A Study of Favorability of Puzzle Game Design for Older People

Ying-Kit Wong and Yung-Hsiang Tu

***Abstract*—The ageing population increases around the world, and thus the demands of the products with specially design for older people also increase recently. However, the products supply particularly for older people are not too much. About the puzzle game design, most of them are designed for kids or children's markets; therefore the puzzle game might have an unfavorable design for older people. This research is about the favorability of puzzle game design for older people. In this experiment, 2 variables were set in the Puzzle design (Size and Colorful), and each variable has 2 levels, which are a bigger size, smaller size; and with colorful painting, without colorful painting. There were 12 subjects joined the experiment. The structured interviews and survey research by Likert scale 5 points questionnaire to records the results of comparing 2 levels in each variable and then analyze the data with the average numbers, standard deviation, the paired samples t-test, and one-way ANOVA. Results show that there are significant results of older people are more favorable of bigger size puzzle design than smaller size puzzle design, the p-value result is $p<0.05$, so it is statistically significant; and older people are more favorable of colorful puzzle design than non-colorful puzzle design, the p-value result is $p<0.05$, so it is statistically significant.**

***Index Terms*—Game design, toy design, older people, elderly, ergonomics.**

I. Introduction

According to the United Nations Population Fund (UNFPA) (2013), one of the most important trends of the 21st century is population ageing (Population Ageing is One of the Most Significant Trends of 21st Century). Will affect all levels of our society. Whether it is a highly developed country, a low or medium developed country, or even a very low developed country, they will all face the accelerated population aging situation; this phenomenon has been revealed in the 2013 United Nations Global Population Aging Report; [Fig. 1] The population aging rate of developed countries will grow from 12% in 1950 to about 33% by 2050; developing countries will grow from 7% in 1950 to about 20% by 2050; the world The average value is 8% in 1950, and will grow all the way to about 22% in 2050. It can be seen that developed countries are more serious than developing and undeveloped countries [1].

About the regionals population, according to the World Population Ageing 2015 report by United Nations, the number of older persons is expected to grow fastest in Latin America and the Caribbean with an estimation of 71 per cent increase in the population aged 60 years or over, followed by Asia (66 per cent) and Africa (64 per cent). With 508 million people aged 60 years or over in 2015, Asia was home to 56 per cent of the global older population, and, in 2030, Asia's share of the world's older persons is projected to increase to 60 per cent when a projected 845 million people aged 60 years or over will reside in the region [Fig. 2]. According to projections, by 2030, Asia will be home to more than half of the world's oldest-old persons as well, up from 48 per cent in 2015. Moreover, projections indicate that in 2050, nearly 62 per cent of people aged 60 years or over and 59 per cent of people aged 80 years or over will reside in Asia [2].

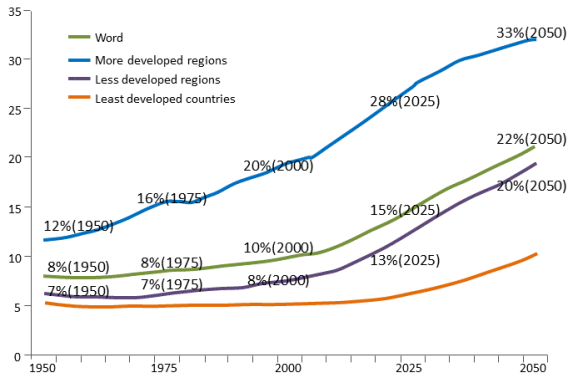

Fig. 1. Percentage of population aged 60 or over, worldwide and in developed regions, 1950-2050.
Source: 2013 United Nations Global Population Aging Report

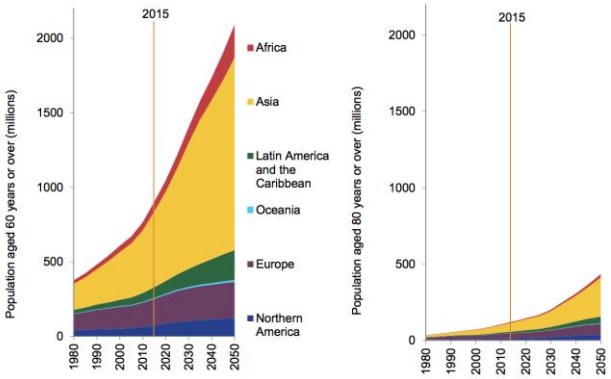

Fig. 2. Population aged 60 years or over and aged 80 years or over, by region, 1980-2050.
Source: United Nations, Department of Economic and Social Affairs, Population Division (2015). World Population Ageing 2015.

Europe and Northern America are projected to see substantial increases in the numbers of older persons, but growth will be slower there than in the other regions. In 2000, Europe's 147 million people aged 60 years or over accounted for close to one in four older persons globally and while their numbers grew to 177 million in 2015, their share of the world's older population fell to just under 20 per cent. Europe's older persons are projected to grow in number to

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217 million in 2030, representing a 23 per cent increase over 2015, but given that this growth is slower than in the other regions, the share of the world's older persons residing in Europe in 2030 is projected to fall below 16 per cent. By 2050, the projected 242 million older persons in Europe would account for just 12 per cent of the global population aged 60 years or over [2].

Population growth continues at the global level, but the rate of increase is slowing, which is at a slower pace than at any time since 1950 [Fig. 3][3].

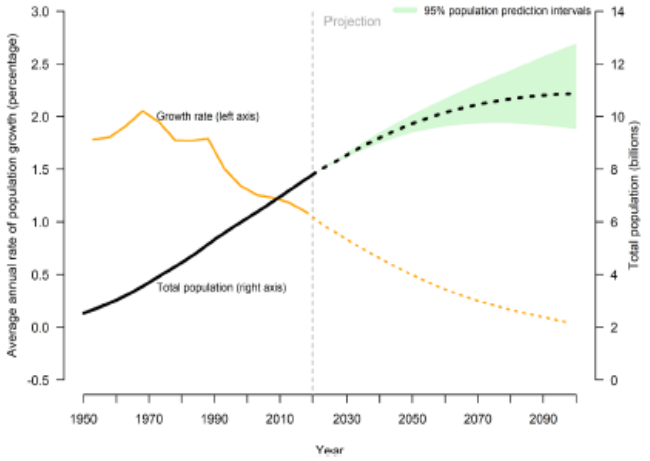

Fig. 3. Population size and annual growth rate for the world: estimates, 1950-2020, and medium-variant projection with 95 per cent prediction intervals, 2020-2100.
Data source: United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019.

In low- and middle-income countries, this is largely the result of large reductions in mortality at younger ages, particularly during childhood and childbirth, and from infectious diseases [4]. In high-income countries, continuing increases in life expectancy are now mainly due to declining mortality among those who are older [5].

Active ageing the idea of active ageing emerged as an attempt to bring together strongly compartmentalized policy domains in a coherent way [6]. In 2002, the World Health Organization (WHO) released Active ageing: a policy framework [7]. This framework defined active ageing as "the process of optimizing opportunities for health, participation and security to enhance quality of life as people age". It emphasizes the need for action across multiple sectors and has the goal of ensuring that "older persons remain a resource to their families, communities and economies". The WHO policy framework identifies six key determinants of active ageing: economic, behavior, personal, social, health and social services, and the physical environment. It recommends four components necessary for a health policy response:

- Prevent and reduce the burden of excess disabilities, chronic disease and premature mortality;
- Reduce risk factors associated with major diseases and increase factors that protect health throughout the life course;
- Develop a continuum of affordable, accessible, high-quality and age-friendly health and social services that address the needs and rights of people as they age;
- Provide training and education to caregivers. [8]

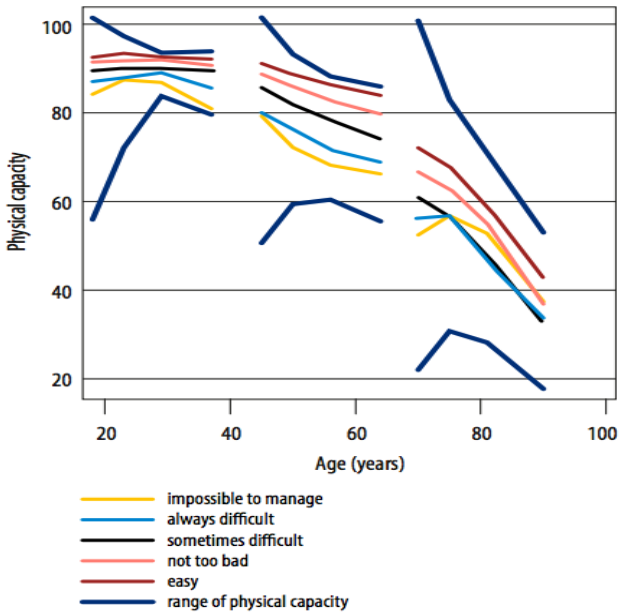

Fig. 4. Physical capacity across the life course stratified by ability to manage on current income.
Data Source: G Peeters, J Beard, D Deeg, L Tooth, WJ Brown, A Dobson; unpublished analysis from the Australian Longitudinal Study on Women's Health.

Fig. 4 shows that some 80-year-olds will have levels of both physical and mental capacities similar to that of many 20-year-olds. Public-health policy must be framed to maximize the number of people who experience these positive paths of ageing. And it must serve to break down the many barriers that limit their ongoing social participation and contributions. Fig. 4 also shows the fact that many other people will experience significant declines in capacity at much younger ages. Some 60- or 70-year-olds will require help from others to undertake basic activities. A comprehensive public-health response to population ageing must address their needs too [8].

Older people need to have instruments or tools for training and teaching, this can help their daily life [9]. Puzzle game is a good training tool for elderly to play and train at the same time, players need to think during the game, and it is also a good entertainment tool for leisure.

Cognitive training is good for older people, there are effectiveness and durability of the cognitive training interventions in improving targeted cognitive abilities for elderly [10].

A research shows that puzzle games training are related to improve the cognitive ability, in that experiment, they use 3 different puzzle games: Word Game Jumbline, Number Game Sudoku and Picture games Matched Plus, all shows the statistical significance results in different cognitive ability [11]. Therefore, puzzle games are proper tools for cognitive training purpose.

Game based therapies for the improvement of the cognitive capacities and socialization of the elderly are starting to be remarkable today. Tangram puzzle game was used in improving and optimization of cognitive game-based therapies aimed at the elderly [12].

Training game for elderly players can maintain their cognitive abilities. Game-type training has several advantages; the trainee enjoys performing the task, the game

offers some types of training that a manual training program cannot, and automatic feedback of the results or scores allows trainees to gauge their performance. Some physical therapists, game makers, and researchers have attempted to use game machines, mainly for physical rehabilitation [13].

Color is a fundamental aspect of human perception, and its effects on cognition and behavior have intrigued generations of researchers [14]. So colorful design is important for the puzzle game.

An ergonomic product may be expressed through the elements of safety, comfort, easiness, size, etc. [15]. The size of product design is one of the important feature.

II. Materials and Participants

A. Materials

The puzzle game that was used in this experiment is Tangram, which is a traditional puzzle game. The Tangram is a deceptively simple set of seven geometric shapes made up of five triangles (two small triangles, one medium triangle, and two large triangles), a square, and a parallelogram. In the process of the game, tangram may be combined to form many different figures [16]. Therefore, it is a good and suitable puzzle game for old people and different ages.

During the game, players need to combine the pieces into different shape. The independent variables of this puzzle game are size and colorful, and each design have two levels, which are bigger size and smaller size; with colorful painting (each piece in different color) and without colorful painting (same color).

Fig. 5. The puzzle game design with different colorful painting on each piece.

Fig. 6. The puzzle game design with the same colorful painting on each piece.

B. Participants

In this experiment, there are 12 subjects joined it. The age range is 65 to 80 years old, and the average age is 72 years old. All participants are healthy and can see things and colors properly and they are volunteers to join this experiment.

C. Location

This experiment took place in an elderly community center in Hong Kong, these subjects are the residents in that local area.

III. Method

This experiment has 12 subjects for testing. The orders of participants are randomly selected.

There are 4 questions of the favorability of puzzle game design in each questionnaire survey. First question is about the favorability of the bigger size puzzle design. Second question is about the favorability of the smaller size puzzle design. Third question is about the favorability of the puzzle design with colorful painting (all 7 pieces of puzzle in the different color painting). Fourth question is about the favorability of the puzzle design with colorful painting (all 7 pieces of puzzle in the same color painting).

The corresponding actual product samples were showed to the subjects based on different question during the process.

The structured interviews and survey research by Likert scale 5 points questionnaire (dislike extremely is 1 point, dislike very much is 2 point, neither like or dislike is 3 point, like very much is 4 point, like extremely is 5 point) to records the results of comparing 2 levels in each variable.

IV. Results

Analyze the data with the average numbers, standard deviation, the paired samples t-test and one-way ANOVA.

The mean of favorability of bigger size is 4.67, standard deviation is 0.492. The mean of smaller size is 1.58, standard deviation is 0.669. The mean of different colorful painting is 4.75, standard deviation is .452. The mean of same colorful painting is 1.75, standard deviation is 0.754.

TABLE I: Mean and Standard Deviation

Variable	Level	Mean	N	Std. Deviation
SIZE	Bigger size	4.67	12	0.492
	Smaller size	1.58	12	0.669
COLORFUL	Different Color	4.75	12	0.452
	Same Color	1.75	12	0.754

TABLE II: Paired Sample t Test

Variable	Level	Paired Differences				t	df	Sig. (2-tailed)
		Mean	Std. Deviation	95% Confidence Interval of the Difference				
				Lower	Upper			
SIZE	Big / Small	3.083	0.793	2.58	3.587	13.47	11	0.000
COLORFUL	D.Color/S.Color	3	0.853	2.458	3.542	12.186	11	0.000

TABLE III: One-Way ANOVA, Favorability of Size

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	57.042	1	57.042	165.484	0.000
Within Groups	7.583	22	0.345		
Total	64.625	23			

TABLE IV: One-Way ANOVA, Favorability of Colorful

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	54	1	54	139.765	0.000
Within Groups	8.5	22	0.386		
Total	62.5	23			

Results show that there are significant results of older people are more favorable of bigger size puzzle design than smaller size puzzle design, the p-value result is $p<0.05$, so it is statistically significant; and older people are more favorable of colorful puzzle design than non-colorful puzzle design, the p-value result is $p<0.05$, so it is statistically

significant.

V. Conclusion

In conclusion, based on the experiment result, for the first variable: SIZE, the comparison between 2 levels (the puzzle design in bigger size and smaller size), the result shows that the elderly are more favorable to have the bigger size puzzle design than the smaller size puzzle design. For the second variable: Colorful, the comparison between 2 levels (the puzzle design with colorful painting and without colorful painting), the result shows that the elderly are more favorable to have colorful painting puzzle design than non-colorful painting puzzle design.

The purpose of this research is to gain more information and details about the product design of puzzle games that are specially for the elderly. As the world ageing population increase, older people are a critical issue for many countries. With the results of this experiment, these crucial data can help us to design a more suitable and favorable puzzle game product for the elderly.

About future research, there are three points that we could improve. Firstly, only 12 subjects for testing in this experiment, the subject quantity is too small, and that can be improved in the future experiment, it is better to have a larger size of subjects for testing, then the testing result will be more reliable. Secondly, the gender of subjects should be controlled in equal number of male and female, this can decrease the influence of this variable. Finally, more research about the different gender's results, the male players' results and female players' results might be significant, so these gender testing data can be used for analyzing in the future experiment.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Ying-Kit Wong had the conception and design of the work, data collection, data analysis, drafting the article. All authors had the final approval of the version to be published.

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Mr. Ying-Kit Wong has the membership of Chinese Institute of Design (Taiwan) and the membership of Ergonomics Society of Taiwan and the membership of Hong Kong Art & Design Association. He was the winner of Hong Kong Toy Design Award 2014, the winner of Hong Kong Youth Council Entrepreneur Award 2015, Taiwan Golden Pin Concept Award Semi-Final Nomination 2016, and Universiade 2017 Taiwan Logo Design Competition Nomination 2017.