys) [16]. With the enlightenment of these findings, it can be deduced that creating enriched environments for older adults who experience social isolation might help maintain healthy functioning brain processes.

To further explore the importance of social connectedness in the aging process, the importance of sustaining social connections for older adults and their experiences in this context will be discussed in the following section.

## 1.3 Social Connectedness

According to Maslow's hierarchy of human needs [17], social connections are fundamental to our well-being, and the importance of social connections remains

in the healthy aging process. Social connection is thought to be protective against physical and mental health problems and early mortality [18] [19] [20].

As they age, it becomes challenging for adults to maintain social connections due to various physical and psychological problems. Their chronic diseases might prevent them from sustaining daily activities [21] and participating in social events, reducing social interaction. The social convoy model (SCM) [22] and the socio-emotional selectivity theory (SST) [23] [24] explain that adults' social network sizes typically decline as they age. With this decline, we observe narrowing social circles that include only family and a small circle of close friends.

Therefore, older adults start to experience social isolation, which is generally defined as the number of people a person meets and the frequency of meeting these people [25]. However, it also includes subjective components such as feelings of loneliness. A study examining social isolation in older ages [26], listed its five components: number of contacts, feeling of belonging, fulfilling relationships, engagement with others, and quality of network members. In this study, social isolation is defined as "a state in which the individual lacks a sense of belonging socially, lacks engagement with others, has a minimal number of social contacts, and they are deficient in fulfilling and quality relationships," encompassing both objective and subjective aspects [26].

In order to understand the importance of social connections and prevent social isolation in later life, it will be beneficial to look at its three dimensions, personal relationships, community connections, and societal engagement as listed in a study [25].

### 1.3.1 Personal Relationships

One of the dimensions of social connectedness in later life is personal relationships [25]. Personal relationships can prevent older adults from experiencing social isolation. Social isolation being linked with the frequency of contact makes "living alone" an important concept in predicting isolation [25]. However, living alone

does not always lead to being alone. Older people living alone may also have relatives and friends around them that they see frequently. On the other hand, older people living with their families may be isolated from their environment. In this case, it is more important to emphasize the vitality of the individual's relationships rather than living alone.

While the lack of support that socially isolated older adults experience is one of the essential parts of personal relationships [25], some studies suggested other components such as reciprocal communication and contributing to young people [27] [28]. These demonstrate that personal relationships do not mean some people look after them for older adults. Contrarily, they search for relationships in which they share things with others and guide them.

### 1.3.2 Community Connections

Another dimension of social connectedness is community connections, which are beyond close family and friends ties, referring to a person's engagement within a community [25]. To sustain community connections, older adults can participate in various activities such as sports or religious organizations [25]. Furthermore, some of the studies in the literature highlighted the importance of neighborhood connections that help establish a routine for daily life and form close relationships with neighbors [29] and that the lack of these connections might cause social isolation [30].

Community connections may weaken with the physical problems experienced by older adults. Preventing this is vital for older adults' well-being. Strategies in this regard include solving transportation problems and creating virtual environments for community engagement. Such strategies help older people remain members of a community and not experience social isolation even in the face of physical problems.

### 1.3.3 Societal Engagement

The third dimension of social connectedness is societal engagement, which is related to both the availability of resources and information and an individual's contribution to society [25]. Societal engagement helps people be aware of political issues and world events, thus reducing their social isolation [25]. When older people do not use digital communication tools, especially television, which help them stay informed about the world and thus integrate with society, they have the risk of being isolated [25]. At the same time, in today's world, where social media platforms are widely used to access news, older adults may not be able to get the necessary information quickly enough, even through television. To prevent this situation, as emphasized in a study [31], it is necessary to design new technologies and services considering older users.

In summary, examining social connectedness with its dimensions will be beneficial in helping older adults maintain their social connections within their personal relationships and the community and society they belong to. With this examination, finding solutions to the factors that prevent older adults from sustaining their bonds will be possible, and the quality of their lives and their well-being can be kept high.

## 1.4 Social Robots

To prevent older adults from experiencing social isolation that has severe mental and physical health consequences, researchers explored social programs, including technology-assisted interventions using social robots as companions [32]. A social robot is defined as "a physically embodied artificial agent," [33] in other words, an agent that can mimic a living being's behavior or appearance [33]. This agent has some characteristics that make people perceive it as a social entity; it can interact with humans with an interface [34], and it can communicate verbally or non-verbally with humans [33]. Broekens and colleagues [4] defined a social robot shortly with the following sentence: "In short, a social robot is an embodied

system that can be perceived as a social entity and is capable of communicating with the user."

Compared to a typical robot, a social robot has both technical and social features [34]. However, it primarily aims to interact socially [34]. To achieve this interaction, it needs to have some characteristics and capabilities. For instance, it should have the necessary communication skills to be able to interact with people in specific contexts. Moreover, it should behave naturally so people can perceive it as a social entity. A social robot's appearance should also be natural to attract people [34].

A study listed social robots' usage areas: medicine, hotel use, entertainment, nursing care, therapy, etc. [35]. In another study, social robots were mentioned as having a role in childcare [36]. More specifically, social robots were investigated to serve older adults in the following areas: mental and physical health, and as social assistants and home companions [37]. Shibata and Wada [38] also mentioned the areas in which these robots were designed to perform: entertainment, communication, mental therapy, education, and other purposes by referring to what we call "social robots" as "human-interactive robots."

Many studies involving people with emotional disorders such as dementia reported users' enhanced enjoyment, pleasure, and engagement with the use of social robots [39]. Thus, social robots can be used in the treatment of psychological disorders or in increasing older adults' well-being. For physical health, social robots can track older adults' exercise routines and serve as their coaches [40] by giving them instructions. Finally, social robots can assist older adults and become companions for them in their homes. Thus, unlike industrial robots, which are evaluated based on objective technical criteria, they are assessed through subjective evaluations in their respective functional areas. We can talk about what a social robot provides to a human emotionally, while for industrial robots, we focus on their efficiency.

Social robots used in the above-mentioned areas were examined in a study under headings such as attitudes toward, trust in, and acceptance of social robots

[33]. Examining studies on social robots in relation to these areas will help understand how these robots can be used for older adults, as well as how to conduct studies that explore older adults' approaches or feelings to social robots.

### 1.4.1 Attitudes Toward Social Robots

Current research on people's attitudes towards social robots offers mixed results, making it difficult to reach a general positive or negative consensus [33]. This might be due to the variety of contexts in which the effects of these robots were investigated, as well as the diversity of people whose attitudes were examined. Instead, employing social robots in specific areas with specific people and examining their attitudes can lead to more influential findings. At the same time, exploring attitudes through not only their polarity but also with the underlying reasons will be effective. For instance, in a study in which older people's attitudes and emotions toward different robots and in various situations were examined, older adults demonstrated more negative attitudes and emotions in a care situation, suggesting the situation in which a robot interacts with a human can determine attitudes and emotions [41].

### 1.4.2 Trust in Social Robots

Trust is another factor examined in human-robot interactions. It can also determine the willingness of people to use robots in certain areas [33]. Thus, trust is vital in understanding the effectiveness of integrating robots into people's lives. Although not many studies investigate trust specifically in social robots [42], it will be helpful to examine trust in robots. Thus, this thesis examines a study demonstrating that robot-related factors such as performance and attributes are the most substantial contributors to trust. In contrast, environmental factors play moderate roles [42]. Furthermore, in another study examining how mistakes made by robots affect people's trust in and acceptance of robots, it was observed that the robot's performance did not affect participants' decisions about

whether to follow the robot's decisions. Still, the nature of the task performed by the robot, such as whether it could be undone, determined whether participants would follow the robot's instructions [43].

### 1.4.3 Acceptance of Social Robots

Acceptance of social robots refers to people's intention to use them [25]. There is more evidence on acceptance, especially for elderly and healthcare domains, than trust [25]. Moreover, acceptance is related to many factors. For example, one study combining qualitative and quantitative methods to understand the acceptance of Socially Assistive Robots (SAR) found that planning to employ SAR was lower for now than for later [44]. Furthermore, personalizing robot appearance and abilities are found necessary for acceptance in the same study [44].

## 1.5 The Current Study

This thesis aimed to examine the attitudes of older adults and caretakers toward social robots. Specifically, the thesis investigated polarity of their attitudes toward social robots and the ideas behind these attitudes.

The study was conducted with older adults over 65 years old -according to the older adult definition of the Turkish Statistical Institute [2]- who are in the healthy aging process and who do not have neurological or psychiatric disorders. This is because, by studying this cohort, a baseline understanding of typical aging processes without the confounding factors of neurological or psychiatric conditions can be established. Moreover, in this way, the results of the study will be more generalizable to the broader population of older adults. Also, studying healthy aging helps find effective interventions that support older adults' lives.

Caretakers who take care of older people were also recruited in the study. This

recruitment is because social robots can help them by sharing their responsibility for older people. Thus, caretakers who do not have enough time to care for their older relatives can more easily establish balance in their lives. Moreover, they will feel more comfortable when they are not around their elders. As one study suggested [45], the benefits of social robots are not just for older people. They can also help family members, nurses, managers of nursing homes, etc., by enhancing older adults' well-being and quality of life [45].

The study was conducted in Türkiye with a Turkish sample. This creates an advantage for two reasons. First, not many studies investigate social robots' role for older people in Türkiye. Thus, it can contribute to the development of the field and form a baseline for future studies as one of the initial studies conducted in this field in this country. Secondly, as Broekens and colleagues [4] mentioned, most of the studies in the field were done in Japan. This situation prevents observing cultural variation in older adults' attitudes toward social robots. However, with the current study's findings, these cultural differences can be examined.

Social robots that are thought to function in the areas mentioned above come in various forms, from humanoid ones to pet-like ones. Like their appearance, these robots' capabilities and usage areas also vary. Three social robots were included in this thesis. These are Aibo, Paro, and Pepper (See Figure 1.2). Numerous studies have used these three robots in various contexts. However, only some studies in the literature directly compare the effects of these three robots. Therefore, the current study compared attitudes toward these robots, which have different abilities and appearances. In other words, these robots were chosen due to their features that enable them to interact and react differently from each other. Furthermore, previous studies that will be mentioned demonstrate their effectiveness in different contexts in which these robots were used.


Figure 1.2: **Social robots included in this study**

Sony released the companion robot Aibo in 2018 [46]. Aibo is in dog shape and performs dog-like behavior (See Figure 1.2 - a). With its appearance and behavior, it is aimed to provide warm feelings. Like a dog, it tries to interact with people by making eye contact [46]. In addition, the Aibo robot has a microphone, speaker, camera, and touch sensor. With its camera, it can recognize the people and places around it and act accordingly. Also, it is responsive to human voice and touch [46]. In one study [47], researchers investigated the effects of Aibo on older adults who stay in nursing homes by measuring some hormones in their saliva. They found that older adults' loneliness decreased after interacting with Aibo for one hour for 20 sessions within seven weeks.

Paro is another companion robot shaped like a baby seal (See Figure 1.2 - b). It was initially developed for use in therapy. For this reason, it was designed soft to evoke warm feelings in patients. It does not move but can move its eyelids, hind legs, and neck. Moreover, it has sensors to recognize speech and determine

the sound location [1]. Paro was used in many hospital and rehabilitation settings [38] and for research. In one study [48], researchers examined the effects of interacting with Paro on older adults using face and geriatric depression scales. Ten participants engaged with Paro regularly, twice a week, for one hour each session. The results showed that after one year of interaction, the participants' depression levels had decreased. Additionally, caregivers who facilitated the interactions reported that engaging with Paro helped the older adults laugh more and become more active. In another study conducted at a day service center, Paro's effects on mood and stress levels of older people with face scales and stress levels of nursing staff using a burnout scale were investigated [49]. Results of the study demonstrated that the robot improved older adults' mood and stress resilience while it decreased nursing staff's stress levels [49].

Pepper is a humanoid robot that can interact with people (See Figure 1.2 - c). It can move, express body language, perceive and understand its environment, and recognize people. Additionally, it has the necessary algorithms to identify emotion by analyzing people's facial expressions and voice tones. One study [50] used Pepper in a care home for older people for ten weeks and twenty sessions. They observed participants within this period and interviewed them to understand their adaptation and attitudes toward Pepper. The study's findings suggest that participants were positively occupied in the sessions when they interacted with the robot in the presence of an assistant who mediated the interaction.

In summary, Aibo, is a dog-shaped robot, while Paro is in the shape of a baby seal, a less familiar animal than a dog. In addition, Paro can be considered more toy-like because of its soft structure. Finally, Pepper is a humanoid robot that looks and behaves like a human. It is expected that the differences between these three robots would create different attitudes toward them.

Consequently, two research questions were developed. RQ1: "How do older adults and caretakers respond to social robots?" and RQ2: "How do older adults and caretakers respond to different types of social robots?"

# Chapter 2

# Methods

## 2.1 Participants

Participants comprise older adults who visit the Geriatrics department at Hacettepe University Hospital and those who care for older adults. All of the participants were Turkish speakers. Since this thesis examined older adults' attitudes toward social robots in the healthy aging process, participants without neurological or psychiatric disorders were recruited. Because two of the participants did not complete the interviews, one participant did not meet the inclusion criteria, and the answers of another participant were not clear, the data of these participants were excluded from the study. The remaining 30 participants' responses were analyzed.

Older adults (N=18) needed to be over 65 years old, and the age range for them was 66-88 (M=76.47, SD=5.03), and caretakers (N=12) over 18 years old (M=52.33, SD=6.10), with an age range between 38 and 64. 13 of the older adults and 9 of the caretakers were females.

## 2.2 Measures

Semi-structured interviews, including open-ended questions, were conducted with the participants. The interview questions were created to understand how the participants feel about the social robots, how they respond to them, and their attitudes toward them. Interview questions can be seen in Table 2.1 for older adults and Table 2.2 for caretakers.

Table 2.1: **Interview Questions in English and Turkish for Older Adults**

| **Questions in English** | **Questions in Turkish** |
|---|---|
| 1. What do you feel about this robot? | 1. Bu robot hakkında ne hissediyorsunuz? |
| 2. Would you like to meet and interact with this robot? Why/Why not? | 2. Bu robotla tanışmak ve etkileşimde bulunmak ister misiniz? Neden/Neden olmasın? |
| 3. Do you think this robot can help you in your daily living? Why/Why not? If yes, how? | 3. Bu robotun günlük yaşamınızda size yardımcı olabileceğini düşünüyor musunuz? Neden/Neden olmasın? Evet ise, nasıl? |
| 4. Would you like to have this robot at your home? Why/Why not? | 4. Bu robotun evinizde olmasını ister misiniz? Neden/Neden olmasın? |
| 5. Is there anything that you wish the robot is doing for you? | 5. Robotun sizin için yapmasını istediğiniz bir şey var mı? |

Table 2.2: **Interview Questions in English and Turkish for Caretakers**

| **Questions in English** | **Questions in Turkish** |
|---|---|
| 1. What do you feel about this robot? | 1. Bu robot hakkında ne hissediyorsunuz? |
| 2. What would your elderly feel about this robot? | 2. Yaşlılarınız bu robot hakkında ne düşünürdü? |
| 3. Would you like to meet and interact with this robot? Why/Why not? | 3. Bu robotla tanışmak ve etkileşim kurmak ister misiniz? Neden/Neden olmasın? |
| 4. Do you think your elderly would like to meet and interact with this robot? Why/Why not? | 4. Yaşlılarınızın bu robotla tanışmak ve etkileşim kurmak isteyeceğini düşünüyor musunuz? Neden/Neden olmasın? |
| 5. Do you think this robot can help you/your elderly in their daily living? Why/Why not? If yes, how? | 5. Sizce bu robot size/yaşlılarınıza günlük yaşamlarında yardımcı olabilir mi? Neden/Neden olmasın? Evet ise, nasıl? |
| 6. Would you like to have this robot at your home? Why/Why not? | 6. Bu robotun evinizde olmasını ister misiniz? Neden/Neden olmasın? |
| 7. Is there anything that you wish the robot is doing for you/your elderly? | 7. Robotun sizin/yaşlılarınız için yapmasını istediğiniz bir şey var mı? |

## 2.3 Procedure

Participants agreed to participate in the study by receiving information about the study's purpose, procedure, risks, and benefits. At the same time, participants were informed that their information and data would be kept confidential and could only be accessed by the researchers involved in the study. After the consent form was approved, interviews started. The Human Subjects Research Ethics Committee of Bilkent University (Decision number: 2022_11_26_01) approved the study.

In the interviews, participants were randomly shown the photos and videos

of the three social robots. After they saw the photos and watched the videos of each robot, they needed to answer some open-ended questions about the robots. Stimuli, consisting of photographs and videos, were chosen to allow the robots' appearance and capabilities to be examined in detail. Photos show moments when robots interact with humans, including older adults (See Appendix A.1, A.2, and A.3). The videos reveal what kinds of actions the robots can perform, again including their interaction with humans. The procedure can be seen in Figure 2.1, and the structure of the interviews can be examined in Figure 2.2.

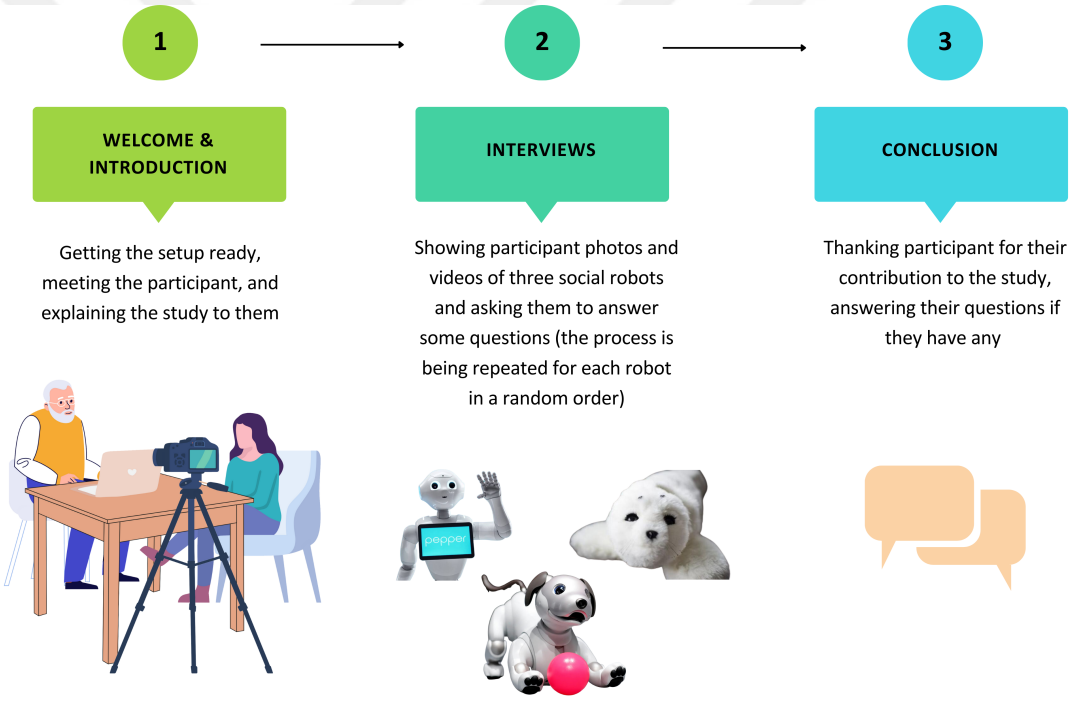


Figure 2.1: **Procedure of the study**

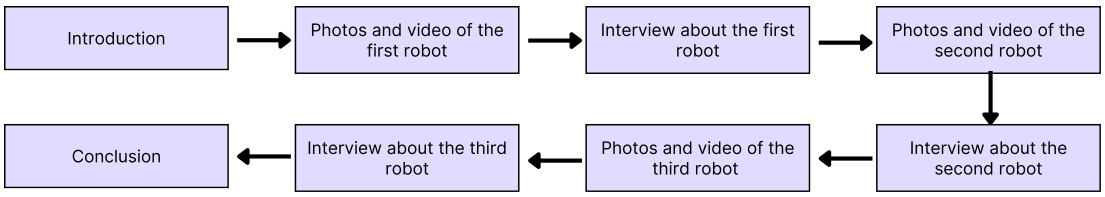


Figure 2.2: **Structure of the interviews**

As can be seen from the Figure 2.1, in the first step of the procedure, a convenient setup was created to conduct the interviews. In this setup, a laptop was placed in front of the participant so that they could review robot photographs and watch the videos. Since the videos contained explanations and conversations in some languages other than Turkish, they were watched with the sound turned off in order not to distract the participants. To analyze the interviews later, a tripod and camera were placed to frame the participant's face and recording began. After the interview was completed, recording was stopped.

## 2.4 Data Analysis

The auditory data collected from participants was manually converted into a text format for analysis. Then, text data was analyzed using both sentiment analysis, an NLP method, and thematic analysis.

### 2.4.1 Sentiment Analysis

Sentiment analysis is a method for obtaining and examining ideas, feelings, and perceptions regarding different topics, goods, or services [51]. The aim of this method is to classify the polarity of a given text. This polarity can be binary (positive/negative), ternary (positive/neutral/negative), or more granular (e.g., very positive, positive, neutral, negative, very negative). It can be applied to various texts, including reviews, social media posts, customer feedback, etc. Thus, the method is used in multiple areas, such as hotel, restaurant or airline services, and healthcare [52]. Applying sentiment analysis to these areas can help us understand customer attitudes, design better products, and solve problems.

Sentiment analysis generally works with the following steps: collecting data, text preprocessing, feature extraction, and sentiment classification (See Figure 2.3. In the first step, the dataset is getting done. In text preprocessing, several steps are followed to clean the data. First, the text is tokenized, which

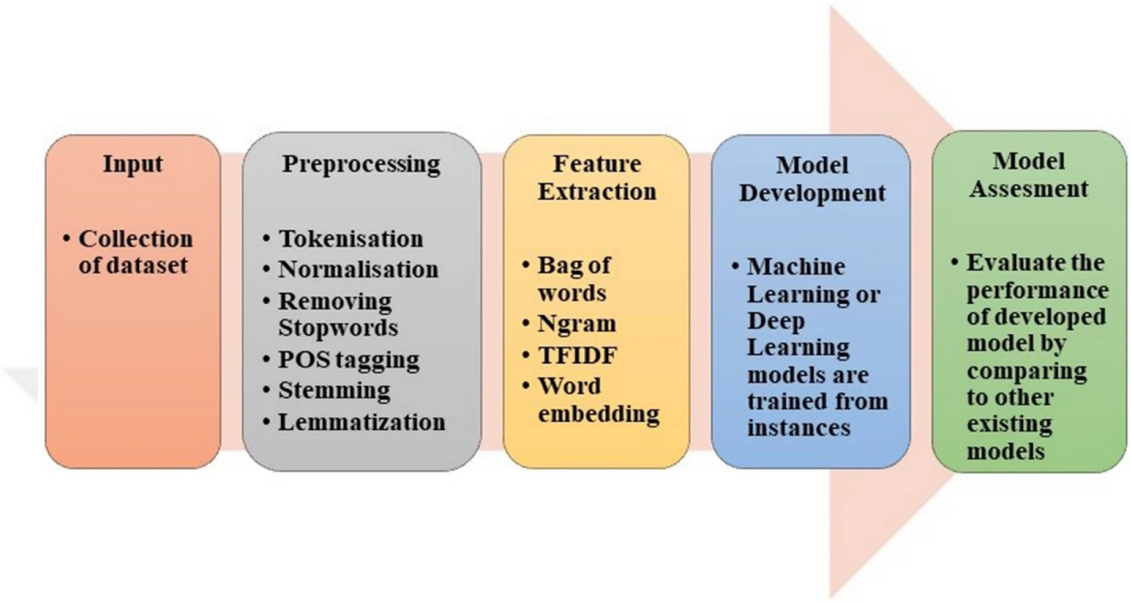


Figure 2.3: **Basic steps to perform sentiment analysis and emotion detection.** Reproduced from [54]

means splitting the text into tokens. Then, normalization, including converting all characters to lowercase, removing punctuation, and correcting misspellings, is performed. Other steps include stop word removal, eliminating the words that do not change the meaning of the sentiment, and stemming, in which the words are reduced to their root form. These steps are being followed since it is necessary to prepare and clean the data to make it ready for analysis. The third step is feature extraction, which is the process of transforming a text into a numerical format. In this step, various techniques, such as Bag of Words (BoW), Term Frequency-Inverse Document Frequency (TF-IDF), and word embeddings (e.g., BERT), can be used. Sentiment classification (model development) is the fourth step. In this step, texts are defined by some classes (e.g., positive, negative, or neutral). Again, there are multiple techniques to perform this step. These techniques include the lexicon-based approach and machine learning [53]. In the final step, the model's performance is being evaluated.

Sentiment analysis was used in this thesis to determine the participants' attitudes toward different types of social robots as positive, negative, or neutral. The analysis was performed with BounTi, one of the first Turkish sentiment analysis

Twitter datasets, consisting of three classes [55]. This dataset was formed from 7964 tweets. Two judges labeled these tweets, and their disagreements were resolved through discussions. Additionally, the performance of transformer models on this dataset has been compared. Multilingual transformers like XLM-Roberta and multilingual BERT were compared with Turkish-specific transformers like BERTurk. It was observed that the Turkish-specific transformer outperformed the multilingual transformers [55].

The success of models trained on the presented dataset was also analyzed through a social media experiment. It was found that the model successfully identified negative sentiments in tweets about a brand in the food sector and the short- and long-term effects of this sentiment. This demonstrates that models trained with the data can be successful not only in the area they were collected but also in other areas [55]. Therefore, this model was used to conduct sentiment analysis.

The necessary libraries were first imported into the model used for sentiment analysis. Then, training, validation, and test datasets were loaded. After these steps, the pre-trained model, "bert-base-turkish-128k-uncased," and the tokenizer for the model were initialized. Later, a function to initialize the model for sequence classification with three labels (negative, neutral, positive) was defined. Then, the data were prepared for the training. A custom trainer class to handle multi-label classification and apply class weights during loss computation was defined, and the model was trained and evaluated. In summary, the code leveraged the transformers library to fine-tune a pre-trained BERT model for sentiment analysis on a dataset with Turkish text.

This pre-trained model gave each answer in our data a score from 0 to 1 and a label indicating whether the answer was positive, negative, or neutral. For instance, for the statement "Bu robotu sevdim," which means "I liked this robot," in English, the tool gives the label "positive" and the score "0.68."

To prepare the scores for statistical analysis, the scores were adjusted by making negative scores also mathematically negative and giving 0 to neutral answers

instead of their original scores. Then, the averages for participants' scores for different questions in each interview about a particular robot were calculated. Thus, all participants received one sentiment score for each robot. The scores for Aibo, Paro, and Pepper were then averaged for both the older adults and the caretakers. In the end, six scores were obtained: the older adults' average scores for the three robots and the caretakers' average scores for the three robots.

### 2.4.2 Thematic Analysis

This study used thematic analysis by Braun and Clarke [56] to systematically identify, analyze, and report patterns within our qualitative data. This method enabled detailed investigation of older adults' and caretakers' approaches to social robots and allowed the combination of some of the recurring approaches, thoughts, and feelings expressed by the participants into specific patterns. These patterns are called themes that indicate essential aspects of the data in connection with the research topic [56]. The procedure that was followed to perform this analysis can be examined in Figure 2.4.

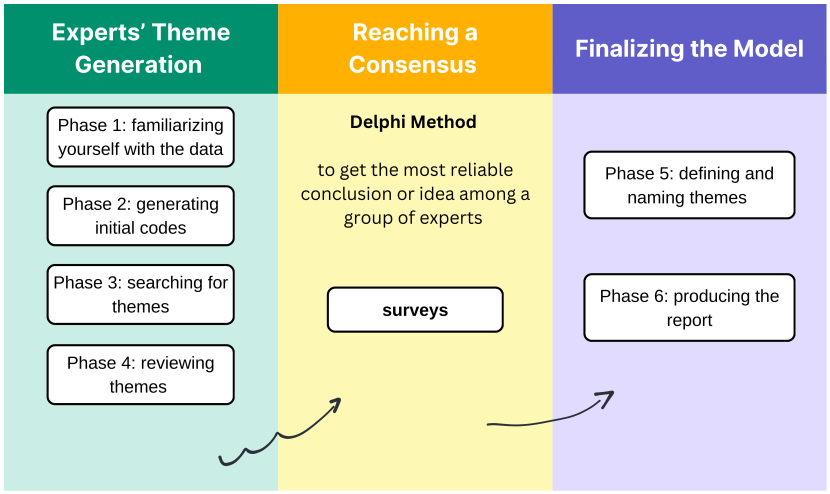


Figure 2.4: **Procedure of the Thematic Analysis.** The structure of the performed Thematic Analysis by Braun and Clarke [56] including its six phases and the use of surveys to conduct the Delphi method [57] [58]

This analysis method has six phases: familiarizing yourself with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report [56].

To be as objective as possible in this method, three experts who work in the human-robot interaction (HRI) area were recruited. Two of the experts are PhD students whose research area is how people perceive robots. The other expert is an undergraduate research assistant who has been involved in projects in the HRI field for several years. They performed the first four phases of the analysis separately after they were briefly informed about the study, its purpose, and research questions. In these four phases, they adopted deductive orientation, in other words, a more researcher- or theory-driven approach [56]. In this case, the experts determined a perspective by benefiting from their experience in this field and our study and research questions. For the first phase, the experts read and re-read the data that was given them in the text format to make themselves familiar. This phase also involves taking some initial notes to perform better in the following analysis phases. The second phase includes the formation of initial codes from the data. These codes indicate what the data is about and what some interesting parts are about it. In the third phase, potential themes are created by looking at the codes generated. Braun and Clarke [56] mentioned that it is beneficial to make visual representations (e.g., mind maps or tables) in this phase. The fourth phase is related to reviewing themes, which includes operations such as removing some themes, adding new ones, and combining several themes when necessary.

After the experts finalized their analyses, their separate models of themes were combined and a new model was created. The Delphi method [57] [58] was used to get the experts to agree on a final model. This method was found to get the most reliable conclusion or idea among a group of experts [57]. This is achieved by conducting questionnaires about the subject, getting experts' feedback, forming other questionnaires according to the feedback, and repeating this process if necessary [57]. Furthermore, it is important to make the experts carry out this process separately from each other [57]. In this way, they won't discuss the subject and influence each other.

This method was used by creating a survey that asked them how much they agreed with the themes in the new model, whether they were neutral or if they disagreed, why they disagreed, and what they would change about the themes. Following two rounds of discussion, all experts accepted the model, and the final set of themes was developed.

The last two phases of TA were conducted by the authors of the thesis. In the fifth phase, themes were defined and named. When the themes of the three experts were combined, appropriate names were found for each theme, the themes were formatted as overarching themes, themes, and sub-themes, and the meanings of the themes were written. Additionally, any overlaps between the themes were checked [56]. For the last phase, a report was produced explaining the themes with some quotes from the participants in the Results section.

# Chapter 3

# Results

Sentiment analysis and thematic analysis methods revealed essential results that will be explained in this section. Sentiment analysis demonstrated the polarity of the attitudes and identified differences between older adults' and caretakers' attitudes, in terms of polarity, across the three robots. Thematic analysis, on the other hand, uncovered overarching themes that illustrate the ideas behind participants' attitudes. Within these four overarching themes, there are themes and sub-themes that allow to understand the attitudes in detail.

## 3.1 Polarity of the Attitudes

2 (Participant group) x 3 (Robot type) mixed ANOVA was performed to analyze sentiment analysis scores on JASP [59]. As can be seen from the Table 3.1, results of the analysis showed that robot type does not have a main effect ($F(2) = 2.409$, $p = 0.099$), demonstrating no significant differences between the sentiment scores for the three robots. However, the interaction between robot type and participant group is significant ($F(2) = 4.299$, $p = 0.018$). The difference between the sentiment scores of caretakers and older adults is not significant ($F(1) = 0.037$, $p = 0.849$).

Table 3.1: **ANOVA Results for Within-Subjects and Between-Subjects Effects**

| **Effect** | **SS** | **df** | **MS** | **F** | **p** | $\boldsymbol{\eta^2}$ |
|---|---|---|---|---|---|---|
| Between Subjects | | | | | | |
| Older Adults/Caretakers | 0.014 | 1 | 0.014 | 0.037 | 0.849 | |
| Residuals | 10.515 | 28 | 0.376 | | | |
| Within Subjects | | | | | | |
| Robot Type | 0.334 | 2 | 0.167 | 2.409 | 0.099 | 0.022 |
| Robot Type x Participant Group | 0.596 | 2 | 0.298 | 4.299 | 0.018 | 0.039 |
| Residuals | 3.881 | 56 | 0.069 | | | |

$^{*}p < 0.05$

When looked at the post hoc comparisons, it was observed that, for older adults, there was no significant difference between sentiment analysis scores for the three robots (See Table 3.2 and Figure 3.1). This result indicates that their attitudes toward the three robots are similar regarding their polarity.

Table 3.2: **Post Hoc Comparisons for Robot Types.** C for caretakers and E for elderly

| **Comparison** | **Mean Difference** | **SE** | **t** | $\boldsymbol{p}_{\text{holm}}$ |
|---|---|---|---|---|
| C, Pepper vs. C, Paro | 0.325 | 0.107 | 3.053 | 0.003 |
| C, Pepper vs. C, Aibo | 0.053 | 0.107 | 0.496 | 0.622 |
| C, Paro vs. C, Aibo | -0.275 | 0.107 | -2.557 | 0.013 |
| E, Pepper vs. E, Paro | -0.030 | 0.088 | -0.343 | 0.733 |
| E, Pepper vs. E, Aibo | 0.041 | 0.088 | 0.469 | 0.641 |
| E, Paro vs. E, Aibo | 0.071 | 0.088 | 0.813 | 0.420 |

$^{*}p_{\text{holm}} < 0.05$

For caretakers, there was a significant difference between the sentiment analysis scores for the Paro robot (M = -0.07, SD = 0.38) and the Pepper robot (M = 0.258, SD = 0.31) (p = 0.003) (See Table 3.2). In addition, the difference between the scores for the Aibo robot (M = 0.205 SD = 0.28) and the Paro robot was also significant (p = 0.013). However, the difference between the Aibo robot and the Pepper robot was not statistically significant. These results suggest that caretakers have more positive statements for Aibo and Pepper than Paro. The

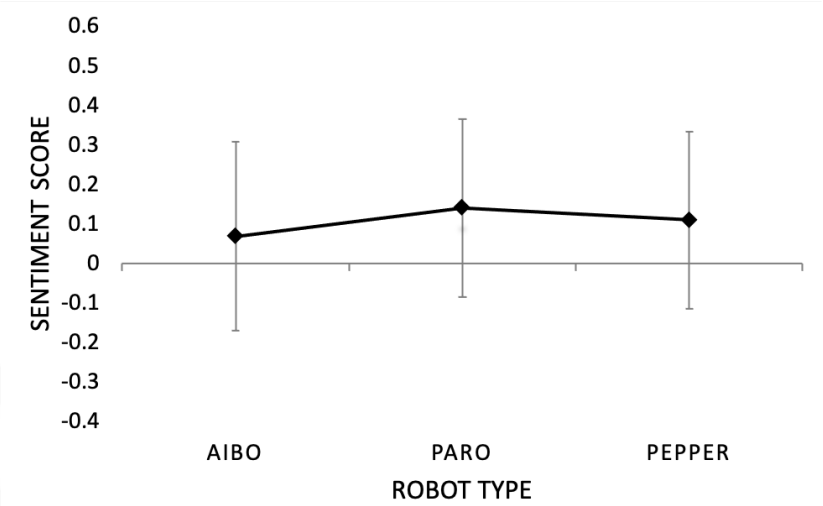


Figure 3.1: **Older adults' average sentiment scores for Aibo, Paro, and Pepper**

mean score for Paro shows us that the caretakers, on average, have negative attitudes toward the robot (See Figure 3.2).

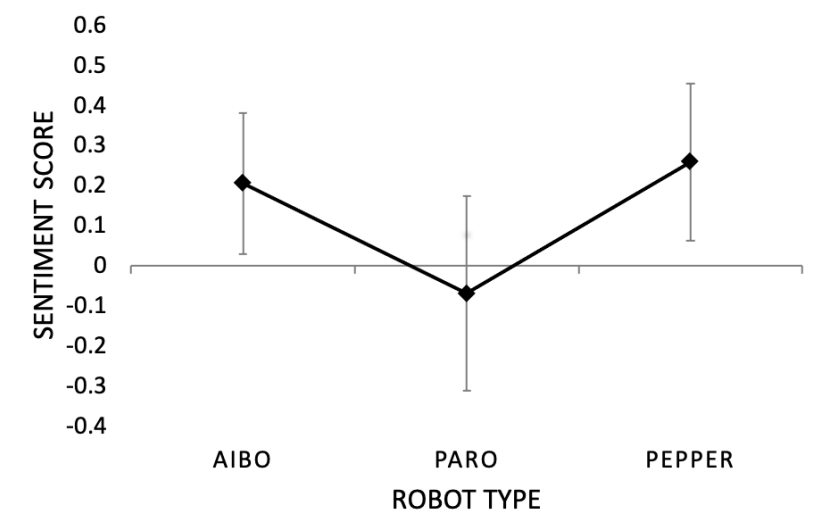


Figure 3.2: **Caretakers' average sentiment scores for Aibo, Paro, and Pepper**

## 3.2 Overarching Themes Behind the Attitudes

Four overarching themes emerged. These are perceived and expected roles of the robot, physical characteristics and design features of the robot, factors influencing acceptance of the robot, and disadvantages of the robot. Themes and sub-themes under those differed partly between the three robots. Venn diagrams demonstrating the themes and sub-themes across the three robots can be seen in Figure 3.3 and Figure 3.4.

The HRI experts evaluated the themes according to whether they were positive or negative. The themes demonstrating positive attitudes toward the robots were labeled positive, themes with negative attitudes were labeled negative. This labeling allowed understanding thematic explanations of the positivity and negativity observed in sentiment analysis. Positive and negative themes can be seen in Figure 3.3 and Figure 3.4 with labels in parentheses (+ for positive, - for negative).

Now, the thesis will discuss the themes with supporting quotations from the participants. There are letters and numbers representing the participants in parentheses at the end of the quotes. "E" represents elderly (older adults), and "C" represents caretakers. The numbers following these letters indicate the participant numbers. Tables containing these quotations and their original versions in Turkish and English translations, separated by themes, can be accessed in Appendix C.

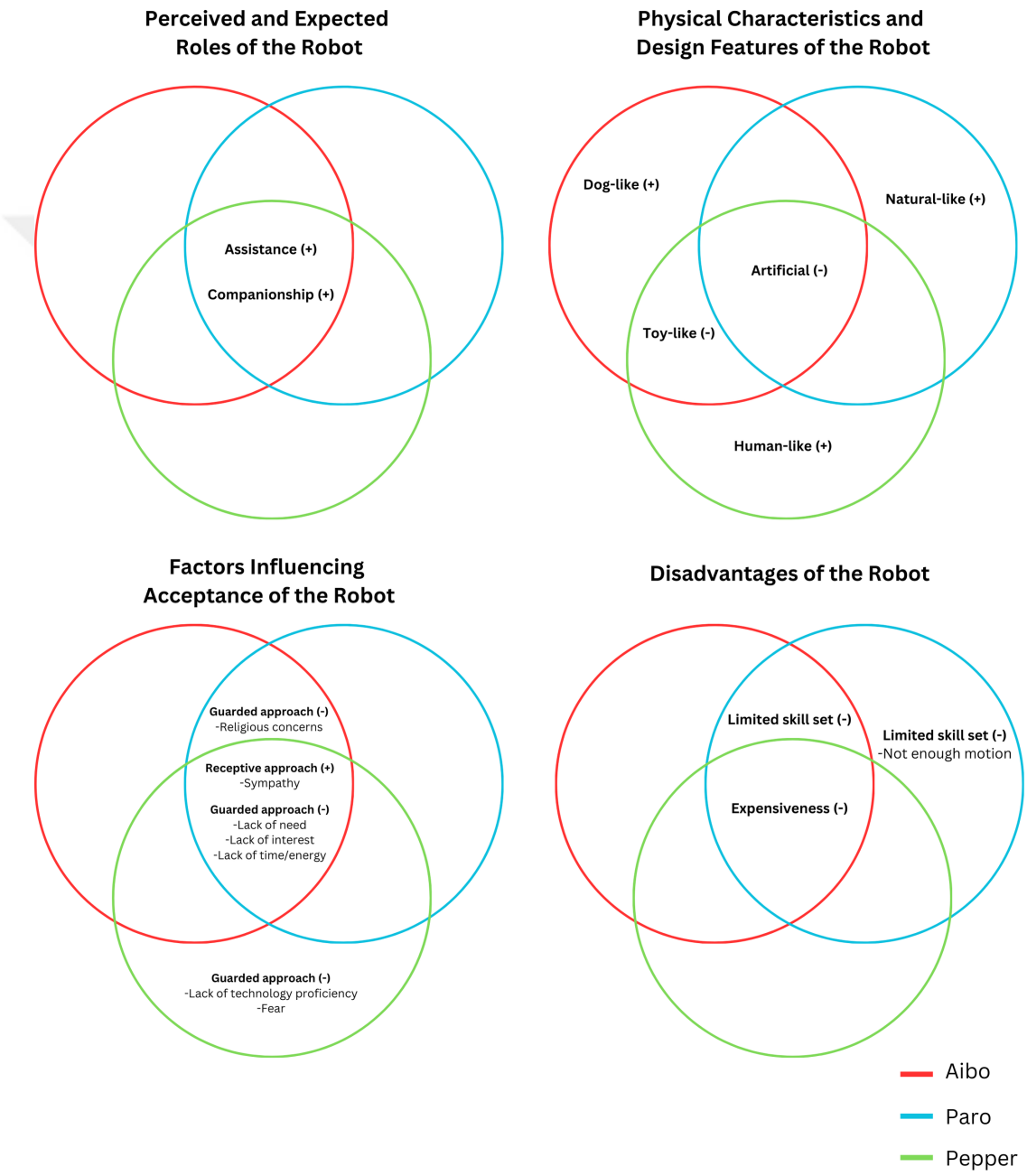


Figure 3.3: **Thematic diagram for older adults' attitudes toward social robots (Aibo, Paro, and Pepper)**

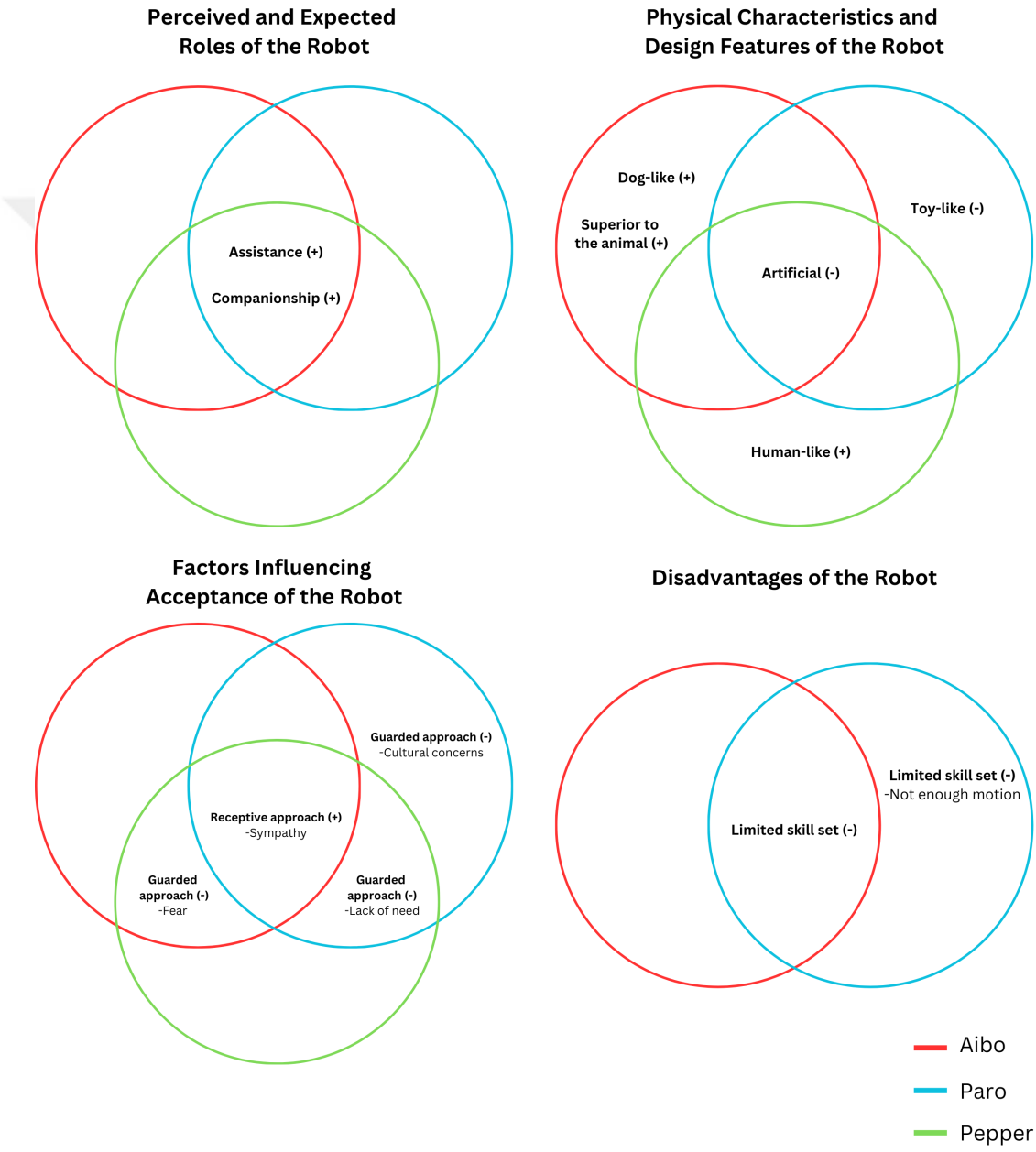


Figure 3.4: **Thematic diagram for caretakers' attitudes toward social robots (Aibo, Paro, and Pepper)**

### 3.2.1 Perceived and Expected Roles of the Robot

This overarching theme represents some of the roles and functions of the robots mentioned by the participants. These roles and functions might be based on what participants perceived or the roles they expected the robots to have after looking at photos and watching videos of the robots. In both older adults' and caretakers' responses, it can be observed that participants mentioned the robot's roles as assistance and companionship for the three robots. In the theme "assistance", there are some ideas related to the robots' roles in mostly physically assisting an older adult. For instance, one participant expressed his expectation from Aibo as follows:

> "... being able to bring the necessities, if I can't get up and I need it, when I say "bring me this", if it can bring it, of course, it will be where it (the robot) can get it, I want it to bring it if it can and help me with my needs." (E18)

As it can be understood from this quotation, some of the participants stated that the robots, especially Aibo and Pepper, since they can move, can help them by bringing their needs, such as water and food. In this way, robots can help older adults in their daily lives since they might have difficulty moving, get tired quickly, and are slower than younger adults.

Since Pepper is a humanoid robot with a screen on and some human-related abilities, such as recognizing emotions, many participants thought it is more developed. Thus, they believed that it can help older adults in many ways. One of the participants, who is an older adult, said the following after she was asked whether the Pepper robot can help her in her daily life:

> "Yes, it would help more. Like I said, at least 'pull that curtain,' 'tidy up there,' 'bring that,' 'take that away.' It helps in every way." (E1)

Furthermore, many of the caretakers highlighted that it would be beneficial if the

robots could inform older adults' relatives in an emergency. For instance, one participant said the following about Pepper:

> "...if it has such functions, such as calling for help in case of a life-threatening situation or an illness, it will definitely help." (C10)

Additionally, another participant mentioned the following about Aibo:

> "If it exists, it would be nice if it notifies you when there is an emergency. If it gives a warning signal... You know, if they (older adults) fall or something happens, I think it would be good for those kinds of things. I would like it to notify something like that." (C3)

These statements emphasize that relatives of older adults, especially those living alone, want to be informed when there is an emergency or danger. Robots with this ability will lift the burden from caretakers, making them more comfortable when they cannot care for their elderly.

Another theme about what participants perceive and expect as the roles of the social robots is "companionship," which can be defined as having someone or something that provides emotional support and friendship. It includes a close relationship with mutual trust and willingness to spend time together. In the current study, the theme "companionship" refers to the close relationship between a person and a social robot. Many participants talked about the possibility of Aibo, Paro, and Pepper being friends with older adults, giving them happiness and motivation, bringing color to their lives, and keeping them entertained. It was observed that this theme is common across the three robots in both older adults and caretakers. For example, an older participant mentioned the following about what Aibo can do for her:

> "...I think how nice it would be that it sits next to me in the house, walks around, attracts my attention and keeps me entertained." (E8)

Furthermore, a caretaker mentioned that Pepper can be a friend, a confidant to an older adult. Another caretaker emphasized that older adults can be distracted from obsessive thoughts by saying:

> "It seems unreasonable for me right now to establish an emotional bond with the robot, but I think that an old person might need it. In other words, it might distract him (the older adult), he might have some obsessive things, it will disperse that atmosphere. He gets into obsessive thoughts, it (the robot) wants a game, maybe it says 'love me,' something. It distracts their thoughts, maybe it relieves their loneliness, entertains them, and makes them laugh. Even laughter is good for them." (C3)

In summary, the "companionship" theme demonstrates that many older adults and caretakers believe in the possibility of social robots becoming friends with older adults and helping increase their mental well-being.

### 3.2.2 Physical Characteristics and Design Features of the Robot

Both older adults and caretakers took cognizance of what the robots look like and their design features. As expected when including three robots with different appearances in the study, varying sub-themes emerged for the three robots under this overarching theme. For Aibo, both older adults and caretakers mentioned, in a positive way, that the robot is dog-like. The theme "dog-like" illustrates that Aibo, with its appearance and movements, was found to be similar to a real dog. Some older adults stated:

> "So, I like animals. It is sympathetic because it is in the shape of a dog. I liked it. My feeling is that it became sympathetic. I mean, I like animals, so I liked it very much." (E3)

"Well, it does everything just like normal animals kept in homes." (E8)

Some caretakers believed Aibo could be even better than a real dog. Since the Aibo robot does not shed hair, cause allergic problems, and require care, it was found to be "superior to the animal." Example statements are:

"I mean, I would like to have this robot in my house. I love dogs anyway. It is hairless and it moves. I would definitely want it." (C9)

"Normally, many people do not want to keep pets at home because they are affected by cat hair or dog parasites, but with this robot style, at least those features are eliminated." (C11)

Additionally, some caretakers stated that they are afraid of dogs. Thus, they could take care of Aibo at home instead of feeding animals and even overcome their fear of animals thanks to Aibo.

Overall, participants' thoughts related to the physical appearance and design features of Aibo demonstrate that the robot's similarity with a real dog can make them like and adopt it. Moreover, in some cases, Aibo can serve some people even better than a real dog.

Some older adults found Paro "natural-like." An older participant reflected on this theme by mentioning that since it is hairy, it is similar to a living being and natural. While Paro was approached positively from this perspective by some older adults, it was seen as "toy-like" by some caretakers, which became a negative theme. Reflections on this theme can be examined from the following quotations:

"So, his toy-like appearance didn't make me feel much." (C5)

"I just saw it as a toy." (C12)

The "toy-like" theme was also observed in older adults. However, some older adults perceived Aibo and Pepper but not Paro as toys. For instance, a participant stated the following about Aibo:

> "So, at first, I likened them to toys, the little things that children play with. I mean, I don't know what use they would be for adults." (E13)

Moreover, about Pepper, another participant said:

> "This is something that is more in the domain of young people and children. So, they can play with it." (E8)

Pepper was found human-like by some of the older adults and caretakers. A caretaker said:

> "So, when I looked at the robot, I saw it as a human-like being that lives with its emotions. It is likened to a human. Most of all, emotions, love, compassion, sharing, being together, making friends... So, this aspect is likened to a human." (C12)

Pepper's similarity to a human was perceived positively. An older participant stated that she would like the robot in her home with the following sentence:

> "I would like this robot very much. A human in the house. Let it wander around and have fun." (E1)

Under the physical characteristics and design features of the robot, the "artificial" theme can be seen. This theme is present for both participant groups and all of the robots. Many participants remarked that they would not prefer to meet with or have the robots since they are artificial. They also indicated that they choose to interact with living beings, either animals or people. For instance, about Pepper, an older participant stated that nothing can replace a human, so making a humanoid robot is unnecessary.

> "I think the most valuable being in the universe is a human being. Nothing can replace a human being. Why is there a need for such a robot? There are many people in the world who are unemployed and without anything reliable. Why such an artificial person when there are real people? When we can help real people? I do not approve of imitating people, robotizing them, cloning them, etc." (E3)

Another older adult said that Pepper is not an emotional thing, so it does not mean anything to him.

> "I mean, this doesn't mean anything to me, something that is not emotional... There should be a person with emotions." (E10)

### 3.2.3 Factors Influencing Acceptance of the Robot

Various factors influenced participants' acceptance of the robots. These factors indicate the reasons behind willingness or reluctance of older adults and caretakers to approach and engage with these robots. This overarching theme is divided into two themes: receptive approach and guarded approach. The receptive approach refers to the factors that make the participants accept the robots. On the other hand, the guarded approach is related to the factors that cause participants to be reluctant to accept the robots.

The receptive approach was encountered in both older adults and caretakers and for the three robots. By approaching positively, the participants demonstrated sympathy, which became a sub-theme under the receptive approach. Participants who expressed sympathy used words such as "cute," "beautiful," and "nice." Although the answers related to sympathy for the three robots were similar, there were some different answers as well. For instance, an older adult found Aibo's movements cute.

> "It's cute how it moves like this. The other party is probably doing

something with their remote control. It's a cute thing, nice." (E2)

Additionally, a caretaker focused on Pepper's technological features while showing it sympathy.

> "It is a very useful thing. It is extremely good to use technology. I think it is extremely good because it is a technology product." (C2)

Moreover, some participants remarked that Paro looks real, feels warm, and attracts people. These feelings made them approach Paro with sympathy and be willing to accept it.

There were several reasons why the participants, who approached social robots with caution and distance, did not want to meet and interact with these robots, did not want them to be in their homes, or believed that these robots could not help them. When older adults' guarded approach to social robots was considered, it can be observed that, for Aibo and Paro, some of them had religious concerns. By religious concerns, it is meant that they do not consider having Aibo and Paro at home to be religiously appropriate. An older adult emphasized that even praying in a room with pictures is not appropriate. Thus, even though a robot is not a living being, having it in a house where people worship is also inappropriate.

> "What I'm saying is, I don't want animal things, I don't want them at home, it's not appropriate at home. Even if it's not a living being, I don't want it at home. In fact, I don't like pictures of them at all. Their grandfather puts up pictures of our grandchildren since they are abroad; for example, I pray with my back turned to the pictures. So, it's not appropriate, it's not appropriate according to our religion. That's what we knew. We read books, too. Also, hodjas tell. That's why I don't want animal things at home; I mean, they are not even appropriate for clothes or pictures. I mean, in worship, it's for everyone, not just for me. Because even though they are not living beings, they are like ones. I don't want it, dear." (E17)

Older adults also mentioned their lack of need, interest, and time/energy toward accepting social robots. These sub-themes are common among Aibo, Paro, and Pepper. Some of the older participants stated that although they might need these robots in the future, they don't think the robots can perform actions that help them at the moment. For instance, an older adult who is already active and can care for herself stated that she doesn't need Aibo.

> "...I don't really need it. So, how I don't need it? For example, I am already very active. Even without movement, I can take care of myself with bringing and taking stuff." (E11)

Some older adults expressed a lack of interest in social robots, stating that they don't feel sympathy or any related emotions towards them and don't believe these robots are intended for their demographic.

Moreover, some older participants remarked on their lack of time and energy to meet and interact with social robots, have them in their homes, or get help from them in general. For example, one of the older participants in our study stated that she is receiving treatment in oncology, so she doesn't have the energy to interact.

> "I would like to, but I am not in a position to meet or interact. I am receiving treatment in oncology, I am sick." (E1)

A few participants, who are older adults, pointed out that they don't have any time to interact with the robots since they are already busy in their daily lives. An older participant stated:

> "I don't have time. I do my own work at home. There is no time for this, no time to do anything." (E2)

On the other hand, when asked about her opinions about the Paro robot, another older participant focused on the necessity to pay a good amount of attention to the robot and said:

> "...you should look at it and be happy with its actions constantly, I don't have time for that right now." (E11)

Some older adults remarked on their lack of technology proficiency by approaching Pepper cagily. They stated they did not know enough about other technological devices, such as phones and vacuum cleaners, so they would not understand how to use Pepper.

> "Well, there are these robot vacuum cleaners, I don't even use them. I mean, since we are getting older..." (E14)

> "I don't understand that, dear. You must know everything about it. My husband and I are both primary school graduates. This needs to be understood. Our children know it, but we don't understand it, dear. I don't understand everything about the phone, either." (E17)

Another reason that might cause older adults to abstain from social robots, specifically Pepper, is fear. While one of the older adults mentioned she would be scared if she had Pepper in her house,

> "If I had such a robot in my house, I would be afraid of it." (E3)

another participant focused on the possibility of robots replacing humans in some occupations and causing them to become unemployed.

> "These robots will probably be the thing of the next century. They will work instead of people, with people's jobs... It is said that they will cause harm as well as benefits. Why, it is said that they will make a lot of people unemployed." (E13)

When caretakers' responses related to the guarded approach sub-theme were examined, it was seen that they have fear-related concerns about Aibo and Pepper.

One participant focused on the possibility of Aibo being greeted with hostility by some older adults (e.g., people with Alzheimer's disease) by stating the following.

> "It might even seem hostile to an elderly person or to an Alzheimer's patient. So, it might even be viewed as hostile." (C4)

A few of the other caretakers indicated that they found Pepper cold and scary.

> "Well, maybe it's the technology of our future, but it's very repulsive, very scary." (C1)

> "Looks a bit scary to me." (C6)

These approaches to Aibo and Paro demonstrate that caretakers contribute to the study by commenting on both their own thoughts and what their elders would think about these robots.

As in the older adults' responses, caretakers also mentioned a lack of need for social robots, especially for Paro and Pepper. Nonetheless, it was discovered that the "lack of need" sub-theme stems from their own attitudes toward these robots, not from their ideas about how older people approach them. For Paro, a caretaker mentioned:

> "I guess it's because it's not needed, because I have a lot of preoccupations right now... Mental fatigue, body fatigue... Since I'm dealing with many things, I don't think I'll need it or make time for it right now." (C5)

Furthermore, about Pepper, the same caretaker emphasized that she wants to meet with the robot but does not think about living with it since she does not need it.

> "Since I don't feel such a need for myself right now... I would like to meet but don't think about living together right now." (C5)

The "cultural concerns" sub-theme detected only for Paro in caretakers' responses is related to some ideas referring to the importance of caring for older people in our society and that this job should not be left to robots. Supporting quotations for this theme include:

> "You know, we have a culture that didn't just form overnight. In our culture, children look after their mothers and fathers. There is such a loneliness, a feeling of need here, and frankly, I think it was designed for that purpose. Our elderly are more like, 'our children should come and take care of us.' Or... There is no 'or.' In fact, it is exactly like that. A nursing home, a rehabilitation center... Since they are not even open to such concepts, it is impossible for them to come close to these (robots)." (C10)

> "But for example, we are always with our mother and father... It seems like our social structure has something like not leaving mothers and fathers alone. That's why it didn't really suit me." (C2)

However, there was another caretaker who was also aware of the cultural foundations of caring for older adults but thought that a change might occur in this regard.

> "Of course, the elderly generally want to be in touch with their families more, but could there be a change? It could be." (C11)

### 3.2.4 Disadvantages of the Robot

Older adults and caretakers mentioned some disadvantages of social robots. These disadvantages encompass the negative aspects, limitations, and concerns portrayed by older adults and caretakers regarding social robots.

Both older adults and caretakers noted that Aibo and Paro have limited skill sets. They emphasized these two robots' inability to help people effectively. When asked whether the Aibo robot could help her in her daily life, an older adult said it could not cook or clean. Thus, it cannot help.

> "It can't do it, what can it do? What can it do for me? Right? It can't cook or clean." (E12)

Another participant, a caretaker, emphasized some inabilities of Aibo as follows:

> "It can't bring your water or medicine." (C1)

Older adults and caretakers expressed that Paro does not have enough motion, which became a sub-theme under "limited skill set." They considered it a disadvantage that Paro's movements were more limited than Aibo and Pepper's. An older participant said:

> "What can it do? It can't move. It can't help me in any way. It's just something soft, but the pillow does the same thing." (E3)

Moreover, a caretaker expressed this disadvantage by stating that Paro seemed monotonous to her because it does not walk.

> "This does not move or anything, so it just seems a little more monotonous." (C6)

If the disadvantages of Pepper were to be discussed, it would be found that there were none for the caretakers. However, from the older adults' perspective, there is another theme called "expensiveness" for all three robots, including Pepper. Some older adults indicated that the robots are presumably expensive, making it difficult for them to buy. For instance, a few older adults pointed out that they would like to purchase the robots if their economic situations were suitable. A participant mentioned the following about Pepper:

> "I can also consider it for my house, as I said, if financial means are available." (E2)

To summarize, older adults emphasized the significance of economic circumstances in acquiring social robots, particularly within household settings.

# Chapter 4

# Discussion

This thesis explored older adults' and caretakers' attitudes toward social robots. The research questions were formed to investigate how older adults and caretakers respond to social robots and the differences in their responses toward different types of social robots. Since the study was conducted in the hospital, the participants are composed of people with various economic situations, life conditions, and education levels. This is an essential advantage of the study because it enabled a diversification of participant profiles, leading to a more diverse dataset.

Semi-structured interviews were conducted with the participants. Their answers were analyzed using sentiment analysis and thematic analysis. The findings of this thesis reveal significant insights into the polarity of the attitudes of older adults and caretakers toward social robots, as well as the underlying factors influencing these attitudes. By highlighting the differences observed between two participant groups and three robots, this thesis aims to contribute to the literature and inform the design and implementation of social robots to help older people age healthily.

## 4.1 Polarity of the Attitudes

Sentiment analysis helped identify the polarity of the attitudes. In general, participants had positive attitudes toward social robots. However, there were cases in which some participants had negative attitudes.

The lack of overall difference between the attitudes toward Aibo, Paro, and Pepper demonstrates that participants had similar and positive attitudes toward the three robots. Furthermore, the analysis revealed no difference between older adults' and caretakers' overall attitudes toward social robots.

However, the pattern of the sentiment scores between older adults and caretakers differed, resulting in essential findings. It was observed that older adults had positive sentiment scores toward Aibo, Paro, and Pepper, and there was no difference between them. This indicates that older adults have similar and positive attitudes toward social robots regardless of their different appearances or abilities. On the other hand, caretakers' sentiment scores differed, showing they have negative attitudes toward Paro and positive and similar attitudes toward Aibo and Pepper. These findings suggest that older adults and caretakers respond differently to social robots, emphasizing the importance of including communities of people with different demographic characteristics in the study.

The difference between older adults' and caretakers' approaches to social robots might be due to the differences in their use of technological devices. As stated by Fischer et al. [60], older adults generally don't catch up with new technologies because they don't form enough interaction with technology. Their lack of knowledge regarding developing technologies may have caused them to approach robots with similar attitudes without differentiating them and making sufficient comparisons between their appearance and capabilities. Moreover, caretakers perceiving Paro negatively might have resulted from the fact that it is in the shape of a seal which is not a very familiar animal compared to a dog.

One limitation of the sentiment analysis is related to data training. Due to the small sample size, training a new model was not possible, making relying on

a pre-trained one necessary. Although the model used in the study performed successfully on data outside its original training domain, using a model specifically trained for this research domain or training the data specifically for this study with a larger sample size could have enabled the sentiment analysis to give a more reliable result.

## 4.2 Overarching Themes Behind the Attitudes

First of all, recruiting three experts working in the field of HRI while conducting the thematic analysis provided the opportunity to evaluate and interpret the data consistently and reliably, thus providing inter-rater reliability, as done in one study [61].

As a result of the thematic analysis conducted, this study identified themes that support previous studies and themes that have not yet been seen in the literature. Examining all of these themes will be crucial to better evaluating the study results in relation to the literature.

To begin, in a review study on how older adults experience and perceive social robots [62], there is a theme called "Roles of a SAR" that can be considered similar to the current study's overarching theme named "Perceived and Expected Roles of the Robot." This study mentioned older adults' perceptions of social robots as having servant-like and cognitive assistance abilities [62]. These perceptions are very similar to the current study's theme, "assistance." Furthermore, in the same study, SARs were also considered to provide companionship [62], one of the current study's themes under "Perceived and Expected Roles of the Robot."

In another study, a three-step design process was conducted to make design and ethical recommendations for the robots used as mental well-being coaches [63]. In the first step, well-being users' and well-being coaches' expectations and perceptions were examined. Researchers conducted semi-structured interviews and group discussions and analyzed their data with thematic analysis. Their

themes included "robot features," which can be considered similar to the overarching theme, "Physical Characteristics and Design Features of the Robot," in the current study. In their study, under the "robot features" theme, there is "robot form," which refers to its appearance and embodiment [63]. This theme can be considered compatible with themes under "Physical Characteristics and Design Features of the Robot" (e.g., dog-like, human-like, natural-like), which are closely related to the appearances of Aibo, Paro, and Pepper. Additionally, another overarching theme named "Disadvantages of the Robot" also supports the "Robot Disadvantages" theme in this study [63].

Another overarching theme in the current study, "Factors Influencing Acceptance of the Robot," aligns with the "acceptance of robots" theme in another study [61].

Even though the current study's overarching themes can be evaluated as similar to the previous studies in the literature, there are some distinctions in the themes and sub-themes, which might have resulted from the differences between the current study's and prior studies' aims and research questions.

This study aimed to compare older adults' and caretakers' attitudes toward social robots. Looking at the first overarching theme, "Perceived and Expected Roles of the Robot," for both participant groups, it can be seen that the themes are common. Both groups mentioned "assistance" and "companionship" for all the robots. This suggests that the roles of social robots expected and perceived don't change between older adults and caretakers, regardless of the type of the robot. Participants, in general, indicated that the robots could be assistants and companions for people.

A common negative theme in this thesis is "artificial" under "Physical Characteristics and Design Features of the Robot." This theme is present for both participant groups and all the robots, demonstrating that people have negative feelings about social robots because of their inanimateness. Thoughts related to this theme can be encountered in other studies. For instance, in a study, "lack of humanness" was considered a disadvantage for Pepper in the role of a well-being

coach [63].

The positive comparison of Aibo to a dog by both groups and the positive evaluation of Paro as natural-like by older adults should also be seen as important results of the TA. Since these themes appear as patterns, it is crucial to consider that there may be older adults and caretakers who have these thoughts and that these people may prefer robots of this style.

Moreover, the fact that Pepper was seen as positively human-like by both older adults and caretakers might be considered consistent with the uncanny valley, proposed by Mori in 1970 [64], which explains the idea that making an agent's appearance human-like will positively affect people's attitudes towards them. Still, when this similarity is increased too much, people will perceive it in a strange and disturbing way [65].

The "Superior to the animal" theme that was encountered in caretakers' responses for Aibo is vital in showing a possible use for this robot. As some participants stated, Aibo can be even better than looking after a real dog or another animal because of the reasons mentioned in the results section (e.g., not causing allergies, not requiring actual care). From this theme, it can be understood that Aibo can be used by people who cannot have a real animal in their houses. In this regard, it may also be a suitable alternative for older adults with such concerns, even though they did not directly mention them in this study.

The perception of Aibo and Pepper as toy-like by older adults and Paro as toy-like by caretakers might be influential for social robot designers and future studies exploring the attitudes toward social robots. Since this theme is a negative one, future studies should examine the toy-like features of robots in detail and change/improve these features when deemed necessary, which will contribute to a more positive approach to robots.

The theme of religious concerns under the "guarded approach" reveals an issue we have not encountered in the literature by showing the relationship of religion with the approach to social robots, especially animal-like ones (Aibo and Paro),

in our study. Examining this issue in more detail in future studies would be helpful.

The "lack of technology proficiency" sub-theme that let older adults to approach Pepper with distance is in line with one study that found "lack of experience with technology" as a barrier for the adoption of SARs [44].

The "cultural concerns" sub-theme that emerged from caretakers' responses to questions about Paro is significant as it provides insights into the impact of Turkish culture on the acceptance of social robots. Türkiye has a collectivistic culture, resulting in a responsibility to take care of our elderly and avoid leaving them alone. This theme is seen only for Paro, which might be because of its original design as a companion robot for people with Alzheimer's disease. In the video shown to the participants, Paro was in a rehabilitation center interacting with older residents. Thus, the video might have affected caretakers by reinforcing their cultural concerns about not letting their elderly relatives stay in nursing homes or rehabilitation centers. In addition, these cultural concerns might be due to the novelty of robots in Türkiye, resulting in a lack of culturally established expectations regarding the design and use of robots [66].

Caretakers did not mention any disadvantages for Pepper while indicating that Aibo and Paro have limited skill sets. This demonstrates that they had more positive thoughts about Pepper regarding its skills. On the other hand, in older adults' responses, there is "expensiveness" as a disadvantage for all three robots, including Pepper, supporting one of the previous studies [63]. In another study, authors stated that robots have few functions but high costs by emphasizing the need to consider this situation and conduct studies in which robot costs are the main problem [67]. The absence of the theme of expensiveness among caretakers may be because caretakers consider robots not only for themselves but also for their elderly relatives. They might prioritize the benefits of these robots over the cost for older people.

It is of great importance to evaluate the findings of this analysis by considering all themes together. Roles of the robots, characteristics of the robots, the factors

that influence the acceptance of the robots (including individual preferences and emotions), and the disadvantages of the robot are like pieces of a puzzle. In the future, robots should be designed considering all of these, and their features should be developed accordingly. Only then will it be possible to ensure that social robots offer as much as possible to older people and their caretakers.

## 4.3 Practical Contributions and Implications

Unlike previous studies exploring the roles of social robots for older adults, this study combined NLP and TA. Adopting such a multifaceted analysis approach makes an important contribution to the literature by giving it a different direction. It suggests that analyzing qualitative data does not have to depend solely on qualitative methods. Even though sentiment analysis is more commonly used in social media analyses, companies' product reviews, or hotel reviews, this study now offers another area where it can be used effectively.

Furthermore, combining the TA and Delphi methods was beneficial for rich and reliable results. After developing a new thematic model from the three experts' sets of themes, the Delphi method was conducted to make them reach a consensus instead of just proposing the new model. In this way, the experts could review and refine the new model. This approach can be used in future studies that aim to be as objective and reliable as possible by conducting TA.

Recruiting caretakers in the study enabled learning more about the use of social robots in healthy aging. The knowledge that helps understand caretakers' approaches to these robots, as they are likely to use the robots in the homes of their older relatives, has been acquired. For instance, as observed in the sentiment analysis, caretakers had negative attitudes toward Paro. Moreover, in the thematic analysis, a disadvantage of Paro, because of not having enough motion, was observed. This might support caretakers' negative attitudes. Thus, if a caretaker is going to use the robot and interact with it while providing care to their

older relative, it would be better not to choose Paro. Moreover, caretakers' responses enhanced the knowledge about the older adults' approach to social robots by explaining some factors that are not directly mentioned or unnoticed by older adults. For example, the "cultural concerns" sub-theme under the "guarded approach," demonstrated that some older adults might prefer to receive care from their relatives (e.g., their children) even though they might not be open to sharing this preference. For such cases, a follow-up study can be conducted regarding the robot preferences of older people with this idea. By examining the attitudes of these people toward different robots, alternative tools can be identified for environmental enrichment if they do not prefer any particular robot.

This thesis explored older adults' and caretakers' attitudes toward three types of social robots by demonstrating the differences between polarity scores for these robots with sentiment analysis and uncovering the reasons behind certain attitudes through thematic analysis. The current study provides insights into older adults' and caretakers' perceptions and preferences by comparing approaches to three distinct social robots within a single study. This approach is beneficial since it comprehensively enables us to understand varied answers regarding different robot designs and features. By listing the weaknesses and strengths of each robot from various perspectives (the overarching themes), the study might inform and direct social robot designers and engineers to improve the design and ability-related features of these robots.

## 4.4 Theoretical Contributions

This thesis explored EE, which refers to creating complex environments, stimulating organisms physically or mentally, and helping them live healthily. EE has been found to improve cognitive processes (e.g., memory), reduce the effects of mental problems (e.g., anxiety and depression), promote body health by improving metabolism and maintaining body composition, and help prevent the adverse effects of social isolation. Based on previous studies demonstrating EE's benefits, this thesis emphasizes that enriching older adults' environments can help them

cope with their psychological and physical problems. Moreover, the thesis proposes that enriching older adults' environments can be achieved with the use of social robots. These robots can decrease their social isolation, including feelings of loneliness, and increase their well-being. With this proposal, this thesis offers a possible use of social robots as environmental enrichment tools for older adults and contributes to the literature.

## 4.5 Limitations and Future Research Directions

This thesis was thought to serve as a preliminary one in its area in Türkiye. For this reason, the thesis investigated older adults' and caretakers' initial approaches toward social robots. The participants were not being directed by telling them about Aibo, Paro, and Pepper's capabilities and features. Instead, they were wanted to make inferences about the robots and indicate their perceptions and expectations. Even though this thesis adopted such an approach because there are not many studies in this field in this country, this approach caused a limitation. The participants gave answers according to their expectations, not to the specific features of the robots. This led to mismatches between what robots could do, their design goals, and participants' expectations. Therefore, based on this study's findings, it would be helpful to examine attitudes in future studies by establishing a procedure that explains what these robots can do and for what purpose they were designed.

Although it was beneficial to recruit caretakers for this study, these caretakers were typically relatives of the older adults (e.g., their children). Thus, their feelings toward their older relatives might have influenced their attitudes toward social robots, potentially affecting their objectivity. However, professional caretakers might evaluate the use of social robots as environmental enrichment tools more objectively. Future studies should compare the attitudes of caretakers, who are older people's relatives, and professional caretakers toward social robots to broaden our understanding of their role in the healthy aging process by incorporating perspectives from various stakeholders.

In this study, questionnaires related to the technology and robot familiarity and acceptance were not conducted because of time constraints in the hospital setting. However, these could be used, it would be possible to see the correlation between having a previous knowledge about technology and robots and the attitudes toward them. For instance, the Unified Theory of Acceptance and Use of Technology (UTAUT) questionnaire was created to describe users' intentions for using an information system and their usage behavior [68]. Furthermore, the Almere model was used in many studies to understand how older adults accept assistive social agents [69]. Negative Attitudes Toward Robots Scale (NARS) is another one developed to measure potential robot users' mental states [70]. In future studies, using these kinds of scales before the experiments would help investigate the differences between the attitudes of older adults who are familiar with or accept the robots and the opposite.

Another essential thing is to create face-to-face interactions. Since all three robots were not available in this study, photos and videos of the robots had to be shown. This was a limitation. If participants had been able to see the robots in reality, their approaches might have been different. As suggested in a study [41], in future studies, analyzing older adults' specific needs and attitudes (e.g., themes found in this study) in reality is needed.

In addition to the need for face-to-face interactions, conducting long-term studies to investigate whether social robots can really help people in their lives would be very beneficial. Although it can be tried to understand these people's attitudes toward social robots, it is not possible to observe the long-term effects of social robots with short studies. As suggested in some studies [71] [72], it is important to investigate the use of robots in actual homes with potential users, which can help encounter real problems and solutions.

Moreover, sentiment analysis was influential in understanding participants' positive, negative, and neutral attitudes. However, supporting this method with computer vision techniques to recognize emotions would be better. Thus, it would be possible to understand participants' emotions when viewing robot photographs

and watching their videos. In this way, the alignment and incompatibility between the emotions reflected on the participants' faces and the analysis of their answers could be observed. Using this method in future studies will significantly contribute to the literature.

Another suggestion for future studies that aim to examine the subject further is about the methodology and design of the study. As the introduction discusses, environmental enrichment positively affects brain processes and enhances cognitive abilities. Based on this information, future studies can investigate the use of social robots as environment enrichment tools for healthy aging with brain imaging techniques like EEG or fMRI to observe neural correlates behind the subject. In this way, observing social robots' short-term and long-term effects on older adults would be possible.

# Chapter 5

# Conclusion

In this thesis, older adults' and caretakers' attitudes toward three social robots -Aibo, Paro, and Pepper- were investigated. Even though a positive attitude was observed overall, it's beneficial to focus on some points. Results demonstrated that caretakers' responses differed between the robots. More specifically, they approached Paro negatively while positively toward Aibo and Pepper. On the other hand, older adults approached all of the robots similarly. Through thematic analysis, the thoughts behind these approaches under four overarching themes were gathered. These overarching themes cover the roles of robots, their physical and design features, factors related to participants' acceptance of these robots, and the disadvantages of robots. The themes and sub-themes under these are varied at specific points between older adults and caretakers and between the three robots. These differences are not only between older adults' and caretakers' perceptions, expectations, and acceptances, but also among the three robots. As expected, participants' attitudes varied on some themes among the three robots, along with differences in the robots' appearances and abilities. Findings of this thesis make a significant contribution to the literature by covering the attitudes of both older adults and caretakers, who can benefit from the use of social robots by their older relatives and are also likely to use them, to different social robots that look and behave in different ways. Furthermore, by adapting a multifaceted analysis approach, this study combined an NLP method with a qualitative analysis

method in which the Delphi method was also used. This adaption can contribute to future studies by offering a new method to analyze qualitative data. Finally, by clearing the way for the improvements for these robots and future robot studies, this thesis also proposes that social robots can be used as environmental enrichment tools in healthy aging, thus help older adults maintain their life quality and well-being.

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# Appendix A

# Stimuli

Figure A.1: **Photos of Aibo**

Figure A.2: **Photos of Paro**

Figure A.3: **Photos of Pepper**

# Appendix B

# Participant Quotations (Turkish and English)

| Theme | Robot | Participant Quotes (In Turkish) | Participant Quotes (In English) |
|---|---|---|---|
| Assistance | Aibo | "...ihtiyaçları getirebilme, kalkamıyorsam, ona ihtiyacım varsa “bana şunu getir” dediğim zaman getirebiliyorsa onun da alabileceği yerde tabii olacak, getirebiliyorsa getirmesini, ihtiyaçlarıma yardımcı olmasını isterim." (E18) | "... being able to bring the necessities, if I can't get up and I need it, when I say "bring me this", if it can bring it, of course, it will be where it (the robot) can get it, I want it to bring it if it can and help me with my needs." (E18) |
| | | "O varsa, acil bir durum olduğunda bildirirse o güzel olur. Uyarı sinyali veriyorsa... Hani düşer, şey olur, o tür şeylerde bence iyi olur. Öyle bir şeyi bildirmesini isterdim." (C3) | "If it exists, it would be nice if it notifies you when there is an emergency. If it gives a warning signal... You know, if they (older adults) fall or something happens, I think it would be good for those kinds of things. I would like it to notify something like that." (C3) |
| | Pepper | "Evet, daha çok yardımcı olur. Dediğim gibi işte en azından şu perdeyi çek, şurayı topla, şunu getir, bunu götür. Her türlü olur." (E1) | "Yes, it would help more. Like I said, at least ‘pull that curtain,’ ‘tidy up there,’ ‘bring that,’ ‘take that away.’ It helps in every way.” (E1) |
| | | "...öyle fonksiyonları varsa bir hayati tehlike ya da bir hastalık halinde bir yardım çağırma gibi bir özelliği var ise mutlaka yardımcı olacaktır." (C10) | "...if it has such functions, such as calling for help in case of a life-threatening situation or an illness, it will definitely help." (C10) |
| Companionship | Aibo | "...evin içinde ne güzel yanımda oturur, gezer, dolaşır, dikkatimi çeker, beni oyalar diye düşünüyorum." (E8) | “...I think how nice it would be that it sits next to me in the house, walks around, attracts my attention and keeps me entertained.” (E8) |
| | Pepper | "Bir duygusal bağ kurar da robotla duygusal bağ kurmak şu anda benim için mantıksız geliyor ama o yaşlının ihtiyacı olabilir bence. Yani dikkatini dağıtır belki, bazı takıntılı şeyleri olabilir, o havayı dağıtır. Takıntılı düşüncelere girer, o oyun ister belki beni sev der bir şey der, düşüncesini dağıtır. Yalnızlığını belki giderir, aklını başka yere çevirir. Eğlendirir, güldürür. Hani gülmek bile onlar için iyi." (C3) | "It seems unreasonable for me right now to establish an emotional bond with the robot, but I think that old person might need it. In other words, it might distract him (the older adult), he might have some obsessive things, it will disperse that atmosphere. He gets into obsessive thoughts, it (the robot) wants a game, maybe it says ‘love me,’ something. It distracts their thoughts, maybe it relieves their loneliness, entertains them, and makes them laugh. Even laughter is good for them.” (C3) |

Figure B.1: **Participant quotes for “Perceived and Expected Roles of the Robot”**

| Theme | Robot | Participant Quotes (In Turkish) | Participant Quotes (In English) |
|---|---|---|---|
| Dog-like | Aibo | "Yani hayvanları severim. Köpek şeklinde olduğu için sempatik olmuş. Beğendim. Hissim sempatik olmuş. Yani hayvanları da sevdiğim için ben bunu çok beğendim." (E3) | "So, I like animals. It is sympathetic because it is in the shape of a dog. I liked it. My feeling is that it became sympathetic. I mean, I like animals, so I liked it very much." (E3) |
| | | "Valla normal evlerde beslenen hayvancıklar gibi her bir şeyi yapıyor." (E8) | "Well, it does everything just like normal animals kept in homes." (E8) |
| Superior to the animal | Aibo | "Valla ben bu robotun benim evimde olmasını isterim. Zaten köpekleri çok seviyorum. Hem tüysüz hem kılsız, hem hareket ediyor. Kesinlikle isterim ben bunu." (C9) | "I mean, I would like to have this robot in my house. I love dogs anyway. It is hairless and it moves. I would definitely want it." (C9) |
| | | "Normalde birçok insan evinde kedi kılından veya işte köpeğin parazitinden etkilendiği için evde beslemek istemiyor ama böyle robot tarzında en azından o özellikler ortadan kalkıyor." (C11) | "Normally, many people do not want to keep pets at home because they are affected by cat hair or dog parasites, but with this robot style, at least those features are eliminated." (C11) |
| Toy-like | Paro | "Yani oyuncak gibi duruşu bana pek bir şey hissettirmedi." (C5) | "So, his toy-like appearance didn't make me feel much." (C5) |
| | Paro | "Sadece oyuncak gibi gördüm." (C12) | "I just saw it as a toy." (C12) |
| | Aibo | "Yani ben ilk başta bu çocukların oynadığı küçük şeyler var ya oyuncaklar, onlara benzettim. Yani büyük insanlara ne faydası olur bilmiyorum ben." (E13) | "So, at first, I likened them to toys, the little things that children play with. I mean, I don't know what use they would be for adults." (E13) |
| | Pepper | "Bu daha ziyade gençlerin ve çocukların ilgi alanında olan bir şey. yani onunla oynayabiliyorlar." (E8) | “This is something that is more in the domain of young people and children. So, they can play with it.” (E8) |
| Human-like | Pepper | "Yani robota baktığım zaman duygularıyla yaşayan, aynı insana benzetilmiş bir varlık olarak gördüm yani. İnsana benzetilmiş. En çok da duygular, sevgi, şefkat, paylaşma, birlikte olma, arkadaş edinme... Yani bu yönü insana benzetilmiş." (C12) | "So, when I looked at the robot, I saw it as a human-like being that lives with its emotions. It is likened to a human. Most of all, emotions, love, compassion, sharing, being together, making friends... So, this aspect is likened to a human." (C12) |
| | | "Bu robotu çok isterim, evin içinde bir insan. Gezsin, tozsun." (E1) | “I would like this robot very much. A human in the house. Let it wander around and have fun.” (E1) |
| Artificial | Pepper | "Ben kainattaki en değerli varlığın insan olduğunu düşünüyorum. Hiçbir şey insanın yerini tutamaz. Böyle bir robota neden gerek var? Dünyada pek çok insan var, işsiz, güvenilir bir şeyi yok. Böyle yapma bir insan niye gerçek insan varken? Gerçek insana yardım etmek varken? Ben böyle insanın taklit edilmesini, robotlaştırılmasını, klonlanmasını falan hiç onaylamıyorum" (E3) | "I think the most valuable being in the universe is a human being. Nothing can replace a human being. Why is there a need for such a robot? There are many people in the world who are unemployed and without anything reliable. Why such an artificial person when there are real people? When we can help real people? I do not approve of imitating people, robotizing them, cloning them, etc." (E3) |
| | | "Bunu da yani duygusal olmayan bir şeyle pek benim için bir şey ifade etmiyor yani. Duyguları olan bir insan olacak." (E10) | "I mean, this doesn't mean anything to me, something that is not emotional... There should be a person with emotions." (E10) |

Figure B.2: **Participant quotes for “Physical Characteristics and Design Features of the Robot”**

| Theme | Robot | Participant Quotes (In Turkish) | Participant Quotes (In English) |
|---|---|---|---|
| Receptive Approach - Sympathy | Aibo | "Şöyle hareketleri yapması sevimli. Kumandasıyla herhalde şey yapıyor karşı tarafın. Sevimli bir şey, güzel." (E2) | "It's cute how it moves like this. The other party is probably doing something with their remote control. It's a cute thing, nice." (E2) |
| | Pepper | "Gayet faydalı bir şey. Teknolojiyi kullanmak son derece iyi. Bu da teknoloji ürünü olduğu için son derece iyi olduğunu düşünüyorum." (C2) | "It is a very useful thing. It is extremely good to use technology. I think it is extremely good because it is a technology product." (C2) |
| Guarded approach – Religious concerns | Paro | "İşte diyorum ya hayvan şeyi düşünmüyorum, evde düşünmüyorum, evde uygun değil. Cansız da olsa, evde düşünmüyorum Hatta resimlerinden ben hiç hoşlanmam. Torunlar yurt dışında diye dedesi resimlerini koyuyor, onların mesela arkası dönük namaz kılıyorum. Yani uygun değil, dinimize göre uygun değil onlar. Biz öyle gördük. Kitapları da okuyoruz. Hocalar da anlatıyor. O yüzden hayvan şeyini ben evde düşünmüyorum kızım. Diyorum ya kıyafette, resimde bile uygun değil. İbadette, yani herkes için, bir benim için değil bunlar. Çünkü bunlar, cansız ama, ya o bir canlı gibi. Onu düşünmüyorum kızım." (E17) | "What I'm saying is, I don't want animal things, I don't want them at home, it's not appropriate at home. Even if it's not a living being, I don't want it at home. In fact, I don't like pictures of them at all. Their grandfather puts up pictures of our grandchildren since they are abroad; for example, I pray with my back turned to the pictures. So, it's not appropriate, it's not appropriate according to our religion. That's what we knew. We read books, too. Also, hodjas tell. That's why I don't want animal things at home; I mean, they are not even appropriate for clothes or pictures. I mean, in worship, it's for everyone, not just for me. Because even though they are not living beings, they are like ones. I don't want it, child." (E17) |
| Guarded approach – No need | Aibo | "...benim pek ihtiyacım yok. Şimdi nasıl ihtiyacım yok, mesela zaten çok hareketliyim kendim, devamlı oturup hareket olmasa da kendim getirip götürüp kendim bakabiliyorum kendime." (E11) | "...I don't really need it. So, how I don't need it? For example, I am already very active. Even without movement, I can take care of myself with bringing and taking stuff." (E11) |
| | Paro | "Herhalde yani ihtiyaç olmadığı için, şu anki meşgalelerim daha çok olduğu için, koşuşturmalarım. Kafa yorgunluğu, beden yorgunluğu... Birçok şeyle uğraştığım için yani şu an ona ihtiyaç duyacağımı veya ona vakit ayıracağımı zannetmiyorum." (C5) | "I guess it's because it's not needed, because I have a lot of preoccupations right now... Mental fatigue, body fatigue... Since I'm dealing with many things, I don't think I'll need it or make time for it right now." (C5) |
| | Pepper | "Kendim için şu an böyle bir ihtiyaç duymadığım için. Tanışmak isterim ama yani beraber yaşamayı şu an düşünmem." (C5) | "Since I don't feel such a need for myself right now... I would like to meet but don't think about living together right now." (C5) |
| Guarded approach – No time/energy | Aibo | "İsterdim ama ne tanışmaya, ne etkileşmeye gidecek halim var. Onkolojide de tedavi görüyorum, hastayım." (E1) | "I would like to, but I am not in a position to meet or interact. I am receiving treatment in oncology, I am sick." (E1) |
| | Pepper | "Vaktim yok yani evde işimi kendim yapıyorum. Buna ayıracak zaman, şey yapacak zaman yok." (E2) | "I don't have time. I do my own work at home. There is no time for this, no time to do anything." (E2) |
| | Paro | "...bakacaksın devamlı onun hareketlerine sevineceksin ama ona şimdi vaktim yok." (E11) | "...you should look at it and be happy with its actions constantly, I don't have time for that right now." (E11) |
| Guarded approach – Lack of technology proficiency | Pepper | "Şey bile bu süpürgeler var robot onları bile şey yapmıyorum. Yani biz yaşımız ilerlediği için..." (E14) | "Well, there are these robot vacuum cleaners, I don't even use them. I mean, since we are getting older..." (E14) |
| | Pepper | "Onu ben anlamam ki kızım. Onu bileceksin her şeyini. İkimiz de ilkokul mezunuyuz eşimle. Bunu anlamak lazım. Çocuklar bilir ama biz anlamayız kızım. Telefonun her şeyini ben anlamam." (E17) | "I don't understand that, dear. You must know everything about it. My husband and I are both primary school graduates. This needs to be understood. Our children know it, but we don't understand it, dear. I don't understand everything about the phone, either." (E17) |
| Guarded approach - Fear | Pepper | "Ben evimde böyle bir robot olsa ben ondan korkarım." (E3) | "If I had such a robot in my house, I would be afraid of it." (E3) |
| | | "Gelecekteki bu robotlar zaten önümüzdeki asrın şeyi olacak herhalde bu insanların yerine çalışacak insanların yaptığı işleri.. Faydası kadar zararı da olacağı söyleniyor. Niye, bir sürü insanı da işsiz bırakacağı söyleniyor." (E13) | "These robots will probably be the thing of the next century. They will work instead of people, with people's jobs... It is said that they will cause harm as well as benefits. Why, it is said that they will make a lot of people unemployed." (E13) |
| | | "Valla geleceğimizin belki teknolojisi ama çok itici, çok korkutucu." (C1) | "Well, maybe it's the technology of our future, but it's very repulsive, very scary." (C1) |
| | | "Biraz korkunç gibi geldi bana." (C6) | "Looks a bit scary to me." (C6) |
| | Aibo | "Hostile bile görünebilir bir yaşlı için, veya bir Alzheimer hastası için. Yani düşmanca bile karşılanabilir." (C4) | "It might even seem hostile to an elderly person or to an Alzheimer's patient. So, it might even be viewed as hostile." (C4) |
| Guarded approach – Cultural concerns | Paro | "bizim hani dünden bugüne oluşmayan bir kültürümüz var. Kültürümüzde çocuklar anneye babaya bakar. Burada böyle bir yalnızlık söz konusu, bir ihtiyaç duyma söz konusu ve o amaçla tasarlandığını düşünüyorum açıkçası. Bizim yaşlılarımız daha çok çocuğumuz gelsin, bize baksın. Ya da... Ya dası yok hatta direkt öyle yani. Huzur evidir, bakım evidir, rehabilitasyon merkezidir... O tip kavramlara bile çok uzakken bunlara mümkün değil, yaklaşacaklarını düşünmüyorum ben." (C10) | "You know, we have a culture that didn't just form overnight. In our culture, children look after their mothers and fathers. There is such a loneliness, a feeling of need here, and frankly, I think it was designed for that purpose. Our elderly are more like, 'our children should come and take care of us.' Or... There is no "or." In fact, it is exactly like that. A nursing home, a rehabilitation center... Since they are not even close to such concepts, it is impossible for them to come close to these (robots)." (C10) |
| | | "Ama mesela biz hep annemizle babamızla... Bizim sanki toplumsal yapımızda biraz daha anneleri babaları yalnız bırakmamak gibi şey var ya. O yüzden yani hiç çok bana uygun gelmedi yani." (C2) | "But for example, we are always with our mother and father... It seems like our social structure has something like not leaving mothers and fathers alone. That's why it didn't really suit me." (C2) |
| | | "Yaşlılar tabii genelde daha çok aileleriyle muhattap olmak istiyorlar ama değişiklik olabilir mi? Olabilir." (C11) | "Of course, the elderly generally want to be in touch with their families more, but could there be a change? It could be." (C11) |

Figure B.3: **Participant quotes for "Factors Influencing Acceptance of the Robot"**

| Theme | Robot | Participant Quotes (In Turkish) | Participant Quotes (In English) |
|---|---|---|---|
| Limited skill set | Aibo | "Yapamaz ne yardım edecek? Benim neyimi yapacak? Değil mi yani? Ne yemek yapabilir ne temizlik." (E12) | "It can't do it, what can it do? What can it do for me? Right? It can't cook or clean." (E12) |
| | | "Suyunu getiremez, ilacını getiremez." (C1) | “It can’t bring your water or medicine.” (C1) |
| Limited skill set – Not enough motion | Paro | "Ne yapabilir ki? Hareketi yok. Bana hiçbir şekilde yardımcı olamaz. Sadece yumuşak bir şey ama yastık da aynı şeyi görüyor." (E3) | "What can it do? It can't move. It can't help me in any way. It's just something soft, but the pillow does the same thing." (E3) |
| | | "Bu yürümüyor falan ya biraz daha monoton geldi." (C6) | "This does not move or anything, so it just seems a little more monotonous." (C6) |
| Expensiveness | Pepper | "Evim için de düşünebilirim, dediğim gibi maddi imkanlar müsait olsa." (E2) | "I can also consider it for my house, as I said, if financial means are available." (E2) |

Figure B.4: **Participant quotes for “Disadvantages of the Robot”**

# Appendix C

# Ethics Approval

**Bilkent Üniversitesi**
Akademik İşler Rektör Yardımcılığı

**Tarih** : 26 Kasım 2022

**Gönderilen** : Yasemin Afacan, Michelle Adams, Burcu Ayşen Ürgen, Mustafa Cankurtaran, Meltem Gülhan Halil, Begüm Conka

**Gönderen** : H. Altay Güvenir
İnsan Araştırmaları Etik Kurulu Başkanı

**Konu** : *"The Role of ..."* çalışması etik kurul onayı

[redacted]

Üniversitemiz İnsan Araştırmaları Etik Kurulu, 26 Kasım 2022 tarihli görüşme sonucu, *"The Role of Social Robots in Healthy Aging - Sosyal Robotların Sağlıklı Yaşlanmadaki Rolleri"* isimli çalışmanız kapsamında yapmayı önerdiğiniz etkinlik için etik onay vermiş bulunmaktadır. Onay, ekte verilmiş olan çalışma önerisi, çalışma yürütücüleri ve bilgilendirme formu için geçerlidir.

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