國立交通大學

應用藝術研究所

碩士論文

探討機器人陪伴高齡者之日常生活

Design Guidelines of Companion Robot for Elderly People

研 究 生：黃盈嘉

指導教授： 鄧怡莘 教授

中華民國九十七年一月

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Design Guidelines of Companion Robot for Elderly People

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中文摘要

如今世界各國高齡人口快速的成長，皆面臨人口高齡化的社會現象，而台灣的高齡人口在近幾年內不僅在比例上快速成長，其成長速度僅次於日本，在先進國家中，台灣人口老化的速度亦為全世界第二名。為了增進高齡者的生活品質，許多世界各國的組織積極投入機器人的研究與發展以提供高齡者生活上之協助，正在發展中台灣機器人產業應針對社會的需求朝向不同性質的機器人發展，以及考慮與歐美國家的區別性。

本研究的目的是希望了解台灣高齡者對於陪伴機器人的態度及意見，並提供陪伴性質機器人的設計規範以協助未來機器人之設計與發展。此外，希望透過本研究能促進台灣機器人產業的發展。研究工作進行了四個階段的調查以及相關文獻的分析，使用probe這項工具透過受測者的自我觀察對高齡者的生活進行初步的探測，接著透過深度訪談獲得高齡者的生活需求及產品使用經驗，採用Perceptive Sorting 方法詢問高齡者對機器人外觀的意見，最後，透過問卷以進行高齡者對陪伴機器人的功能需求度調查。

綜合本研究發現以及其他相關研究的貢獻，此研究提出了三項設計規範以提供給機器人設計師作為設計參考：（一）與陪伴機器人的互動方式應是低認知負載（ Interaction with companion robots must be low cognitive load）；（二）陪伴機器人的外觀必須是高齡者所熟悉的外型（Companion robots for elderly people must have familiar appearance）；（三）陪伴機器人必須鼓勵高齡者參與社會互動並增進互動的品質（Companion robots must encourage and enhance social interaction among elderly people），本研究希望能了解高齡者的生活需求及對於機器人的態度，以提供設計師及其他研究者參考資訊及設計建議。

關鍵字：高齡者、陪伴機器人、探針法、感知分類法、設計規範

ABSTRACT

The elderly population has grown rapidly in the past decades, and the problems of aging society have been gradually emphasized by governments all over the world. Many organizations have devoted to the research and development of robot companion for the elderly. The study aims to explore Taiwanese elderly people's needs and attitudes toward a robot companion, and provide design guidelines for the developing Taiwanese robot industry.

An investigation consisting of four user research methods, namely, probes, in-depth interview, perceptive sorting exercise and questionnaire, was conducted in this study. The probe method was used to directly explore elderly people's daily life, and an in-depth interview was used to further investigate their needs in different aspects and their preference of home appliance. A perceptive sorting exercise was used to understand the elderly people's perceptions and attitudes towards the idea of home robot. Furthermore, questionnaire was used to acquire information about the expected features and capabilities in robot companion.

Finally, findings in this investigation and related literature survey were organized to propose design guidelines for the development of robot companion for elderly people in Taiwan: (1) interaction with companion robots must be low cognitive load, (2) companion robots for elderly people must have familiar appearance, and (3) companion robots must encourage and enhance social interaction among elderly people.

Keywords: elderly people, robot companion, probe, Perceptive Sorting exercise, design guidelines

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CONTENT

FIGURE CONTENT

TABLE CONTENT

1. INTRODUCTION

The world's elderly population has grown rapidly in recent years. Taiwan has become an aging society. By the year 2010 elderly people in Taiwan will account for more than 10% of the total population. To date, many robotic technologies have been developed in elderly care. It is essential to consider appropriately designed robot for providing assistance to elderly people.

1.1 Elderly people in Taiwan

The elderly population grows rapidly in the past decades and the problems of aging society have been gradually emphasized by governments all over the world. Recently, the elderly population in Taiwan increases not only in proportion but also in the speed, 2.35 times annually. Moreover, the speed of aging situation in Taiwan ranks second among advanced countries, only after Japan.

The most common living style for elderly people in Taiwan is living with their children and other relatives. According to the Old-age Living Survey 2005 issued by the Department of Social Affairs, Ministry of Interior (2006), 61.7% of elderly people live with their children, and 19.5% live with their companion. Adding up, 81.2% of the elderly people live with their families. Comparing to statistics in Europe and North

America, 70% of elderly people live alone or just live with their spouse. Elderly people in Korea and Japan, no matter how much their living expanse relying on their children, have both lower intentions to live with their children. (The percentage of economic support from children in Korea is higher than percentage in Taiwan, and percentage in Japan is lower.) Due to the traditional culture reason and real living needs, most Taiwan elderly people choose to live with their children. This phenomenon reflects a particular type of family respect toward parents in Chinese culture. Elderly people can enjoy living with family members, taking care of their grand children and being cared by their children attentively.

According to the elderly people survey report 2005 issued by Taiwan's Ministry of Interior(2005), people aged over 65 consider the ideal way of living is to live with their children, including spouse, children and grandchildren. Their daily habits are getting up and sleeping early, taking midday naps, and daily exercise. Their activities of daily life are chatting with friends, engaging in leisure entertainment, and taking care of grandchildren. Life expectations of the elderly people are having a healthy body, getting together with their families and having no economic problems.

Women used to be the major family role to take care of other members since long time ago, especially children and elderly people. However, due to the economic development and the social migration, women choose to work now. More and more women enter the labor market instead of staying at home. The young generation work all day long, children go to school regularly and the elder parents still stay at home by themselves for

very long time every day.

Most elderly people lose their living focus in the final stage of life. For instance, their social participation has reduced gradually after retiring. The declination in physical performance affects their life quality, too. Most elderly people have no confidence and lack of emotional companion. Those are reasons which affect their mental health or cause mental illnesses. The government and researchers should assist elderly people to adapt the aging process and provide them a high quality living environment.

1.2 Robotics for assisting elderly people

In order to improve the life quality of elderly people, many organizations in the world, such as Honda, SONY, IZIrobotics and the Robotics Institute of CMU, devote to robotic research and development. The primary goal is to enhance independent living for elderly people. Robots provide a wide range of supports for elderly people in medical and basic activities. Firstly, medical robots and assistive robots are used in treatment and rehabilitation of debilitated people who suffer from accidents, diseases and temporarily impair of their normal function. Secondly, they can be used to assist people with chronic illness (Massimiliano et al., 2005). Furthermore, medical robots facilitate surgical procedures and enhance operation precision (See Figure 1). Some assistive robots can also be used to help elders in managing everyday tasks at home. Regarding the companion robots, they perform a wide variety of tasks including educational functions,

home security, diary duties, entertainment and message delivery services, etc. However, the main design principle of companion robot for elderly people is still to alleviate loneliness and provide fulfillment. Robot companions are expected to communicate with non-experts in a natural and intuitive way (Kerstin et al., 2005). When designing a companion robot for elders, the acceptance of robot by elders is the most important issue.

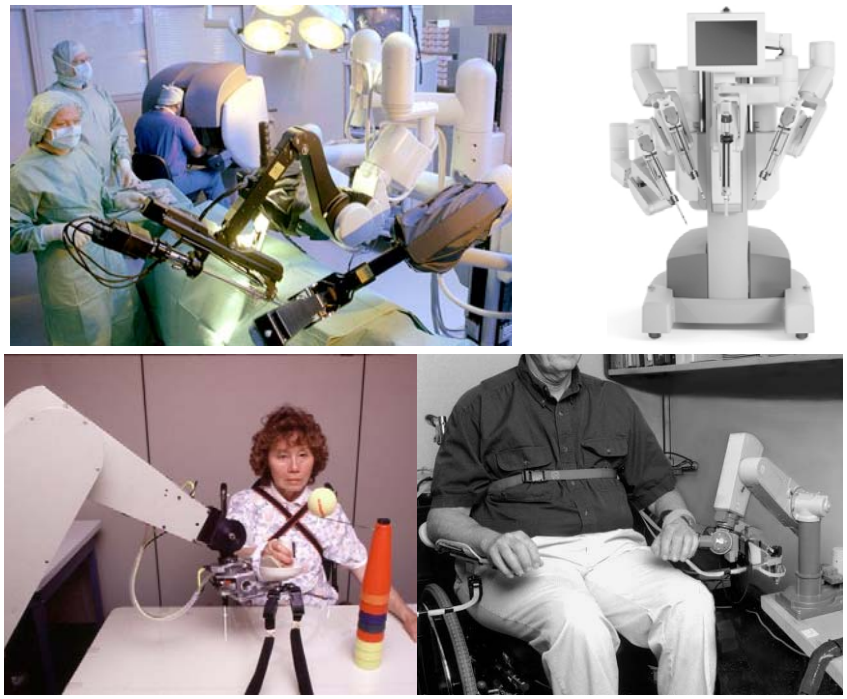


Figure 1. Medical robots and assistive robots

1.3 Motivation

Because of the advanced technology and the economy achievement, people maintain better health condition and live longer in most countries. Thus, the proportion of elderly population increases rapidly every year, especially in Taiwan. In addition, owing to the trend of fewer children in this society, most people will live without proper care from

offspring when they become old. Fulfilling elderly people's needs and enhancing quality of life becomes a noteworthy issue. The elderly people's living environment, physical and mental declines has been gradually emphasized by many researches.

Recently many countries have encountered the problem of aging population. The aging speed in Asia countries is faster than speed in Europe and North America, especially in Taiwan and Japan. The aging speed of Taiwan population is second only to Japan in the world. The feeling of loneliness among elderly people could be a major factor related to elderly mental illness. Karin mentioned that subjective health status was related to experienced loneliness (Karin, 2002). Therefore, this research focuses on the issue of elder companion and tries to provide assistance to improve elderly mental health.

Today, many countries develop robot technology for a better life. Japan has achieved rapid advances in different kinds of robot. When comparing the robot industry of America and Europe countries, other Asia countries advance in the development of companion robot. The developing Taiwan's robot industry should consider the strategy of differentiation with America and Europe countries. Consequently, they should aim on local people's needs. The research expectations in this thesis are to fulfill elderly people's needs by technology and provide some guidelines for robot companion design. Furthermore, a suitable direction is also expected to promote the development of Taiwan robot industry.

1.4 Objectives

People become isolated and lonely in the process of getting old because their friends are becoming disabled or dead. Many researchers believe that artificial companionship can alleviate loneliness for the elderly people and assist their independence. Therefore, this research aims to propose the design guidelines for robot companion and to provide some references and resources for robot designers and researchers. The major goal of this research is to study the robot companion acceptance for Taiwan's elderly people. The investigations of attitudes towards robot companion in this research involve the acceptable appearances, proper functions and interaction patterns of the companion robot. Research on robot and agent acceptance can be subdivided into two areas: acceptance of the robot in terms of usefulness and ease of use (*functional acceptance*) and acceptance of the robot as a conversational partner with which a human or pet like relationship is possible (*social acceptance*) (Marcel et al, 2006).

1.5 Limitation

This research aims to get a whole understanding of Taiwan elderly people. Living with their children is the major life style in Taiwan, and this pattern is the most prevalent in Taipei. Considering the resource and real situation, elderly people in Taipei living with their children have been chosen as our research sample.

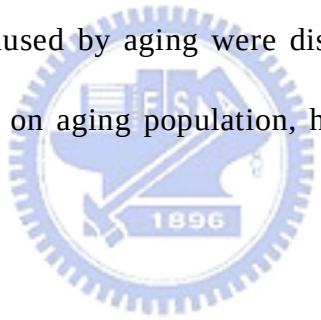
Nowadays, many countries had outstanding achievements in robot technology development. However, designers can conduct research to explore users' attitude towards robot and design a suitable robot in human society. This research will focus only on obtaining the understanding of user needs, and exploring the ability, appearance and interaction patterns of companion robot.

1.6 Outline of Thesis

This thesis is divides into six chapters. The research background, motivation, objectives, limitations, and outline of this thesis are introduced in chapter One. There are two parts in chapter two, literature reviews. The first part, elderly people, discusses aging society, definition of aging, mental and physical functionality of elderly people. The second part, robot companion, discusses elderly companion, definition of robot companion and related robotic products. In chapter three, methodology, plan and methods for research activities are proposed. In chapter four, research finding, interpretation and analysis of the collected data formulate the guidelines of companion robot. In chapter Five, the evaluation result and the design guidelines were proposed for future robot companion design. In chapter six, research outcome are summarized and suggestions for further studies in elderly companion and robot development are concluded.

2. LITERATURE REVIEW

Facing aging society, many countries had strived for providing assistance and developing service for elderly people. In recent years, numerous research groups are studying in the field of human-robot interaction and hoping to bring a better life to humankind. Many companion robots were developed to assist elderly people's mental health and promote their independence. The ultimate goal of this research is to explore elderly people's essential needs and their attitude towards robot companion. In order to facilitate the comprehension of our research subject, the characteristics of the aging population and the effects caused by aging were discussed. Furthermore, this research also reviewed related studies on aging population, human-robot-interaction and related robotic product development.



2.1 Aging and aging society

Populations are growing older all over the world. Aging is becoming a universal and probably irreversible trend. It is a great challenge for many countries to provide care and welfare for elderly people. In this section, we discuss the fact of aging and the phenomenon of aging society.

2.1.1 Definition of aging

Aging is an important part of all human societies and also an inevitable stage of human beings. Aging is defined as the changes which occur in a living organism, generally in the post reproductive period, which temporally result in a decreased survival capacity and an increased vulnerability of the individual organism (Strehler, 1962). To human being, aging refers to a multidimensional process of physical, psychological, and social change.

When study of population aging is initiated by a concern over the load of retirement system, the aging of population is often measured by increases in the percentage of elderly people of retirement ages. The definition of retirement ages may vary, but a typical cutoff is 65 years. Nowadays a society is considered relatively old when the fraction of the population aged 65 and over exceeds 8-10 %.(Leonid and Patrick, 2003)

The aging process is difficult to describe objectively, and the changes may be subjectively imperceptible. Many theories have been proposed to explain the aging process. The theories can be organized as genetic aging theories, biochemical aging theories, physiological aging theories, and aging as socio-psychological development.

2.1.2 Aging society

According to the definition of “aging society” by WHO, when the percentage of population of people over 65 years old is more than 7%, the society will be called “aging society”. Moreover, if the proportion of elderly people in the total population is more than 14%, that society will be called “aged society” (EVA Report, 2006).

Because of advanced medical technology, people can live longer than before. However, there are some demographic factors affecting population aging. Underlying global population aging is a process known as the “demographic transition” in which mortality and then fertility decline from higher to lower levels. Fertility decline has been the primary determinant of population aging.

Many developed and developing countries faced rapidly growing aging population. The population aged 65 and over is expected to increase substantially between now and 2040 (Stone, 1997). Based on the reports from WHO, in 2000, there were 600 million people aged 60 and over; there will be 1.2 billion by 2025 and 2 billion by 2050. Regarding the time of the demographic change, it took 75 years in USA, 115 years in France, and 25 years in Japan for the proportion of elderly to change from 7 percent to 14 percent in the total population (Kim, 1997). These trends reflect a real challenge for every country in the world. These trends also value the importance of developing new and more cost-effective ways of providing care and support to the elderly people. As a consequence, the development of assistive technology to fulfill special needs of elderly

people must be considered a incoming problem in aging society.

2.2 Physical and mental functional decline in elderly people

As people get older, they experience physiological and cognitive changes. This phenomenon can involve a degree of physical and mental functional decline. Elderly people lose their independence in their life due to a wide variety of physical or mental disabilities. Suffering from the emotional or physical illness is one of the causes of depression in the elderly people. Hence, elderly people's physical and mental health should be considered in this research.

2.2.1 Physical decline

As people get older, they suffer a wide variety of deterioration in cognitive, perceptual, and motor abilities. Cognitive abilities include comprehension, memory and determination. Perceptual abilities include the sense of vision, hearing and touch. Motor abilities include muscle strength, flexibility and mobility speed.

Regarding the degeneration of cognitive abilities in elderly people, Vercruyssen stated that older adults have problems maintaining attention over long periods of time

(Vercruyssen, 1996). Normal aging (excluding pathological conditions such as Alzheimer's disease) produces different degrees of impairment with the different forms of memory. In addition, age gives only a slight decline in the number of items which can be held in short term memory; an average of around 6.5 items can be held from the 20s through to the 50s but this then drops to around 5.5 for the 60s and 70s. Salthouse suggests that decline in working memory underlies older peoples' problems in text comprehension. Processing of visual information in short term memory also slows with age (Salthouse, 1994).

With age comes lengthening of response times on more complex motor tasks. Vercruyssen notes that the standard finding, incompatibility between stimulus and response slows response time (i.e. the Stroop Effect), is accentuated with age. Older adults are reported as having less ability to control and modulate the forces they apply (Siedler and Stelmach, 1996). This is consistent with Dixon et al. who found that handwriting quality declines in older people. It has been reported that older people are less accurate in reporting body position in relation to surroundings (Dixon et al., 1993). In addition, older people may have difficulty in receiving new information during the execution of movements (Vercruyssen, 1996).

There are some age-related changes in perceptual abilities. Perceptual abilities related to the sensory function in human beings, such as the sense of vision, hearing, touch, taste and smell. According to the information from WHO, the skin of older people loses turgor, becomes wrinkled, thinner and more fragile, and is more susceptible to cuts and

bruises. As for elderly hearing decline, approximately 30% of people over 65 have significant hearing impairment. High frequency sounds are affected first with progression to lower frequency sounds. Men are affected a little more than women. Presbycusis is a loss of hearing which is common in older persons. Uncompensated hearings decrements can make older people appear to be mentally impaired and/or withdrawn when they are not. Inadequate hearing can result in lack of understanding. The older person's inappropriate response or expression may be mistakenly interpreted as confusion or problems with mental status. Hearing loss can also interfere with socialization. If listening becomes too much an effort, older persons may eventually give up trying to hear what is being said, talking and participating less. Moreover, the impairment of smell and taste often occur in aging process. With age, the number of taste buds diminishes.

2.2.2 Mental health

Mental health is as important as physical health to the overall well-being of individuals, societies and countries. Mental health can be conceptualized or composed of two inclusive elements, psychological distress and psychological well-being (Veit & Ware, 1983), which are not mutually reducible, but rather complementarily indicate the variations in a person's mental status (Lewinsohn, Redner, & Seeley, 1991). The WHO proposed the most common mental health problems of older adults: widowhood and the deaths of significant others, caregiver stress, fear of death or financial difficulties,

change from previous roles, living arrangements and social isolation. The most common mental health problem for elderly is depression, chronic illness, pain, death of loved ones, frustration with limitations in activities of daily living, lack of control over one's life and activities may all contribute. In elderly people, depression may appear very similar to confusion and dementia. Physical decline or mental problem may affect the elderly life quality. For these reasons, this research emphasizes on assistive robotic products to provide assistance in maintaining their health.

2.3 Companion robots

Nowadays many countries devoted to robot development for helping elderly people's life. The companion robots have been embodied in various forms and functionalities. Studies investigate people's attitudes and perceptions towards robots for developing suitable robotic products. There are several companion robots described in this section.

A conceptual robot, the Hug, was created by the research group of Carnegie Mellon University. This robot is a conceptual design exploration of form for a robotic product that facilitates intimate communication across distance (See Figure 2, 3). The design proposed that maintaining social and emotional bonds through intimate communication is an essential human activity and characteristic of healthy family life. Furthermore, in their opinion, communication products such as the phone and email are used regularly; however, those products tend not to support intimate communication because intimate

communication is generally rich, involving physical interaction and multiple senses. Intimate communication is not only pleasurable, but also profoundly important for maintaining mental, emotional and physical health. The design of The Hug explores how current robotic technology can be used to facilitate intimate communication across distance.

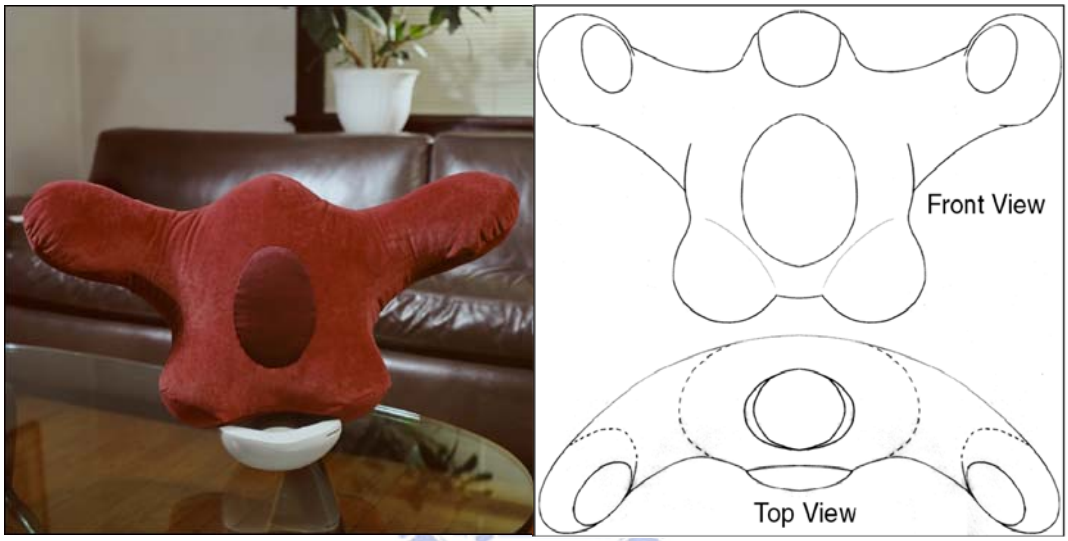


Figure 2. The Hug.

Figure 3. An example of The Hug in use.

The project PERSONAL ROBOTIC ASSISTANTS FOR THE ELDERLY (Pearl) is an inter-disciplinary research initiative on Personal Service Robots for the

elderly that brings together researchers from the University of Pittsburgh and Carnegie Mellon University. They have described Pearl, a mobile robot system being designed to assist elderly people in navigating their daily activities and their environment. Pearl has two primary functions: (i) reminding people about routine activities such as eating, drinking, taking medicine, and using the bathroom, and (ii) guiding them through their environments. (See Figure 4)

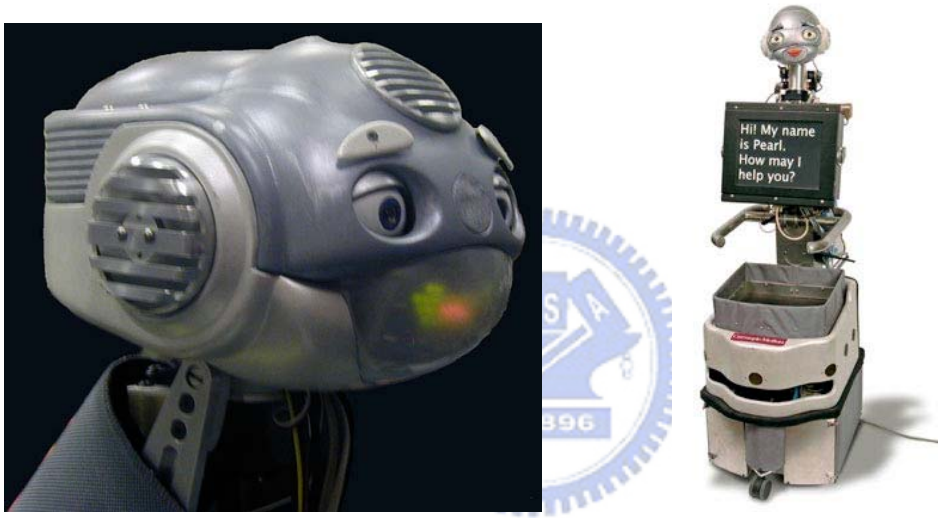


Figure 4. Pearl

Pleo is a robotic dinosaur, made for all ages, designed to emulate the appearance and behavior of a week-old baby Camarasaurus. It was created by UGOBE from USA. Pleo is equipped with senses for sight, sound, and touch. Every Pleo begins life with certain tendencies but, interaction with his environment has subtle effects on his behavior. Every Pleo eventually exhibits a unique personality. In addition, Pleo is capable of expression. (See Figure 5)

Figure 5. Pleo

AIBO (See Figure 6) is one of several types of robotic pets designed and manufactured by Sony. AIBO is the first model of Robot Entertainment Systems. The main application of this robot is a pet-style robot, which must maintain a lifelike appearance (Masahiro Fujita, 2001). The goal of Sony to develop AIBO is to bring humans and robots closer together. AIBO is designed for entertainment purposes. Personality and capabilities change depending on user's interaction.

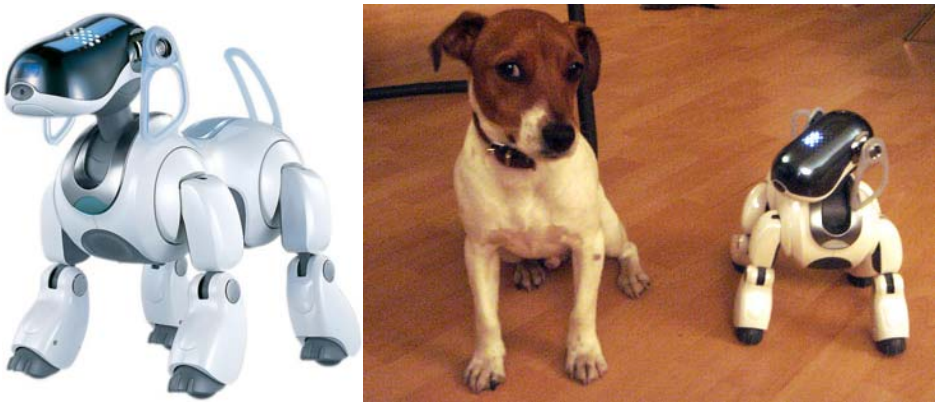


Figure 6. AIBO

Paro(See Figure 7) is a therapeutic robot with the appearance a baby harp seal, intended to have a calming effect on and elicit emotional responses in patients of

hospitals and nursing homes, similar to Animal-Assisted Therapy, but without its negative aspects. It was designed by Takanori Shibata of the Intelligent System Research Institute of Japan's AIST beginning in 1993. They argue that it is very important to keep in mind our everyday experiences and knowledge while designing a robot's appearance. In addition, they have found that people are generally interested in interacting with robots with the appearance of non-familiar animals. Paro is covered with soft artificial fur to make people feel comfortable just like touching a real animal. It is an autonomous robot, so it can express its feelings, such as surprise and happiness, voluntarily by blinking its eyes, moving its head and legs. This behavior can be perceived as Paro has feelings.

Figure 7. Paro

CUBO (See Figure 8) was created by a company, IZIrobotics, from Korea. CUBO is a home robot for education and entertainment and it seems a member of the family or a pet

at home. It can read books for kids, teach English, provide "home monitoring," update the news and weather, give a wake-up call, and even display messages called "robot mail".

Figure 8. CUBO

In this section, we introduced companion robots from different countries. These data were referred to our research. The goals and features of these companion robots were listed in Table 1.

Table 1. Summary of companion robots.

	Robot	Goal	Product features
USA	**CMU-Hug**	To maintain social and emotional bonds through intimate communication.	(1) It provides intimate communication through voice augmented with touch, warmth, lights, and sound. (2) The physical shape of The Hug expresses the gesture of hugging.
	Pearl	To assist elderly people in navigating their daily activities and their environment.	(1) Reminding people about routine activities such as eating, drinking, taking medicine, and using the bathroom (2) Guiding people through their environments.
	UGOBE-PLEO	Through evolving companionship, Pleo will suspend disbelief by bringing magic and beauty to life.	(1) Ability to avoid obstacles (2) Sound output, stereo sound sensors and music beat detection (3) Autonomous interaction with owner and environment (4) Distinct moods (5) Interaction with his environment has subtle effects on his behavior.
JAPAN	**SONY AIBO**	(1) For entertainment purposes (2) Sony's purpose in developing AIBO is to bring humans and robots closer together.	(1) Personality and capabilities change depending on user's interaction. (2) Emotions and instincts programmed into its brain.
	PARO	Paro intended to have a calming effect on and elicit emotional responses in patients of hospitals and nursing homes.	(1) Covered with soft artificial fur to make people feel comfortable (2) Can recognize light and dark (3) Can express its feelings
KOREA	**IZIrobotics CUBO**	Home robot for education and entertainment use seems to be like a member of the family or a pet at home.	A network-based home robot specifically designed for delivering education and entertainment content.

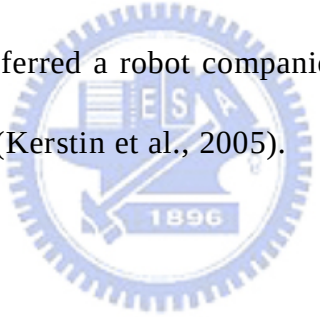
2.4 Related research

In recent years, more and more research groups have placed increasing emphasis on developing robotic technology. In this section, we reviewed related researches of investigating people's reactions towards robotic technology.

Jodi et al. (2003) applied the Perceptive Sorting(PS) exercise to gain responses about appropriate functionality, aesthetic design of existing products, perceptions and responses to new/futuristic products. They proposed that the most successful robotic products of the future will leverage the simple and often-used design of today's home appliances. New robotic products must also fit appropriately into the environments and contexts in which they will be used. In year 2004, they presented an ethnographic study of aging adults who live independently in their homes. They conducted qualitative semi-structured interviews and observations with two types of elderly people to examine their activities and interactions with products. The goal of their research is to aid the design and development of assistive robotic products for the elderly through the development of design guidelines grounded in ethnographic research (Jodi et al., 2004).

Massimiliano et al. investigated people's representation of new technologies and domestic robots by using a psychological approach. They conducted questionnaire investigation by comparing the attitudes towards technology in general, and domestic robots in particular, held by people at different stages of the lifespan (Massimiliano et al., 2005). Sarah et al. explored children's and adults' attitudes towards different types of

robots. They recruited children to view different robot images and completed a questionnaire to discover different robot physical attributes, personality and emotion characteristics. They invited few adults to rate the appearance of different robot images (Sarah et al., 2005). Scopelliti et al. revealed differences between young and elderly populations towards the idea of having a robot in the home with young people scoring highly positive and older people expressing more negativity and anxiety towards the idea of having a robot assistant in the home (Scopelliti et al., 2004). Kerstin et al. explored people's perceptions and attitudes towards the idea of a future robot companion for the home. They adopted a human-centerd approach by using questionnaires and human-robot interaction trials to derive data from participants. Results indicated that a large proportion of participants preferred a robot companion and saw the potential role as an assistant, machine or servant (Kerstin et al., 2005).



2.5 Summary

With population aging, elderly care is becoming significant issue in many countries. The concerns about the effect and consequence of the aging population have been growing. Many scholars and experts of different fields have developed robotic technologies to help elderly people to maintain their independence and try to improve their life quality. However, in Taiwan society, elderly people are extremely unfamiliar with robotic technology and there are seldom researches to investigate elderly people's attitudes towards robotic products.

In this research, we focused on supporting elderly people's mental fulfillment. The key features of companion robot are providing happiness to elderly people and giving them the independence they need. Robot companion has been developed to overcome some restrictions for human companion and promote the application of technology. Nevertheless, there are lots of challenges and difficulties in human-robot interaction, and many existing robotic products was not widely accepted and applied in our society. It is important to understand people's needs thoroughly before introducing robotic products entering human life.

3. METHODOLOGY

In this research, the goal is to explore elderly people's attitudes towards companion robot, and provide insight for future companion robot design. This research conducted a four-step investigation: probes, in-depth interview, perceptive sorting exercise and questionnaire. The probe method was used to directly explore elderly people's daily life, and the in-depth interview was used to get further understanding of their needs and product appearance preferences. In addition, the questionnaire was used to obtain information about the expected robot capabilities. Research results will contribute to elderly care and robot design in the future. The complete structure of the research is shown in the figure 9 and explained in the following.

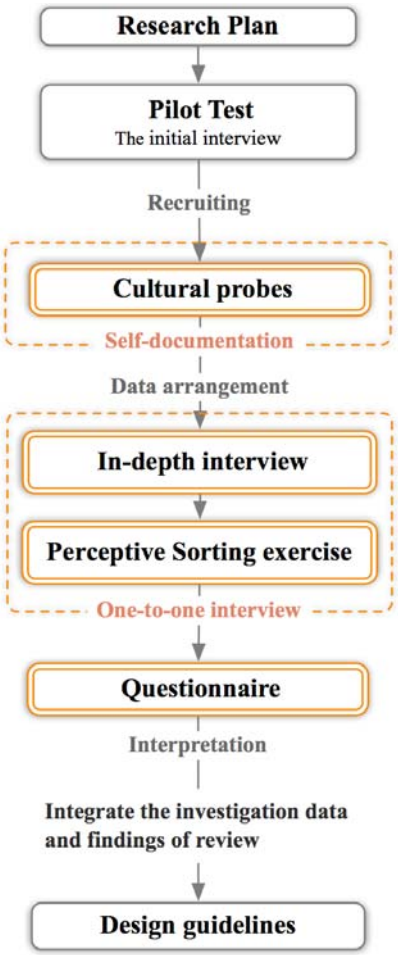


Figure 9. Research structure of this thesis

3.1 Probes study

In the initial stage, elderly people's daily activities and living environment were recorded through self-documentation toolkits which are inspired by cultural probes research. The probe approach is a valuable observational methodology in the real-life contexts. The intention of these probe tools is to see the world through people's eyes and understand them better.

The probe tools include task postcards and a disposable camera. We selected the camera as a tool because it is difficult for most elderly people to record ideas with writing. The postcards are designed by the researcher to provoke inspirational responses from elderly people, and the camera is used as a diary to record their life. There are images in front of the card, and questions on the back, such as: *what is your favorite stuff? What housework do you dislike most?*

The first step of the probing process is to introduce our research purpose. After that, we gave the probe tools package to experiment participants. The duration for probe experiment was about one week. After taking back these tools from participants, we used photos in cameras as materials for future interview.

Figure 10. Probe tools

The participants in this probes study were chosen to represent a certain life pattern of elderly people. We recruited six elderly people who were over 65 years old and lived with their children or other relatives. Two participants were found through Elderly Association and other four participants are friends recommended by researcher's grandmother.

3.2 In-depth interview

In the in-depth interviews, we visited the same participants from probes experiment and another two elderly participants. The profile of those eight interviewees is shown in Table 2. The in-depth interviews were conducted to gain further understanding of their lifestyle and interpret their probe data. The interview took place in elderly people's home. Each interviewee was asked to describe the context of the photos. Some open-ended questions were also required to answer about daily life, individual routines, specific inconveniences of aging and product experience. In addition, we tried to find out their relationships with family members and friends. The questions of the in-depth interview consisted of three parts, shown in Table 3.

Table 2. Profiles of interviewees

Interviewees	Ages (yrs) and gender	Number of people living together (ppl)	Leisure Activities
1	65 Female	2	Taking exercise, watching TV,
2	74 Female	2	Taking exercise, watching TV, making stock investment, shopping, singing
3	66 Female	3	Chatting with friends, shopping, singing, dancing, taking exercise, Scripture recitation
4	79 Female	2	Taking exercise, watching TV, listening radio, reading newspaper
5	74 Female	2	Chatting with friends, singing,
6	72 Female	2	Taking exercise, watching TV, chatting with friends, shopping
7	67 Female	3	Sutra recitation, singing, chatting with friends

8	76	Female	2	Taking exercise, watching TV, chatting with friends, shopping, travelling

Table 3. Set of questions of in-depth interview (more details refer to Appendix)

Product usage

(1) What kind of products do you use before sleeping?

(2) Did you buy any new furniture or appliance recently?

Everyday life and leisure time

(1) Which housework should you do every day?

(2) Did you go anywhere today?

(3) What kind of transportation do you use?

(4) Do you always go out alone?

(5) Who do you often go out with?

(6) Did you participate in any activities recently?

(7) Do you have any pet? What kind of pet do you have? What kind of games do you usually play with your pet?

(8) What do you usually do with your family?

(9) Did you learn something new lately?

(10) What do you do in your leisure time?

Needs and expectation

(1) Which housework do you dislike most?

(2) Did your family member do any special thing for you today?

(3) Has your family member ever helped you do housework?

(4) What will you be glad to do for your family?

(5) Did you usually go to the grocery store and buy some stuff?

(6) Will you feel troublesome? Did anyone go with you?

(7) Who is closer to you?

(8) Who do you usually chat with?

(9) Is there anything to make you feel inconvenient?

(10) Is there anything to make you feel unhappy?

(11) Do you always forget something? Are you forgetful?

3.3 Perceptive sorting exercise

The purpose of this section was to acquire feedback of product appearance, interaction mode and function on the expected companion robot from elderly people. We adopt a method, Perceptive Sorting (PS) exercise that used in research, “Perceptive Sorting: A Method for Understanding Responses to Products”. We invited the same eight elderly people to participate in this exercise. The PS is a method that uses photographic image as a stimulus to reveal stories and experiences of product use. This method also reveals user’s reactions to function and aesthetic aspects of products. PS was conducted by asking participants to pair product images with three categories of descriptive words: narrative, affective and lifestyle words (See Table 4). We select images of products in these three categories in order to understand the functional and relational relationship between elderly people’s and products (See Figure 11). Images were chosen to represent a full product space, from familiar to unfamiliar and from functional to stylish. By describing what they see in a particular product image, people reflect how they structure prior experience with that product, and potential experience with future products.

Table 4. Word pairs

Narrative Words	Affective Words	Lifestyle Words
Breakable	Bewilder	Antiquated
Complex	Bore	Classic
Durable	Delight	Common
Easy to Manipulate	Disappoint	Contemporary
Requires Effort	Entertain	Sophisticated
Simple	Understandable	Sporty

Figure 11. Images used in the study.

3.4 Questionnaire

In the last step of this study, we conducted a survey through questionnaire. The questionnaire contained 20 items to represent the imaginary companions with different capabilities. These 20 items were:

1. teaching
2. event-reminding

3. entertaining
4. emergency contact
5. cooking assistance
6. playing game with you
7. appliance-setting
8. making contact to your friends
9. event-recording
10. protecting
11. health checking
12. message-leaving
13. health caring
14. friend-making
15. chatting
16. guarding
17. information providing
18. house chores assistance
19. pet, plants-keeping
20. information-inquiring

These capabilities were inspired from interview results. The survey focused on concluding the robot capabilities that elderly people expected the companion robot would be equipped with. The purpose of this questionnaire is to determine the possible functions of robot companion for elderly people. In order to gather information about robot capabilities, we had send out about 50 questionnaires. People over 65 years old

were selected to be our partcipants . After several weeks, the returned questionnaires were categorized for future statistics.

4. RESULTS AND ANALYSIS

In the initial stage of the research, we conducted cultural probes to acquire rough information of elderly people's living circumstances. Through following in-depth interview, Perceptive Sorting method and questionnaire, we collected more detailed understanding of elderly people's needs, including their opinions of familiar products and robotic products, for comprehensive discussions.

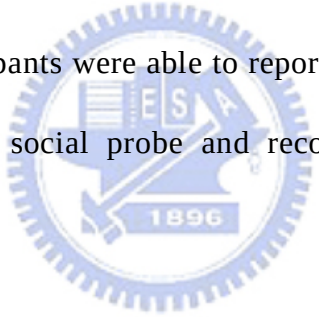
4.1 Probes study

We received the returned materials from six research partcipants. Some photos that returned from elderly people were damaged or unable to recognize. However, elderly people's daily life including product use and routine works could still be observed from some valid photos. We gained an initial understanding of our partcipants' life.

The returned photos revealed that most of our partcipants live in an ordinary space with simple decoration. Most of the partcipants took photos in their morning exercise. It can be observed that doing morning exercise is one of their important daily activities. Doing house activities and cooking for their family members also seem the responsibilities of our partcipants. Furthermore, it can be observed in the photos that there are various kinds of products existed in their living environment for entertainment (television and radio) and cooking (electric pot and microwave). One of our research

partcipants owned professional medical equipments and a high-effect fruit blender for fresh juice and food to maintaining health. Furthermore, the interests and social activities of elderly people can be observed from part of the returned photos. Most of our partcipants enjoy singing with friends and participating in some activities held by elderly association. Our partcipants recognized that health and social interaction are vital elements in their life. This recognition can be observed from the phenomena that some elderly people, even sometimes they got a pain in legs, insist doing morning exercise with friends.

The result from social probe may contain elements of uncertainty. Through following in-depth interview, the partcipants were able to report their daily life personally. We can interpret the raw data from social probe and reconfirm the information from them accurately.



4.2 In-depth interview

The in-depth interview was conducted with three topics in elderly people's life: *product usage, daily life and leisure time,* and *needs and expectation*. Eight elderly people were invited to participate in the interview process. The findings were generalized and interpreted via these topics respectively.

4.2.1 Product usage

Open-end questions were designed to reveal the elderly people's demand for products and their past product experience. The interview was held in each interviewee's living environment, and we can observe the product types in their house. We try to explore the differences and similarities among their opinions for product usage.

Regarding product types, our partcipants pointed out that the most frequently used products are home appliances for entertainment and working purpose, such as TV, radio, electric pot, and oven. Partcipant 1 mentioned, *"When I feel bored, I enjoy watching television and I prefer listening to radio while sleeping."* In addition, most elderly people are capable of controlling these home appliances independently. Partcipant 5 said, *"I usually use the oven for cooking and it is easy for me to operate."* Due to age-related memory decline, elderly people are becoming forgetful. Our participants found many ways to remind themselves. Partcipant 2 mentioned, *"My daughter bought me a whiteboard for keeping a record of events, and I think it is pretty useful."* With regard to elderly people's attitudes towards product, each participant is willing to learn new product and technology; however, they hope to be instructed and get assist from others. Partcipant 8 said, *"I used to have fun using camera and computer, but I no longer learn new things because no one gave me new instruction to use those products."*

4.2.2 Daily life and leisure time

All participants live a regular life and they do routine activities every day. They take charge of all houseworks. Partcipant 4 said, *"I do exercise everyday morning in the outdoor space. When I arrived home, I need to do houseworks, such as cooking and cleaning."* Partcipant 3 said, *"My children work outside all day, so no one could help me to mop the floor."* Most participants do not have a pet, because they feel it is troublesome to take care of the pet. Partcipant 1 mentioned, *"Pet and small animal are lovely and sweet only when I don't in charge of pet feeding."*

Regarding the elderly people's interests and leisure activities, singing, cooking and watching television are their common interests. Singing with karaoke machines is one of the learning channels and group activities. Partcipant 5 said, *"I perfer singing with my friends, and I will try to learn new song to challenge myself."* Partcipant 5 also said, "I usually watch cooking program on TV and learn to cook a new dish." For elderly people, religious beliefs and attitudes are important considerations. Partcipant 6 mentioned, *"I can get spiritual comfort when I join in religious organizations and activities in church or Buddhism temple."*

4.2.3 Needs and expectation

After the entire interviewing process, several obvious needs in elderly people's daily

life including housework assistance, cognitive support and social enhancement, were gathered. Partcipant 2 expressed, *"I hope someone can help me in heavy work."* In addition, they hoped to get guidance and assistance to use product and inquire specific information. Loss of memory is a common symptom for the elderly, and all our partcipants suffered from the same problem. Thus, event reminding or recording seem essential requirements to elderly people. Moreover, partcipant 3 mentioned, *"I feel happy when I participate in singing performance."* To feel achieved seems one of the vital factors to promote mental health of elderly people.

4.3 Perceptive Sorting exercise

After conducting the perceptive sorting exercise, some routine patterns of our partcipants were revealed to assess the product attributes. The overall finding was that familiarity in form was more dominant than the simplicity or complexity of organization. Products using familiar forms, no matter simple or complex, were associated with simple operation, durability, understandability, and ease of use.

The results of the study are shown in Table 5. We invited eight participants in this pairing exercise. Affective words were most frequently used in the pairings (n = 79), followed by lifestyle words (n = 39), and then narrative words (n =26). For teapots, 13 narrative word pairs, 12 lifestyle word pairs, and 23 affective word pairs were made. For watches, 5 narrative word pairs, 26 lifestyle word pairs, and 17 affective word pairs were

made. Watches were associated most frequently with lifestyle words. This may indicate that watch is regarded as a fashion accessory and a more personal product by our participants. For consumer robotic products, 8 narrative word pairs, 1 lifestyle word pairs, and 39 affective word pairs were made. Affective words were selected most frequently in teapots and robots category. This represent that when participants were not certain of the product function, they expressed their thoughts and surmises in emotional response. The most frequent narrative word choice was “Complex,” the most frequent lifestyle word choice was “Contemporary,” and the most frequent affective word choice was “Delight.”

Table 5. Results of image-word pairings.

	Narrative Words	**Lifestyle Words**	**Affective Words**
teapots	13	12	23
watches	5	26	17
robots	8	1	39
Total (sum)	**26**	**39**	**79**

Though PS exercise, we gain many descriptive data about perceptions and attitudes about products. In the teapot category, our partcipants expressed high preference of the traditional teapot and they liked the teapot with single function and bright color. In the watch category, familiar simple forms were considered simple and easy to manipulate, while familiar complex forms were considered requiring effort. Some elderly people thought that digital watch was hard to comprehend than needle watch. For the product appearance, they don’t prefer a watch with lively color and expensive or delicate forms

to be a cloth accessory. In the robot category, our partcipants preferred products with human-like or animal-like appearance than those with mechanical robotic form. Product appearances made the products seem more familiar to our test partcipants, despite they had never seen these products before. Some elderly people believed that humanoid robots would obey human, so they have no fear of robot. One informant insisted that robotic products were made for children and she don't need a robot toy. Table 6, shows the key points sorted by the three product categories in product appearance, function and interaction pattern.

Table 6. Summary of participants' opinions.

	teapots	**watches**	**robots**
Appearance	traditional, cute style, cartoon pattern, bright color	classic, lady style, simple layout	against mechanical form, doll-like, animal-like, human like
Function	practical, simple-function	simple-function,	assistance providing,
Interaction Pattern	easy-to-use, familiar operation	familiar operation (traditional watch)	doubtful, voice control, human-like interaction

4.4 Questionnaire

In the former experiments, all of our respondents were female elderly people. In order to keep the research partcipants consistent, female elderly were selected as respondents

in the questionnaire survey. The questionnaire contained 20 items which are designed according to the former results of experiments. The respondents were supposed to rate the robot capabilities by a 5-point scale according to the level of their need.

Finally, we received 40 completed questionnaires from our participants. The data analysis was divided into three stages:

(1) The first stage of the analysis was averaging the scores. The results showed that our respondents gave highest score on three capabilities: event-reminding, emergency-contacting and information-inquiring.

(2) In the second stage of the analysis, the resulting scores were examined using factor analysis. SPSS software was used to carry out factor analysis and extract important factor to reduce the numbers of variables and simplify data. Consequently, six factors were extracted. The score of each extracted factor is shown in Table 7 and the items of each six factors are shown in Table 8.

The six factors represented the consistency of six different user groups. The results show different emphasis of robot capabilities:

Factor 1: entertaining, event-recording, health-checking, friend-making, chatting and house chores assistance

Factor 2: health-caring, guarding and the tendency to play with.

Factor 3: emergency-contact, appliance-setting and protecting.

Factor 4: message-leaving and information-providing.

Factor 5: event-reminding and making contact to friends.

Factor 6: assistance, pet or plants-keeping and information-inquiring

Table 7. Rotated Component Matrix (a): Scores for 20 items, six factors extracted

	Component					
	1	2	3	4	5	6
11. health-checking	0.785	0.274	0.088	0.102	-0.147	-0.033
3. entertaining	0.767	0.198	0.049	-0.057	0.089	0.204
15. chatting	0.727	-0.151	0.065	0.186	0.204	-0.068
9. event-recording	0.644	0.080	0.243	0.199	0.474	-0.025
18. house chores assistance	0.594	0.564	0.003	-0.115	0.097	0.169
14. friend-making	0.549	0.313	-0.319	0.111	0.274	-0.117
13. health-caring	0.066	0.731	0.285	0.094	0.346	-0.163
6. playing game with you	0.238	0.720	0.174	0.319	-0.069	0.099
16. guarding	0.210	0.657	-0.119	-0.138	0.267	0.109
7. appliance-setting	0.072	0.057	0.751	-0.111	0.116	0.081
4. emergency contact	-0.124	-0.052	0.658	0.004	0.486	0.011
10. protecting	0.301	0.114	0.644	0.263	0.120	-0.240
17. information-providing	-0.003	0.072	0.012	0.786	0.138	0.197
12. message-leaving	0.302	0.260	0.181	0.714	-0.209	0.051
1. teaching	0.078	-0.207	-0.469	0.662	0.183	-0.146
8. making contact to your friends	0.133	0.191	0.325	0.227	0.736	0.229
2. event-reminding	0.238	0.231	0.097	-0.085	0.697	-0.031
5. cooking assistance	0.114	0.133	0.331	-0.110	0.219	0.708
20. information-inquiring	-0.071	0.472	-0.233	0.123	0.016	0.637
19. pet, plants-keeping	0.032	-0.239	-0.115	0.343	-0.104	0.620

(3) In the final stage, we conducted a hierarchical cluster analysis according to the score of six factors to identify different representations of robot capability. The result is summarized in Table 7. The respondents were divided into six groups according to the outcome of cluster analysis (See Table 8). The respondents in the same group show a high degree of homogeneity.

Table 8. Hierarchical cluster analysis and the average of factor scores of each cluster

G	Informants in groups	FAC 1	FAC 2	FAC 3	FAC 4	FAC 5	FAC 6	Mean	STDEV
1	9, 1, 11, 12, 13, 15, 8, 18, 39*, 30, 34*, 38*, 37*, 7, 14, 40, 17, 28	-0.284	0.023	0.207	0.457	-0.469	0.241	0.175	0.348
2	2, 5, 36*, 33	0.876	-1.049	-0.867	-0.601	0.930	1.262	0.551	1.038
3	21, 22, 23	-0.434	1.732	0.626	-1.394	0.343	0.619	1.492	1.063
4	35*, 27, 25, 19, 24, 6, 4, 3	0.029	-0.012	-0.755	-0.828	-0.493	-0.898	-2.957	0.412
5	29, 32*	1.735	1.298	-0.485	1.922	0.604	-1.645	3.429	1.395
6	20, 26, 10, 16, 31	-0.435	-0.562	0.632	0.280	1.770	-0.774	0.911	0.956

* number with underline means that the informant has been interviewed

4.5 Summary

Through several steps of experiments, we found that the elderly people are living a regular life. However, they not only take care of their personal lives, also looking after their family. A certain degree of mental stress and physical burden were produced in their live. These elderly people have an active involvement in social activities. Moreover, we found several equivalent interests of elderly people who live in the city, such as watching television, singing, chatting with friends and so forth.

As for the opinions of product appearance, elderly people do not like the accessory product with complex forms, and household products with bright colors. Regarding product function, practicality is the important consideration of product choice by elderly people, and they do not like complicated operational or multifunctional products. Regarding attitudes of robot, the elderly people prefer animal-like and human-like

robots. Overall, the elderly people expect to obtain assistance from robotic products. Through a questionnaire survey, the three robot functions, event reminder, emergency contact and information searching, got higher scores.

Through experiments, the information about the needs of the elderly people and their attitudes toward companion robot were explored. The results were integrated and discussed to formulate the design guidelines of companion robot for elderly people.

5. COMPANION ROBOTS TO ASSIST ELDERLY PEOPLE

The major aims of this study were to explore elderly people's attitudes towards the robot companion. A summary of the results were listed in the first part of this chapter. Moreover, according to the integration of research results and reviewed data, the design guidelines for improving robot companion were proposed.

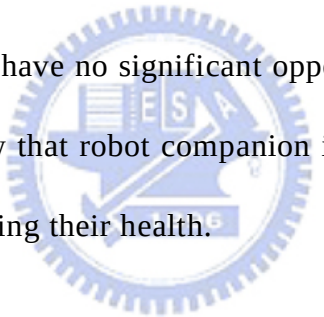
5.1 Elderly people's attitudes towards robot companion

Through a series of experiments, we obtained the acceptance of existing robotic products from the responses of elderly people. As a result, the opinions for related technical products could be more positive compared to the responses for having a robot companion in the home.

Overall, the elderly people have positive feelings towards robot companion. They felt great admiration for robot's capabilities and showed their expectations to have a robot companion. Same as other related products, they were willing to learn how to use new techonology, such as computer and cell phone. Our participants had different opinions about the robot appearance. Some elderly people preferred the animal-like or fluffy robot. Others considered the human-like robots which are able to carry out some tasks to assist their life. However, some elderly people doubt the interaction with robot. They

wondered that professional skills are required to operate the robot. All of our participants expressed desire of a robot companion to communicate in a human-like manner. Kerstin et al. found that people may link similar perceptions of the ability to communicate to the types of robot appearances. When being asked about their inclination of purchasing a robot companion, most elderly people thought they can't afford the expensive robots. Conservatively, some elderly people show mistrust and fear about the robot companion. They want a robot companion to be controllable and predictable. Kerstin et al. stated that any technology for the home should be controllable, in that the user should be able to instruct the device to perform requested actions (Kerstin et al, 2005).

To sum up, elderly people have no significant opposition about having a robot beside them. The whole results show that robot companion is a potential role of giving elderly people assistance and supporting their health.



5.2 Design guidelines

The fundamental goal of this research was to aid the design and development of robot companion for the elderly people through the development of design guidelines. In this chapter, three design guidelines were proposed from the results of our study. These three design guidelines can be generally applied to the design of robot companion.

5.2.1 Interaction with companion robots must be a activity with low cognitive load

It was observed from the interview that elderly people feel confused about the interaction with robot. They were anxious because they feel it is a great effort to operate and maintain the robot. They hope the robot has the ability to communicate with them naturally like a human. As for other products, elderly people dislike the product with complex and multiple functions. Although most of elderly people have strong intention in learning new technologies or new skills, they feel mentally stressed about the complicated product. Our participants expressed positive attitudes towards robot companion as well as they request an uncomplicated way to interact with them.

Designing companion robots for elderly people should consider the cognitive capacity of elderly people. When arranging robot interaction, designers should consider age-related cognitive decline and mild cognitive impairment. In addition, most elderly people lose their short-term memory. They suffer from the ability diminishment to process and retain new information. Jodi et al. proposed that elders who accept physical and cognitive decline seem to be more willing to explore the use of appropriate assistive products. Even though the robotic products embodied sophisticated technology, robot performance should be simplified to adapt to the users' behavior (Jodi et al., 2004). Robot companion for elderly people must avoid specialized operations and complicated information. Furthermore, the robot interaction and communication modality should refer to human companion, animal companion and other products familiar to elderly people. Designing the interaction with companion robots should minimize the cognitive

effort and facilitate the robot operation for elderly people.

5.2.2 Companion robots for elderly people must have familiar appearance

Robot companion was an emerging product and was unfamiliar to people, especially elderly people. Moreover, elderly people are more conservative and afraid of new things than younger people. When designing the appearance of robot companion for elderly people, it is important to get design inspiration from their everyday experiences and knowledge. According to related researches, a high acceptance of human-like and animal-like robot from elderly people was discovered. It seems that elderly people may accept the forms that ever appeared in their living environment or memories.

Through the PS exercise, we found that our participants showed strong preference of human-like and animal-like robots. Mori (1970) proposed a general effect in which people will act in a much familiar way towards robots when the robots exhibit human-like characteristics increasingly. When looking at the robot picture of Paro, some elderly people mistook the seal as a dog. Participants 2 mentioned, *"Is that a dog? Pretty cute! I like this one! "* Although they made a mistake about the animal type, they showed agreement likeness of animal-like robot. When looking at the humanoid robot picture, some elderly people regarded the role of this robot as a servant or assistant. Participants 3 said, *"Can he help me mop the floor? Can she serve me as a housemaid? "* They projected the familiar role they knew to this human-like robot companion. Most elderly

people disliked the robot with mechanical appearance. Participants 1 mentioned, *"Is that also a robot? It looks so strange! I don't prefer this one. What can it do for me? "* It was an encouraging finding that elderly people were in favor of robot companions with the familiar appearance in the home rather than the awkward and unfamiliar forms.

5.2.3 Companion robots must encourage and enhance social interaction among elderly people

Companion robots should provide encouragements to elderly people and promote the elderly people's involvement in social activities. Encouragements are offered to enrich unsociable and friendless elderly people's mind. Companion robots should provide stimulations and assistance to elderly people by building their self-esteem and self-confidence. Furthermore, companion robot should be designed as a communication media among a group of people to facilitate social interaction for elderly people.

In the findings of this research, most elderly people had a regular habit participating in social activities, such as morning exercise with a group of people and singing with friends. Participant 4 mentioned, "My life became more splendid and I felt pleased everyday since my best friend encouraged me to join their gatherings." Participants 5 mentioned said, "I owned a karaoke machine in the living room. I seldom sing along, and I always invite my friends to my house to sing together." According to the research data, we found that our participants generally paid a lot of attetion to involve in social

interaction and felt pleased to join social activities.

Social participation and interpersonal relationships are important to elderly people's physical, mental, and emotional health. Feelings of loneliness among elderly people could be attributable to increasing functional disability and decreasing social contact (Andersson, 1992). Jerrome, D. proposed that friends typically provide essential emotional support for elders, thus declining social interaction poses challenges to maintaining good mental health, well-being, and self-identity (Jerrome, 1981). Social interaction is a key psychological factor to enhance elderly people's health and life fulfillment. Consequently, when designing the companion robots, designers should consider the social involvement among elderly people.

6. CONCLUSIONS

The ultimate goal of this research was to assist the development and design of future robot companion, and provide design references for robot designers. The experiment results were integrated to formulate the design guidelines of companion robot. Consequently, we proposed three design guidelines: Interaction with companion robots must be a activity with low cognitive load, companion robots for elderly people must have familiar appearance and companion robots must encourage and enhance social interaction among elderly people. These design guidelines can be generally applied to the design of robot companion.

In Paro's appearance evaluation, the users compared the robot that look like familiar animals with the real animals. The differences between real animals and the animal-like robot became a source of disappointment. They found that people are generally interested in interacting with robots modeled after non-familiar animals. However, in our research, robots with familiar appearance were easily accepted by our participants. They associated the robots with the familiar animals, such as dogs and cats. Most participants didn’t have pet-owning experience, so they expect the animal-like robots to be their pet.

In this research, we conducted cultural probes, in-depth interview, perceptive sorting exercise and questionnaire to investigate elderly people’s daily life and their attitudes towards robot companion. We invited eight elderly people who were over 65 years old

and lived with other family members. After conducting these experiments, we found that elderly people hope to be assisted in housework which required physical strength because they were tired easily due to physical decline. In addition, our participants emphasize on the social interaction and interpersonal relationship. In PS exercise, the results showed that elderly people had positive attitudes toward robot companion and they preferred the robot with human-like or animal-like appearance. Moreover, the desired capabilities of robot companion were surveyed via questionnaire. The result indicated that three items including event reminder, emergency contact and information searching, rank highest. However, there are some difficulties in the pairing process. It seemed hard for our participants to pick one suitable word for one image, and they couldn't completely understand the word's meaning. This might be because we presented the three word pairs directly and our participants with different cultural difference were not used to describing objects in these. Additionally, the static images may not be enough to acuire user's response related to complex, technology-based and unfamiliar products.

In the results of questionnaire analysis, we attempted to find out the meaning of each extracted factor, but no reasonable factor significance could be integrated. This might be the reason that we didn't have enough questionnaire data.

In this research, due to the limitations of subject recruitment, female elderly people were selected as research sample. Consequently, the research results have revealed female-oriented specialties. In order to consider overall opinions of elderly people

towards companion robot, male elderly people should be investigated in further study.

The current study have explored elderly people's attitudes and needs toward the robot companion and proposed the robot design guidelines. For the future research, the challenge would be how to investigate the communication among elderly people, their family member and friends. It is because we try to enhance the future robot companion as an intermediary in social interaction. We also try to develop the robot companion into a feasible robotic product.

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Appendix A: The Research Script for Probes (Chinese)

探針法實驗規劃

研究人員：黃盈嘉

1) 實驗目的

此實驗希望透過高齡者的角度觀察高齡者生活形態及所接觸的人事物，讓受測者自由發揮，藉由第一手的資料，作為整理設計規範的參考資訊。

2) 招募受訪者

本實驗依照台灣高齡者的普遍居住形態以及根據國際衛生組織制定年齡達65歲以上為高齡者，挑選六位65歲與家人共同居住的受測者。

3) 實驗方式

請受測者依照明信片上的指示進行實驗，利用即可拍相機記錄影像以作為問題的回答方式。

4) 實驗步驟

招募受測者 > 準備實驗工具 > 向受測者說明實驗目的及實驗方式，並將實驗工具交給受測者 > 期間以電話詢問實驗狀態 > 一週後向受測者回收實驗資料

5) 實驗工具

即可拍相機、11張附有問題的明信片

即可拍相機

明信片

最近有什麼事情
讓你不開心嗎？

家裡你覺得好看的
電器或**傢具**

最近有去學什麼嗎？

最近有沒有覺得
什麼事情很不方便？

最讓你得意的事？

最不喜歡什麼東西？

哪個產品覺得最**難用**？

希望能收到什麼樣的禮物？

最不喜歡做什麼家事？

最近喜歡買什麼東西？

最喜歡的休閒活動？

Appendix B: The Research Script for In-depth interview (Chinese)

深度訪談法-研究計劃

研究人員：黃盈嘉

1) 目的

本研究希望透過與受訪者深入訪談來調查高齡者的生活需求、日常例行事項以及對於產品的使用經驗，希望從訪談中了解台灣高齡者的興趣及喜好，並針對probes實驗所拍攝的相片進行詢問及內容的再確認。

2) 研究問題

此訪談的研究問題分為三個面向進行調查：

- 產品的使用經驗
- 日常活動與休閒生活
- 生活需求與生活期望

3) 受訪者招募

此階段的受訪者挑選前次probes實驗中相同的高齡者，為了獲得更普遍性與更有代表性的資訊，本研究再增加兩位同為65歲以上之高齡者進行訪談。

4) 受訪者基本資料

Interviewees	Ages (yrs) and gender	Number of people living together (ppl)	Leisure Activities
1	65 Female	2	Taking exercise, watching TV,
2	74 Female	2	Taking exercise, watching TV, making stock investment, shopping, singing
3	66 Female	3	Chatting with friends, shopping, singing, dancing, taking exercise, Scripture recitation
4	79 Female	2	Taking exercise, watching TV, listening radio, reading newspaper
5	74 Female	2	Chatting with friends, singing,
6	72 Female	2	Taking exercise, watching TV, chatting with friends, shopping
7	67 Female	3	Sutra recitation, singing, chatting with friends
8	76 Female	2	Taking exercise, watching TV, chatting with friends, shopping, travelling

5) 訪談問題

基本問題：

1. 年齡__今年幾歲了？
2. 工作與否__還有在工作嗎？
3. 家庭成員__家中有幾個人？有誰？
4. 例行事項__每天大約都在做什麼事？
5. 興趣

特 定 問 題 ：

產品的使用經驗

1. 睡覺前會使用哪些產品？
2. 最近有買什麼新的傢具或家電嗎？

日常活動與休閒生活

1. 哪些家事是每天都要做的？
2. 今天有去什麼地方嗎？去哪裡？
3. 平常出門都搭什麼交通工具？都一個人出門嗎？最常跟誰一起出去？
4. 最近有參加什麼團體活動嗎？
5. 家中有養寵物嗎？什麼寵物？跟寵物玩什麼遊戲?最喜歡跟寵物一起做什麼?
6. 最近一次學的新事物是什麼？
7. 最常跟家人或朋友一起做什麼事？
8. 無聊的時候都做什麼事？

生活需求與生活期望

1. 最不喜歡做什麼家事？
2. 今天家人幫你做了什麼事？
3. 家人會幫忙做什麼家事？
4. 最喜歡替家人做什麼事？
5. 平常會去買菜嗎？買菜會不會很麻煩？有人陪你一起去買菜嗎？
6. 跟家中哪個成員最親近？為什麼？
7. 最近比較常跟誰聊天？都聊些什麼？
8. 最近有什麼事情讓你很開心或不開心嗎？
9. 最近有沒有覺得什麼事情很不方便？
10. 會不會經常忘記事情？什麼事最容易忘記？

6) 訪談內容重點記錄

受訪者 一__

- 最近在學手語
- 喜歡表演，有時候會當評審（香功觀音協會評審，最近要去鹿港比賽當評審）
- 到外界接觸更多不一樣的朋友，認識很多不一樣的朋友，知道怎麼應對不同朋友
- 每天都嘻嘻哈哈過日子
- 凡是看的很開，不跟別人斤斤計較
- 2個人住 (跟丈夫同住)
- 例行事項：上午5點到7點氣功室外活動，8點到9點買菜，10點半到下午2點半到兒子的午餐店幫忙，中間回來休息一下，下午4點到6點準備晚餐，6點半以後到8點半叫孫子洗澡穿衣服(晚上回來吃飯)四點下課 五點回來吃飯，其他時間轉錄音帶，寫紀錄 ，有時候看電視(看新聞、全民開講)
- 先生習慣聽收音機，自己喜歡吹冷氣，每天都會開，怕沒空氣，調節室內
- 沒買新東西
- 在別的地方養，每天回去幫他打掃，像動物園一樣，有兔子、烏龜
- 不喜歡跟他們玩，小朋友喜歡
- 平常在家掃地，整理衣服
- 最怕煮飯，又一定要煮，家裡人要吃 又不能懶惰，小朋友要吃，還是很認真在煮，不知道要煮什麼，弄得腰酸背痛
- 先生會幫忙分擔家務
- 運動完要去洗頭髮，晚上要去參加老人會的聯誼，帶媽媽去走走
- 沒去買菜也會去市場逛街逛一逛，雖然很麻煩但也當作打發時間、找樂子
- 偶而也會唱歌，沒人陪唱，一下子就想睡，一個人唱無聊

- 最好的朋友，你阿嬤（研究員的外婆），有活動的時候才出去 會一起去遊覽
- 有事情就連絡，沒事情就不想打擾別人
- 最近膝蓋不好，要趕去看醫生
- 腳不好會硬著頭做，叫老伴幫忙做
- 無聊的時候看電視
- 偶而會騎車去晃晃
- 昨天跌倒，騎車傷到腰椎，心情不好
- 不太會忘記事情，會記在月曆上，最近在補牙齒，每件事都會寫在月曆上

受訪者 二__


- 先生愛蒐集東西，手錶、古董相機、集郵、唱歌，先生喜歡唱日語，自己什麼都會唱
- 女兒都不在家，在外商公司
- 74歲
- 兩人 (夫妻同住)
- 5點半運動，9點去股票市場投資
- 滑鼠、電腦周邊東西都知道
- 了解很多資訊，有多股票資訊都知道，有買基金，會幫兒女存錢
- 孩子都很好，本來下午要跟女兒去參加喜宴
- 手機是nokia，簡單的功能會收會聽，簡訊不會
- 看電視看到10點，早上5點就自己起床
- 先生有買新的數位產品
- 沒養狗，以前房子比較大有養，新家生活很單純，住家環境很安靜

- 每天有做家事，掃地、煮菜
- 都要做沒辦法，不愛換季的時候衣服折來折去，沒人幫忙
- 愛煮飯給家人吃，喜歡煮一些特別的菜，媳婦都要加班，難得禮拜天回來特別煮給孩子吃
- 很喜歡玩，愛漂亮，興趣買衣服，愛賺錢愛花錢
- 最近脊椎有點裂開，本來想去日本玩
- 覺得自己一定很長壽，因為爸爸阿嬤都很長壽，所以要快樂盡量玩
- 沒有參加什麼活動，以前在永和，有參加國民黨的小組長
- 坐公共汽車，環保省錢
- 跟同學出去，運動的同學，初中的同學
- 晚上不愛出門
- 有買菜，買給人吃很開心 盡量買很少，平常都自己去，週末孩子會陪
- 無聊看電視、唱歌、逛街、買東西，外號叫愛買
- 換季打折很喜歡去逛，會幫女兒買衣服，女兒上班很忙沒空買，眼光不一樣
- 跟大家都很好，不喜歡有偏見，天平座，很喜歡朋友，喜歡付出
- 在家排行老大，都照顧弟妹，談戀愛出去玩弟妹都跟著去，喜歡小孩
- 看得很多，世界各國都去玩過、南非、美國(去一個月 花五十萬)、日本
- 會講英文一點只知道名牌啦，先生很會講 日文
- 最近身體比較不好，眼睛霧霧，牙齒不好
- 賺錢就開心，賠錢就不開心
- 不太會忘記事情，要出去前就會先準備好，腦筋還很好啦，有吃銀杏，不會老人癡呆
- 從小很獨立，不喜歡別人幫忙打掃，很多朋友都有請人打掃
- 平常很隨性，很自由啦，看到髒才打掃

受訪者 三__

- 喜歡和朋友一起去聊天、去逛賣場
- 家裡有做仰臥起坐的器材，電鍋、烤箱、家裡有病房那種可調整坡度的床、廚房、果汁機、烘碗機、洗水果、健康床、有按摩
- 與先生及一個小孩同住
- 想學電腦，太忙，不過很喜歡學，電腦手機數位相機都會用
- 早上運動，回家後做家事，有時唱歌，有時去山上聊聊天
- 先生最近開刀，常常要打果汁給先生喝
- 最不喜歡拖地，最累
- 兒子都不幫她做，兒子要值夜班，白天要睡覺
- 喜歡去市場買菜，每天都去，買一點，買多拿不動，都自己去
- 最想去韓國，出生在韓國，不常回去
- 最近有練蓮花舞 跳舞很開心 很期待去表演
- 自從認識阿嬤心情便很好，一起去唱歌，逛賣場，和阿嬤最投緣
- 阿嬤又會國語台語客家語，很好溝通
- 平常都騎腳踏車再換公車
- 無聊時都看聖經，喜歡唱歌
- 喉嚨不舒服 ，開過乳癌的後遺症
- 手機不懂的要問人，問兒子，教了又忘
- 忘了拿筆記下來，要買什麼東西要記下來，要看單子
- 喜歡聽收音機
- 最近花很多錢買健康食品

- 不喜歡動物，因為經常不在家，有時去大陸，怕麻煩
- 三十幾歲就會用相機了，別人教就會用
- 以前就會用傻瓜相機了，之前去阿扁下台，就有買來拍做紀念
- 想學唱歌，好難學

受訪者 四__

- 咳嗽要抱著抱枕
- 17年次
- 沒在做事了
- 一個人住，兒子每天會回來陪她吃飯
- 每天做運動，有時出去玩一玩 ，唱歌，最近有開刀，不敢每天跑，以前都每天跑 怕太累，以前有去遊覽阿 運動會
- 收音機聽歌，看電視
- 每天煮菜，沒有天天去，買菜不能提太重
- 沒做家事誰會幫我做，擦地，洗衣服阿
- 擦地最不喜歡，洗廚房啦，有人幫忙最好
- 能動自己動，不需要別人幫忙
- 最近沒出去，開刀後就沒出去
- 走路，坐公車
- 跟阿嬤最好，麻吉，跟鄰居也很好，跟大家都很好
- 聊天都隨便講 不喜歡亂講閒話

- 沒事都唱歌，看報紙
- 走路慢一點，還是每天會出去
- 出去就開心，看老朋友就開心
- 不喜歡寵物，自己都照顧不了，阿嬤那隻狗很可愛
- 會忘記事情，這麼老了，出去時瓦斯會在看一遍
- 沒出去都沒學新東西，唱舊歌沒學新歌
- 沒人幫忙，年輕人都上班，媳婦也在上班

受訪者 五__

- 2人 （與兒子同住）
- 很常用微波爐，電鍋，看電視，有調定時會自己關
- 女兒買的衣服，不喜歡，不合
- 不喜歡寵物，會怕狗
- 沒做家事，兒子會打掃，買吃的東西
- 以前比較常去買菜，自己去買菜，不會麻煩，買少一點
- 跟阿嬤聊天，唱歌
- 腳骨不好
- 想要有人幫忙，請人要錢啊，想要有人幫忙買東西
- 女兒最近下個月要從日本回來，很高興
- 最近有學手語
- 無聊都在看電視，澆花，種花

受訪者 六__

- 72歲
- 兩個人（與二兒子同住）
- 每天都要煮飯，打掃，買菜， 四點起床天天做運動，然後洗衣服，燒香，菜市場買菜
- 很少用家裡電器，洗衣機，電鍋煮飯，煮菜瓦斯爐，烤箱微波爐都沒用
- 以前很愛買新衣服，現在很少
- 養狗很麻煩，要餵
- 希望別人幫忙擦地，拿菜上樓
- 愛煮飯，煮飯最高興
- 九點出去兒子家
- 在家做事，跟朋友聊天最開心
- 買菜不會麻煩，都一個人去
- 平常都走路
- 跟阿嬤最好，心裡感覺最好，沒常常聊天啦
- 開刀開疝氣，之後就好了，弄過大腸一次，開刀之後會便秘，吃東西要小心
- 不太會心煩，快快樂樂 ，最近有學手語，學唱歌
- 會忘記事情，用頭腦記

受訪者 七__

- 沒在工作，平常就煮飯洗衣而已
- 沒事的時候就抄經書，去佛堂念經
- 小兒子偶爾會來吃飯
- 跟先生跟還沒嫁的小女兒，還有小叔一起住
- 早上都去運動
- 每天去市場，家離市場很近
- 買菜習慣，會覺得很重，買好幾趟，住2樓，搬來三十幾年
- 平常都有看電視，煮菜用瓦斯爐，微波爐，烤箱，電鍋
- 去年有買液晶電視，洗衣機
- 兒子教一下就會了，有時候媳婦兒子女兒會教我用
- 擦地擦一下腰會酸，都自己做，洗衣機洗過又用手洗過，不太信任洗衣機
- 一群人都回家就最開心
- 以前有養魚，不愛養狗，麻煩，以前有抓回一隻博美狗，很麻煩，後來又還給別人
- 平常沒事的時候都去拜拜
- 坐公車，做捷運，坐遊覽車
- 跟阿嬤很好，講話和得來
- 愛出去玩，出國玩，都跟旅行團
- 12月又要跟女兒去北海道買藥
- 無聊時都抄經書，或是打電話給朋友聊天
- 最近有去夜間大學學寫字，學注音符號
- 現在身體都不錯，以前都會腰痠，現在身體很好，檢查都沒紅字
- 煮飯會麻煩，不過不煮都不行，現在很少煮，有時候買便當

- 昨天煮給孫子吃，孫子說不好吃，丟垃圾桶
- 記性不好，注音符號都常常忘記，會寫在日曆，白板上，別人打電話來都會記下來，不會寫就寫注音

受訪者 八__

- 2 個人住（與先生同住）
- 閒閒老人家沒做事，早上做運動
- 看電視，煮飯
- 有時晚上會聽收音機，放床頭
- 煮飯兩人吃，打掃都自己來，粗重的工作不行，拖地都夫妻一起擦
- 今天去朋友家聊天，吃飯聊天，聊到兩三點
- 也有學手語，不識字，不太愛唱歌，平常看電視而已
- 愛逛街，愛買東西，以前常跟阿嬤去買，愛買衣服，喜歡比較素的，有年紀了都穿比較素
- 偶爾去買菜，吃一吃放冰箱
- 最近去打針，腰骨膝蓋不好，最近有比較好，以前坐著都爬不起來，現在都可以了
- 出去玩就開心
- 養寵物很麻煩
- 會常常忘記東西，去冰箱拿東西，會忘記要拿什麼，有重要事情會把日曆折起來
- 兒女過年才會回來

7) 訪談內容整理: 受訪者每日例行事項整理以及每位受訪者的興趣

	受訪者 一	受訪者 二	受訪者 三	受訪者 四
上午	室外運動 買菜	室外運動 去股票市場投資	室外運動 買菜 做家事	室外運動 買菜
下午	幫忙兒子做生意 準備晚餐	有時在家做家事 有時跟同學出去	唱歌 去戶外走走	在家休養
晚上	照顧孫子 做家事	看電視	照顧先生	看電視
空閒時間	整理資料 記錄事情 看電視	做家事 看電視	照顧先生 看聖經 做家事	看報紙 做家事 看電視
興趣	逛市場 唱歌 看電視	投資理財 唱歌 看電視 逛街	喜歡和朋友聊天 逛市場 唱歌 跳舞 聽收音機	唱歌 看電視 聽收音機

	受訪者 五	受訪者 六	受訪者 七	受訪者 八
上午	室外運動	室外運動 買菜	室外運動 買菜	室外運動
下午	在家休養	去兒子家	做家事	去跟朋友聊天
晚上	在家休養	看電視 跟家人聊天	看電視 去夜間大學學注音符號	煮飯 看電視 聽收音機
空閒時間	看電視 澆花、種花	做家事 看電視	抄經書 去佛堂念經 看電視 跟朋友聊天	做家事 看電視 買菜
興趣	喜歡和朋友聊天 唱歌	煮菜 跟朋友聊天	旅遊 唱歌	旅遊

Appendix C: The Research Script for Perceptive Sorting Exercise (Chinese)

Perceptive Sorting

1) 與圖片配對之形容詞 Word pairs

Narrative Words	Affective Words	Lifestyle Words
易碎的 Breakable	困惑的 Bewilder	過時的 Antiquated
複雜的 Complex	無聊的 Bore	經典的 Classic
耐用的 Durable	開心的 Delight	普通的 Common
容易操作 Easy to Manipulate	失望的 Disappoint	現代的 Contemporary
費力的 Requires Effort	娛樂的 Entertain	精密的 Sophisticated
簡單的 Simple	可理解的 Understandable	運動的 Sporty

2) 產品圖片

- 茶壺 teapots





• 手錶 watches






• 機器人 robots





3) PS exercise 調查結果

• 各項目得分與總和

	Narrative Words	Lifestyle Words	Affective Words
pots	13	12	23
watches	5	26	17
robots	8	1	39
Total (sum)	26	39	79

• 每位受訪者對於各產品之詳細資訊

	Pot 1	Pot 2	Pot 3	Pot 4	Pot 5	Pot 6
P1	對這種不太有興趣，顏色普通，沒很特殊。	退時，我媽媽有一台，很危險、會燙到，沒有涼或溫的，只有熱水，顏色普通，形狀不喜歡，用途只有一種不太實用，兩用的最好，老人家沒在吃冰的。	有無都沒差時髦，翹翹的年輕人的，不喜歡，比較喜歡四四方方、傳統式的。	也不喜歡，這比較傳統式的，單用的 不實際，不喜歡。	復古的東西比較喜歡。	可愛可以，顏色喜歡，喜歡kitty貓，淺顏色的喜歡，形狀喜歡。
	普通的	過時的	現代的	失望的	經典的	開心的
P2	有看過，有用家裡有，很喜歡，顏色漂亮。	家裡有，沒有用，地方小。	很漂亮，也不錯。	家裡也有，都沒用，好用。	很漂亮，大家來可以泡茶	喜歡，比較年輕，喜歡粉紅色，喜歡kitty家裡有一排玩偶。
	容易操作	普通的	開心的	開心的	娛樂的	開心的
P3	不喜歡，家裡用傳統，不鏽鋼的太複雜太多功能，很貴。	這個蠻好的，形狀也不錯 ，家裡有用。	不喜歡，奇奇怪怪。	一般的。	漂亮	傳統的，不喜歡顏色，感覺太熱了。
	複雜的	容易操作	失望的	普通的	開心的	過時的
P4	可愛阿，不知道用途，有用過濾渣的，橘色很漂亮	這是熱水瓶，沒看過這種的，按了就可以了嘛。	泡咖啡的嘛，我家茶壺很多不錯看，可以加熱（拿了家裡的古董茶壺）這種比較實用，古董茶壺不知道怎麼用，自己泡都用茶杯保溫杯。	不錯用。	插電比較方便。	小朋友會喜歡 。
	困惑的	可理解的	可理解的	耐用的	費力的	娛樂的
P5	不適合用，不用那麼多。	有用過，型有喜歡	型喜歡，感覺比較好用。	好像沒用過。	有看過，不會用到啦，漂亮	可愛。
	複雜的	可理解的	容易操作	困惑的	無聊的	開心的

P6	顏色可以啦，外觀喜歡。	沒用過這個，平常用水壺燒。	沒看過，不會買這種，年輕人用的。	也是可以用啦。	比較沒在用，外型喜歡啦。	不錯，粉紅色喜歡。
	開心的	無聊的	無聊的	耐用的	費力的	開心的
P7	可以泡茶，橘色不錯，家裡很多不會想買	家裡用飲水機，以前家裡的是古早型。	新型，泡咖啡不錯喔，很特別。	沒用過，比較新型的，很漂亮。	一般的，家裡也有，家裡的是比較方便的。	比較漂亮耶，喜歡kitty，家裡很多，喜歡粉紅色。
	耐用的	容易操作	現代的	現代的	簡單的	開心的
P8	都用飲水機，很少用這種的，蠻好看啦	這個也沒用，都用飲水機，去玩都用這種的，旅社都是這種的。	新型的喔，這個很漂亮。	這也是新型的喔。	茶壺很漂亮喔型很漂亮，客人來也是用飲水機，比較方便。	這個很漂亮喔紅色好，新型的很漂亮，我都喜歡紅的啦，買衣服也都買紅的。
	普通的	無聊的	現代的	現代的	複雜的	開心的

	Watch 1	**Watch 2**	**Watch 3**	**Watch 4**	**Watch 5**	**Watch 6**
P1	這個羅馬型的不喜歡，喜歡比較台灣型的，有戴手錶(先生送的25年紀念品)比較年輕人用。	鑽石可以阿，亮亮的錶帶不喜歡，不過形狀方方的喜歡。	不喜歡，年輕人的，不好用，看不懂，顏色也不愛。	男生的。	鮮豔，偶爾客串可以啦。	男生的，不喜歡，很難用，不好。
	失望的	複雜的	現代的	經典的	現代的	複雜的
P2	不喜歡帶手錶，女兒有個手錶很像這個，古董型，很穩重。	比較淑女，比較適合我。	男生的，不喜歡，電子錶，數字方便。	歐吉桑帶的，不喜歡，我先生帶的。	不喜歡，小妹妹帶的。	中年人帶的。
	經典的	現代的	運動的	過時的	無聊的	運動的
P3	流行的，傳統手錶不是這樣，不喜歡。	不喜歡，很貴啦，不實用，送也不要。	不好看，不好用，看不懂。	這個比較好，可以。	不好看。	好像開飛機用的吧，不好用太複雜。
	現代的	精密的	困惑的	開心的	失望的	運動的
	沒有帶手錶，這種好看。	這種好看，年輕型的，敢戴喔。	看不懂，沒看過數字錶。	老人在戴的。	可愛，小孩小姐戴的，不喜歡。	不好看，像貓頭鷹，年輕人用的。

	開心的	開心的	困惑的	過時的	失望的	失望的
P5	男生樣。	不喜歡。	看不懂，沒看過，形狀不喜歡，怪怪的。	有看過。	小孩子樣。	看不太懂。
	經典的	失望的	困惑的	可理解的	普通的	困惑的
P6	通常都壞掉才買新的啦，運動不需要戴手錶，不是很年輕，老人家可以。	比較新型啦，有喜歡啦，鑽石喜歡，看得懂。	沒看過，斯文人戴的啦，年輕人戴的，比較簡單啦，數字顏色黑黑不喜歡。	比較方便。	水水，花花的	年輕人用的，裡面很複雜看不懂。
	普通的	現代的	現代的	簡單的	精密的	現代的
P7	像男生戴的，現在都沒在買這種的。	喜歡這種的，沒數字會看。	沒看過，不知道是什麼，是不是按這個，不會買這種。	傳統。	年輕人，不敢戴，太花。	太複雜，太花裡面看不懂。
	普通的	開心的	困惑的	過時的	現代的	複雜的

	Robot 1	**Robot 2**	**Robot 3**	**Robot 4**	**Robot 5**	**Robot 6**
P1	玩具寵物很喜歡，家裡很多玩偶，女兒去美國澳洲買來送的，這個會回應好阿，這個不錯。	不合適，適合小朋友，老人家對這個不感興趣。	不喜歡。	會怕怕的，自己一個家會怕會覺得怪怪的。	好像會走，中國人比較不適合機器的東西，比較古早，比較不能適應機器人科技的東西，還是無法接受，娃娃的比較不怕，會講話的會怕，會恐懼。	不喜歡，更不能接受，機械的東西不能接受，沒人的時候會害怕，只會叫可以接受，會講話不行，太先進會有恐懼感。
	開心的	無聊的	無聊的	複雜的	複雜的	複雜的
P2	以前在美國住的時候，有個老太太他媳婦也買了一隻好像娃娃的給她會跟她講話，會跟她玩，給老人玩很好，會玩不錯，蠻理想的，柔柔的。	可愛。	感覺比較硬。	恐怖，比較適合男生，星際大戰，怕按錯會亂來。	不愛，房間很小不喜歡。	不愛。
	開心的	開心的	無聊的	精密的	無聊的	無聊的

P3	蠻可愛的，喜歡，只是抱著玩而已。	不錯阿，可愛。	不好，好像會走路吧，太複雜了。	不錯，老人家不太喜歡這個， 不會怕，會幫你拿東西做事，拖地阿，可以。	也可以阿，差不多，能幫忙做事就好。	這個好玩阿，有在電視上看過，狗比較好，狗來富嘛，這個好。
	開心的	開心的	複雜的	耐用的	耐用的	娛樂的
P4	知道機器人，電視上有看到，可愛耶，沒事的時候抱著很好阿，會叫很可愛，最喜歡的。	小孩子玩的，都喜歡。	比較不好，白白那個比較好。	男孩子在玩的，會幫忙做事情很好，形狀不錯。	不喜歡。	孫子比較喜歡狗狗。
	開心的	開心的	無聊的	耐用的	無聊的	娛樂的
P5	會叫喜歡	喜歡 會跟著走	不喜歡	會幫忙很好 最喜歡 會幫忙最好	沒感覺	不喜歡 希望能買菜幫忙拿東西
	娛樂的	開心的	無聊的	耐用的	無聊的	無聊的
P6	喜歡阿，還不需要這種。	這也不喜歡。	不喜歡。	老人家不喜歡這個，人型的比較喜歡。	不喜歡。	不喜歡。
	無聊的	無聊的	無聊的	開心的	無聊的	無聊的
P7	女兒有去美國買一隻青蛙也會動，這隻不錯啦。	這個很可愛。	電視好像有看過。	這個很像人喔 ，機器人跟他講就可以了啦，不會怕，這個最喜歡。	這個也不錯。	這狗狗阿，很可愛，機器都設定好好的阿不用怕，這小狗比較可愛 。
	娛樂的	開心的	可理解的	開心的	開心的	開心的
P8	給小孩玩好啦我比較沒在玩這個	這也是給小孩玩的 這個好看 紅的好啦我都愛紅色	這個不喜歡	覺得機器人很聰明 驚訝 頭腦很好 這個好看 可以做事情不錯喔	這沒看過 這個比較漂亮厚	這個不喜歡 剛剛那個比較可愛
	無聊的	開心的	無聊的	開心的	開心的	無聊的

Appendix D: The Research Script for Questionnaire (Chinese)

Questionnaire

1) 陪伴機器人功能調查之問卷

	非常需要	需要	普通	不需要	非常不需要
8. **與親友聯繫** 幫你打電話或用視訊與遠方親友聯繫	☐	☐	☐	☐	☐
9. **記錄事情** 幫你記別人的電話號碼、記重要事情	☐	☐	☐	☐	☐
10. **安全保護** 保護你不會跌倒、防止你被熱水燙到	☐	☐	☐	☐	☐
11. **健康檢查** 幫你量血壓、量身高體重	☐	☐	☐	☐	☐
12. **留言給家人** 留言給晚歸的家人，告訴他冰箱裡有菜可以吃喔！	☐	☐	☐	☐	☐
13. **健康照護** 關心你的身體健康、飲食狀況	☐	☐	☐	☐	☐
14. **認識新朋友** 介紹新朋友給你認識	☐	☐	☐	☐	☐
15. **聊天** 可以陪你聊天說話	☐	☐	☐	☐	☐
16. **守衛住家環境** 防小偷、保護家人安全	☐	☐	☐	☐	☐

	非常需要	需要	普通	不需要	非常不需要
17. **提供資訊** 告訴你今天氣象好不好，或是哪裡有特價	☐	☐	☐	☐	☐
18. **幫忙做家事** 幫忙你拖地、整理衣服、拿東西	☐	☐	☐	☐	☐
19. **照顧寵物或植物** 幫忙餵寵物或澆花	☐	☐	☐	☐	☐
20. **幫忙查詢資料** 幫忙上網查詢資料或買票	☐	☐	☐	☐	☐

1) 問卷資料整理及分析

• FACTOR ANALYSIS

註解

建立的輸出說明		18-JAN-2008 19:03:38
輸入	資料	F:\問卷統計\01.sav
	過濾	<無>
	加權	<無>
	分割檔	<無>
	目前啟用的資料檔中之橫列N	40
遺漏值的處理	遺漏值的定義	MISSING=EXCLUDE：使用者界定的遺漏值會被 視為遺漏值。

	使用的觀察值	LISTWISE：統計量是以使用的變數 不含遺漏值之觀察值為準。
語法		FACTOR /VARIABLES v1 v2 v3 v4 var00005 var00006 var00007 var00008 var00009 var00010 var00011 var00012 var00013 var00014 var00015 var00016 var00017 var00018 var00019 var00020 /MISSING LISTWISE /ANALYSIS v1 v2 v3 v4 var00005 var00006 var00007 var00008 var00009 var00010 var00011 var00012 var00013 var00014 var00015 var00016 var00017 var00018 var00019 var00020 /PRINT INITIAL CORRELATION KMO EXTRACTION ROTATION FSCORE /FORMAT SORT /PLOT EIGEN ROTATION /CRITERIA MINEIGEN(1) ITERATE(25) /EXTRACTION PC /CRITERIA ITERATE(25) /ROTATION VARIMAX /SAVE REG(ALL) /METHOD=CORRELATION .
資源	經過的時間	0:00:00.47
	所需的最大記憶體	51736 (50.523K) 位元組
建立的變數	FAC1_1	成份分數1
	FAC2_1	成份分數2
	FAC3_1	成份分數3
	FAC4_1	成份分數4
	FAC5_1	成份分數5
	FAC6_1	成份分數6

KMO與Bartlett檢定

Kaiser-Meyer-Olkin 取樣適切性量數。		.525
Bartlett 球形檢定	近似卡方分配	340.416
	自由度	190
	顯著性	.000

共同性

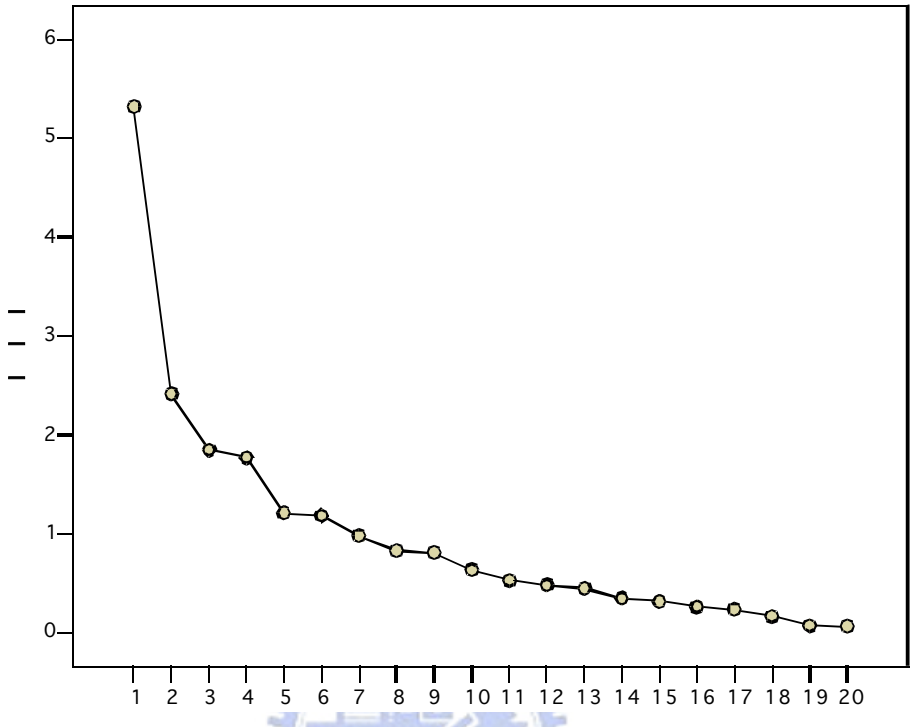
	初始	萃取
1. teaching	1.000	.762
2. event-reminding	1.000	.613
3. entertaining	1.000	.683
4. emergency contact	1.000	.687
5. cooking assistance	1.000	.702
6. playing game with you	1.000	.721
7. appliance-setting	1.000	.604
8. making contact to your friends	1.000	.806
9. event-recording	1.000	.746
10. protecting	1.000	.659
11. health checking	1.000	.732
12. message-leaving	1.000	.748
13. health-caring	1.000	.774
14. friend-making	1.000	.602
15. chatting	1.000	.637
16. guarding	1.000	.592
17. information-providing	1.000	.681
18. house chores assistance	1.000	.722
19. pet, plants-keeping	1.000	.584
20. information-inquiring	1.000	.704

萃取法：主成份分析。

解說總變異量

成份	初始特徵值			平方和負荷量萃取			轉軸平方和負荷量		
	總和	變異數的%	累積%	總和	變異數的%	累積%	總和	變異數的%	累積%
1	5.318	26.588	26.588	5.318	26.588	26.588	3.210	16.051	16.051
2	2.415	12.075	38.663	2.415	12.075	38.663	2.566	12.829	28.879
3	1.852	9.262	47.925	1.852	9.262	47.925	2.256	11.281	40.160
4	1.775	8.875	56.799	1.775	8.875	56.799	2.094	10.470	50.630
5	1.213	6.066	62.865	1.213	6.066	62.865	2.023	10.115	60.746
6	1.187	5.936	68.801	1.187	5.936	68.801	1.611	8.056	68.801
7	.983	4.914	73.716						
8	.833	4.166	77.882						
9	.813	4.064	81.946						
10	.638	3.192	85.138						
11	.536	2.678	87.816						
12	.484	2.422	90.237						
13	.453	2.264	92.501						
14	.352	1.759	94.260						
15	.323	1.613	95.873						
16	.268	1.338	97.211						
17	.239	1.193	98.404						
18	.173	.864	99.268						
19	.078	.391	99.659						
20	.068	.341	100.000						

萃取法：主成份分析。



成份矩陣(a)

	成份					
	1	2	3	4	5	6
9. event-recording	.759	-.037	.231	-.254	.102	.197
18. house chores assistance	.713	.139	-.429	-.032	.093	-.039
3. entertaining	.662	.180	-.190	-.193	.371	.043
8. making contact to your friends	.654	-.316	.279	.257	-.091	.356
13. health-caring	.645	-.242	-.154	.113	-.494	-.138
11. health checking	.636	.303	-.122	-.325	.228	-.250
6. playing game with you	.636	.172	-.133	.256	-.220	-.393
2. event-reminding	.557	-.275	-.039	-.069	-.176	.436
14. friend-making	.544	.369	-.168	-.246	-.147	.244
16. guarding	.532	.029	-.471	.148	-.228	.111
15. chatting	.525	.194	.235	-.418	.270	.142
10. protecting	.519	-.296	.372	-.214	-.039	-.340

12. message-leaving	.468	.406	.384	.141	-.054	-.440
4. emergency contact	.281	-.688	.348	.093	-.025	.069
7. appliance-setting	.327	-.605	.145	.036	.201	-.262
1. teaching	.008	.601	.490	-.051	-.266	.297
17. information-providing	.296	.343	.555	.379	-.156	-.023
20. information-inquiring	.246	.273	-.296	.689	.038	.071
5. cooking assistance	.392	-.270	-.080	.504	.450	.111
19. pet, plants-keeping	-.023	.338	.261	.458	.426	.098

萃取方法：主成分分析。

a 萃取了 6 個成份。

轉軸後的成份矩陣(a)

	成份					
	1	2	3	4	5	6
11. health checking	0.785	0.274	0.088	0.102	-0.147	-0.033
3. entertaining	0.767	0.198	0.049	-0.057	0.089	0.204
15. chatting	0.727	-0.151	0.065	0.186	0.204	-0.068
9. event-recording	0.644	0.080	0.243	0.199	0.474	-0.025
18. house chores assistance	0.594	0.564	0.003	-0.115	0.097	0.169
14. friend-making	0.549	0.313	-0.319	0.111	0.274	-0.117
13. health-caring	0.066	0.731	0.285	0.094	0.346	-0.163
6. playing game with you	0.238	0.720	0.174	0.319	-0.069	0.099
16. guarding	0.210	0.657	-0.119	-0.138	0.267	0.109
7. appliance-setting	0.072	0.057	0.751	-0.111	0.116	0.081
4. emergency contact	-0.124	-0.052	0.658	0.004	0.486	0.011
10. protecting	0.301	0.114	0.644	0.263	0.120	-0.240
17. information-providing	-0.003	0.072	0.012	0.786	0.138	0.197
12. message-leaving	0.302	0.260	0.181	0.714	-0.209	0.051
1. teaching	0.078	-0.207	-0.469	0.662	0.183	-0.146
8. making contact to your friends	0.133	0.191	0.325	0.227	0.736	0.229
2. event-reminding	0.238	0.231	0.097	-0.085	0.697	-0.031
5. cooking assistance	0.114	0.133	0.331	-0.110	0.219	0.708
20. information-inquiring	-0.071	0.472	-0.233	0.123	0.016	0.637
19. pet, plants-keeping	0.032	-0.239	-0.115	0.343	-0.104	0.620

萃取方法：主成分分析。 旋轉方法：旋轉方法：含 Kaiser 常態化的 Varimax 法。

a 轉軸收斂於 11 個疊代。

成份轉換矩陣

成份	1	2	3	4	5	6
1	.647	.521	.293	.225	.398	.126
2	.325	.044	-.722	.488	-.356	.082
3	-.070	-.539	.332	.741	.187	-.099
4	-.519	.309	.025	.255	.037	.754
5	.449	-.497	.200	-.259	-.273	.608
6	.017	-.306	-.492	-.173	.777	.174

萃取方法：主成分分析。 旋轉方法：旋轉方法：含 Kaiser 常態化的 Varimax 法。

成份分數係數矩陣

	成份					
	1	2	3	4	5	6
1. teaching	-.016	-.107	-.259	.324	.215	-.117
2. event-reminding	-.006	.008	-.105	-.084	.402	-.047
3. entertaining	.306	-.073	-.011	-.125	-.055	.142
4. emergency contact	-.107	-.078	.252	.021	.210	.002
5. cooking assistance	.036	-.069	.123	-.110	.043	.460
6. playing game with you	-.057	.340	.090	.149	-.194	-.031
7. appliance-setting	.013	-.030	.367	-.050	-.088	.057
8. making contact to your friends	-.077	-.033	.022	.080	.383	.106
9. event-recording	.194	-.131	.026	.030	.186	-.023
10. protecting	.052	.003	.315	.138	-.098	-.178
11. health checking	.299	.018	.059	-.020	-.231	-.029
12. message-leaving	.029	.102	.149	.352	-.259	-.027

13. health-caring	-.166	.361	.058	.059	.091	-.205
14. friend-making	.143	.063	-.240	-.009	.157	-.108
15. chatting	.306	-.233	-.007	.017	.058	-.015
16. guarding	-.040	.280	-.146	-.106	.115	.004
17. information-providing	-.108	.010	.002	.395	.056	.068
18. house chores assistance	.165	.163	-.048	-.132	-.058	.072
19. pet, plants-keeping	.058	-.193	-.019	.133	-.048	.419
20. information-inquiring	-.109	.201	-.134	.028	.001	.353

萃取方法：主成分分析。 旋轉方法：旋轉方法：含 Kaiser 常態化的 Varimax 法。 成分分數。

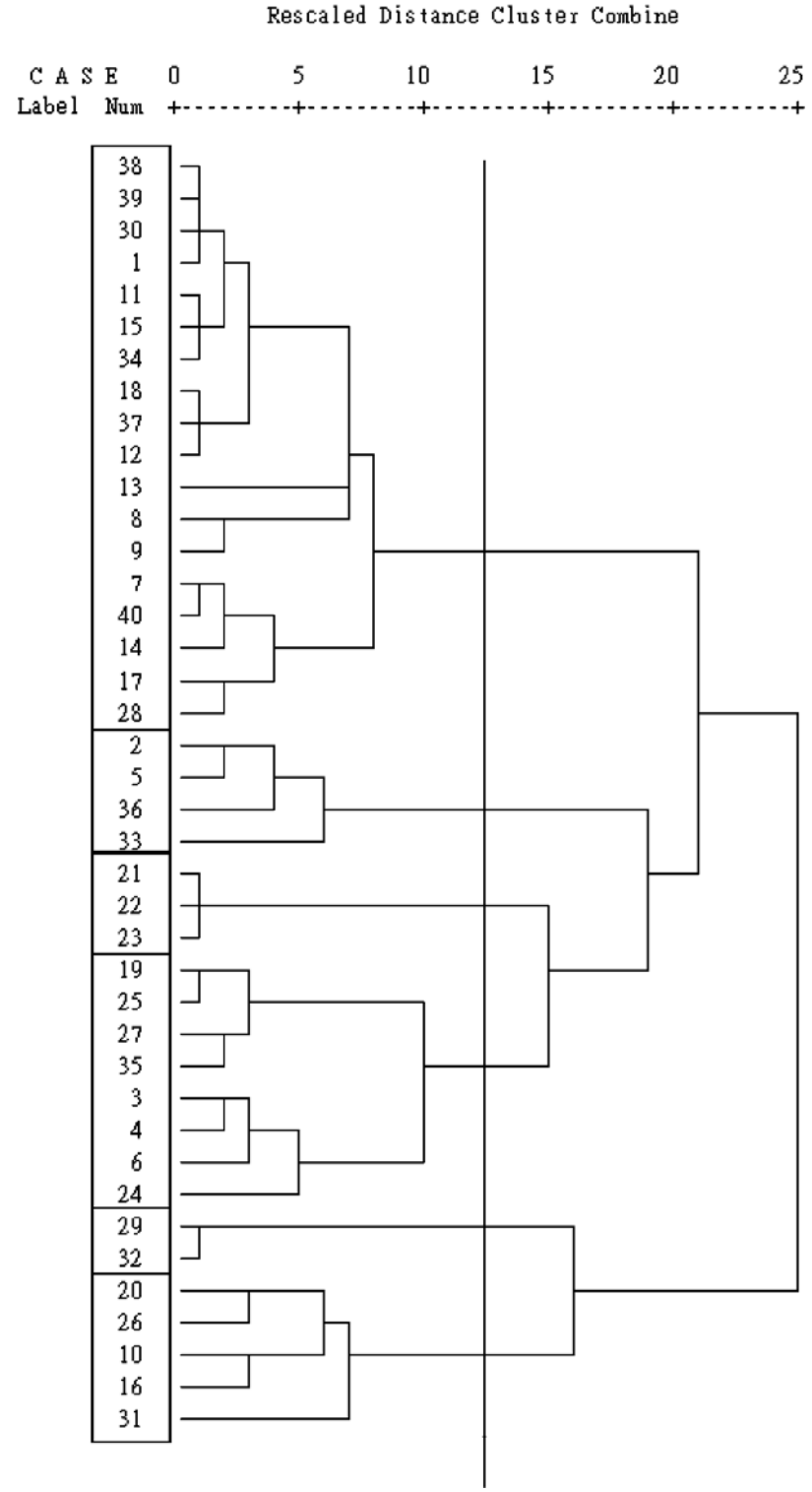
成份分數共變數矩陣

成份	1	2	3	4	5	6
1	1.000	.000	.000	.000	.000	.000
2	.000	1.000	.000	.000	.000	.000
3	.000	.000	1.000	.000	.000	.000
4	.000	.000	.000	1.000	.000	.000
5	.000	.000	.000	.000	1.000	.000
6	.000	.000	.000	.000	.000	1.000

萃取方法：主成分分析。 旋轉方法：旋轉方法：含 Kaiser 常態化的 Varimax 法。 成分分數。

- **Hierarchical Cluster Analysis**

Dendrogram using Ward Method



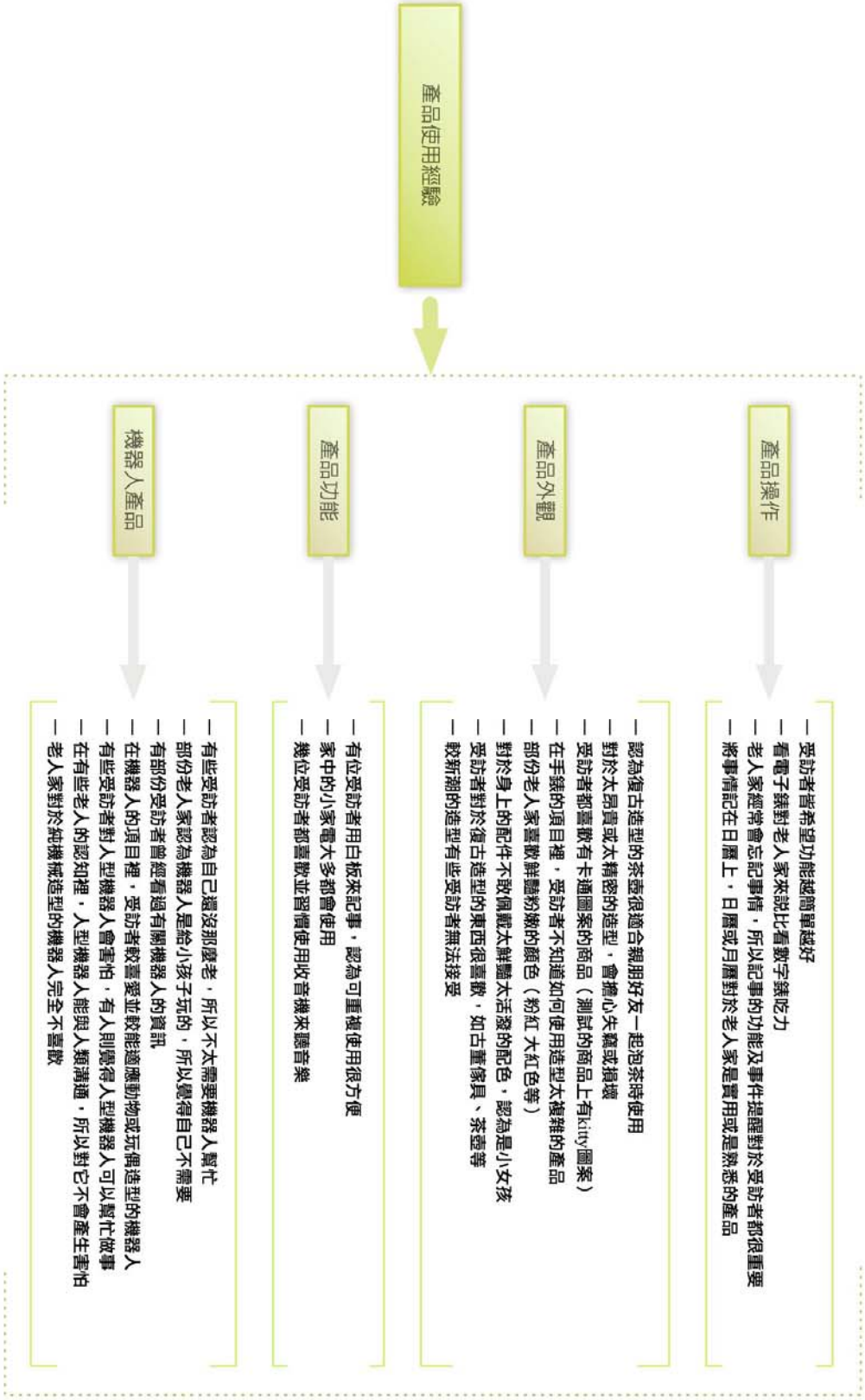
• 根據集群分析將每個受測者的各因子得點綜合整理

cluster	informants	FAC_1	FAC_2	FAC_3	FAC_4	FAC_5	FAC_6
1	9	0.076	0.669	-0.743	0.632	-1.317	1.537
	1	0.077	-0.090	0.640	0.300	-0.523	1.338
	11	0.328	-0.339	-0.119	0.425	-1.189	0.267
	12	0.228	0.017	1.599	-0.015	-0.503	0.034
	13	0.892	0.949	2.787	0.793	-0.436	1.110
	15	-0.035	-0.532	0.120	0.515	-1.229	-0.226
	8	-1.050	0.141	-1.237	0.786	0.330	1.945
	18	0.458	-0.128	0.460	-0.213	0.231	0.215
	39	0.141	0.129	-0.090	0.557	-0.473	0.615
	30	0.678	-0.107	-0.101	0.385	-0.229	0.055
	34	0.351	-0.030	0.339	1.039	-0.861	0.029
	38	0.141	0.129	-0.090	0.557	-0.473	0.615
	37	0.288	-0.180	0.266	-0.475	-0.395	0.279
	7	-1.318	-0.243	0.647	0.095	0.313	0.109
	14	-1.222	0.672	0.846	-0.548	-0.464	-0.255
	40	-0.791	-0.759	0.657	0.656	-0.611	0.074
	17	-2.143	-0.280	-0.886	1.591	-1.116	0.190
	28	-0.832	-0.707	0.342	0.892	-1.916	-0.486
	A3	**-0.207**	**-0.038**	**0.302**	**0.443**	**-0.603**	**0.414**
2	2	0.277	-0.902	-1.213	-1.778	0.468	0.688
	5	-0.529	-0.517	-0.645	-0.711	1.478	1.487
	36	0.739	-2.147	-0.749	0.769	1.216	1.545
	33	3.018	-0.630	-0.861	-0.686	0.558	1.325
	A3	**0.876**	**-1.049**	**-0.867**	**-0.601**	**0.930**	**1.262**
3	21	-0.407	1.730	-0.117	-1.611	0.234	0.519
	22	-0.375	1.648	0.884	-1.890	0.543	0.630
	23	-0.519	1.817	1.110	-0.680	0.253	0.708
	A3	**-0.434**	**1.732**	**0.626**	**-1.394**	**0.343**	**0.619**
4	35	-1.214	-1.168	0.409	-0.743	-0.423	-1.158
	27	0.163	-1.196	-0.165	-0.510	-1.257	-0.345
	25	0.715	-0.627	0.154	-1.569	-0.760	-1.690
	19	0.548	-0.316	-0.054	-1.526	-0.759	-1.146
	24	-0.910	2.319	-1.510	0.409	0.175	-1.190

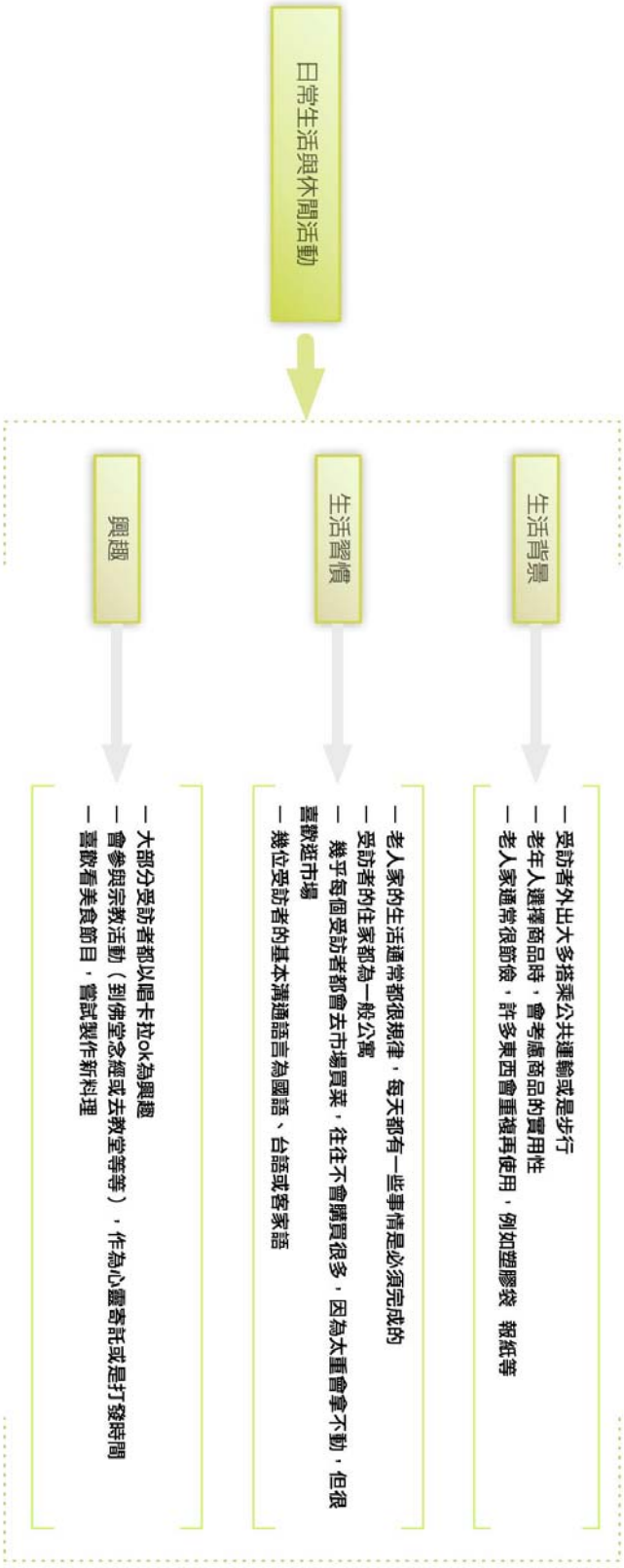
	6	0.306	-0.461	-1.916	-0.729	-0.828	-1.729
	4	0.574	0.580	-1.499	-0.440	-0.044	0.719
	3	0.052	0.772	-1.458	-1.518	-0.050	-0.647
	A3	**0.029**	**-0.012**	**-0.755**	**-0.828**	**-0.493**	**-0.898**
5	29	1.769	1.058	-0.453	1.517	0.093	-1.992
	32	1.701	1.539	-0.517	2.327	1.114	-1.297
	A3	**1.735**	**1.298**	**-0.485**	**1.922**	**0.604**	**-1.645**
6	20	-1.791	-0.930	-0.946	0.764	2.688	-0.292
	26	-1.046	-1.162	0.218	0.764	1.309	-1.441
	10	0.483	0.893	0.537	0.922	1.949	-0.385
	16	-0.946	0.371	1.371	-0.837	1.537	-0.922
	31	1.126	-1.980	1.981	-0.213	1.368	-0.831
	A	**-0.435**	**-0.562**	**0.632**	**0.280**	**1.770**	**-0.774**

Appendix E: Affinity Diagram of Experiment Results (Chinese)

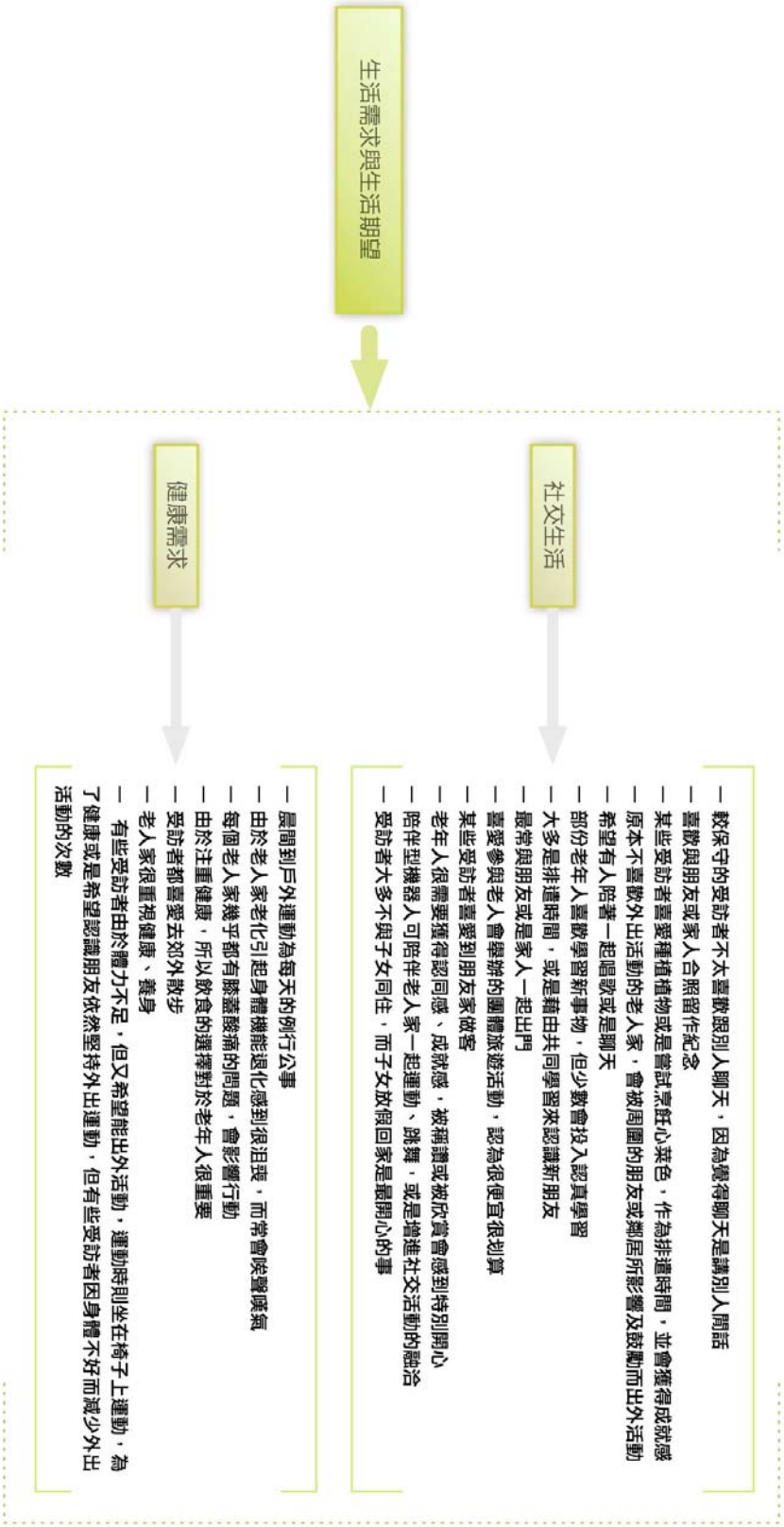
1) 產品使用經驗


產品使用經驗
產品操作
受訪者皆希望功能越簡單越好
看電子錶對老人家來說比看數字錶吃力
老人家經常會忘記事情，所以記事的功能及事件提醒對於受訪者都很重要
將事情記在日曆上，日曆或月曆對於老人家是實用或是熟悉的產品
產品外觀
認為復古造型的茶壺很適合親朋好友一起泡茶時使用
對於太昂貴或太精密的造型，會擔心失竊或損壞
受訪者都喜歡有卡通圖案的商品（測試的商品上有kitty圖案）
在手錶的項目裡，受訪者不知道如何使用造型太複雜的產品
部份老人家喜歡鮮豔粉嫩的顏色（粉紅 大紅色等）
對於身上的配件不敢佩戴太鮮豔太活潑的配色，認為是小女孩
受訪者對於復古造型的東西很喜歡，如古董傢具、茶壺等
較新潮的造型有些受訪者無法接受
產品功能
有位受訪者用白板來記事，認為可重複使用很方便
家中的小家電大多都會使用
幾位受訪者都喜歡並習慣使用收音機來聽音樂
機器人產品
有些受訪者認為自己還沒那麼老，所以不太需要機器人幫忙
部份老人家認為機器人是給小孩子玩的，所以覺得自己不需要
有部份受訪者曾經看過有關機器人的資訊
在機器人的項目裡，受訪者較喜愛並較能適應動物或玩偶造型的機器人
有些受訪者對人型機器人會害怕，有人則覺得人型機器人可以幫忙做事
在有些老人的認知裡，人型機器人能與人類溝通，所以對它不會產生害怕
老人家對於純機械造型的機器人完全不喜歡

2) 日常生活與休閒活動


日常生活與休閒活動
生活背景
生活習慣
興趣
－受訪者外出大多搭乘公共運輸或是步行
－老年人選擇商品時，會考慮商品的實用性
－老人家通常很節儉，許多東西會重複再使用，例如塑膠袋 報紙等
－老人家的生活通常都很規律，每天都有一些事情是必須完成的
－受訪者的住家都為一般公寓
－幾乎每個受訪者都會去市場買菜，往往不會購買很多，因為太重會拿不動，但很喜歡逛市場
－幾位受訪者的基本溝通語言為國語、台語或客家語
－大部分受訪者都以唱卡拉ok為興趣
－會參與宗教活動（到佛堂念經或去教堂等等），作為心靈寄託或是打發時間
－喜歡看美食節目，嘗試製作新料理

3) 生活需求與生活期望


生活需求與生活期望
社交生活
— 較保守的受訪者不太喜歡跟別人聊天，因為覺得聊天是講別人閒話
— 喜歡與朋友或家人合照留作紀念
— 某些受訪者喜愛種植植物或是嘗試烹飪心菜色，作為排遣時間，並會獲得成就感
— 原本不喜歡外出活動的老人家，會被周圍的朋友或鄰居所影響及鼓勵而出外活動
— 希望有人陪著一起唱歌或是聊天
— 部份老年人喜歡學習新事物，但少數會投入認真學習
— 大多是排遣時間，或是藉由共同學習來認識新朋友
— 最常與朋友或是家人一起出門
— 喜愛參與老人會舉辦的團體旅遊活動，認為很便宜很划算
— 某些受訪者喜愛到朋友家做客
— 老年人很需要獲得認同感、成就感，被稱讚或被欣賞會感到特別開心
— 陪伴型機器人可陪伴老人家一起運動、跳舞，或是增進社交活動的融洽
— 受訪者大多不與子女同住，而子女放假回家是最開心的事
健康需求
— 晨間到戶外運動為每天的例行公事
— 由於老人家老化引起身體機能退化感到很沮喪，而常會唉聲嘆氣
— 每個老人家幾乎都有膝蓋酸痛的問題，會影響行動
— 由於注重健康，所以飲食的選擇對於老年人很重要
— 受訪者都喜愛去郊外散步
— 老人家很重視健康、養身
— 有些受訪者由於體力不足，但又希望能出外活動，運動時則坐在椅子上運動，為了健康或是希望認識朋友依然堅持外出運動，但有些受訪者因身體不好而減少外出活動的次數