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Brain-Tactile Interactive Device for Dementia Prevention of the Early Elderly

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ABSTRACT

The increase in aging populations worldwide has led to an increase in dementia cases, a reality that may significantly raise social costs. Reducing the number of dementia cases is likely a good strategy to directly decrease social expenses while ensuring a better quality of life among the elderly. Previous research results have shown that deep depression or loneliness among the elderly is highly likely to accompany dementia syndrome. The elderly in particular may feel lonely or depressed when living independently or losing contact with their children and friends (Khosravi et al., 2016). The problem of dementia involves a variety of complex issues ranging from decreased social interaction to a lack of physical and mental activities. Experts have suggested that the best way to reduce dementia risk is to create a device that can satisfy several of the above-mentioned issues in one. For instance, a device that provides both entertainment and brain training at the same time. This study has developed such a device, called the Brain-Tactile Interactive Board (BTIB), that young elderly (ages 55 to 65 years old) populations can use as a possible preventative measure against dementia. The BTIB can enhance elderly brain stimulation and cognition through physical interaction and math calculation activities. These activities enable users to fulfill their social urges while reducing dementia risk and promoting happiness and well-being.

Keywords: Dementia, Elderly, Interaction game board

INTRODUCTION

Dementia is a terminology describing a syndrome in which patients' cognitive function gradually decreases. According to a WHO research report, there are currently more than 55 million people suffering from dementia worldwide, and nearly 10 million new cases are diagnosed every year (https://www.who.int/news-room/fact-sheets/detail/dementia). In fact, most elderly people with dementia experience significant impacts on their physical, psychological, social, and economic well-being. In Taiwan, elderly populations 65 years and above will increase up to 20% by 2025 (Lin & Huang, 2015). To avoid burdening their children, many elderly people choose to live independently which often leads to feelings of solitude and depression and a decreased quality of life (Chaumon et al., 2013; Khosravi et al., 2016; Singh & Misra, 2009). Some research has shown that maintaining a positive outlook will reduce health problems among the elderly (Telegraph Media Group, 2017). In this study, we purpose a special device that encourages

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interaction among elderly users. Through playing the device, users will automatically increase their social life and happiness, thereby lowering their risk of dementia symptoms.

The definition of dementia is a general term for loss of memory, language, problem-solving and other thinking abilities that is severe enough to interfere with daily life. Dementia is also associated with the loss of mental ability including thinking, memory, judgment, sensitivity, learning capability, and so on. Current research implies that dementia prevention involves many aspects. For instance, research has found that people aged 75 years or older who engage in leisure activities had a lower risk of dementia than other elderly people. Participating in mentally challenging leisure activities (e.g., reading, and playing board games) can help elderly people stay mentally sharp (Gottlieb, 2003). Moreover, some studies have found that external aids and tools can promote mental activation for preventing memory loss among those suffering from Alzheimer's disease.

These at-home daily training activities focus on combining both physical exercise and brain cognition. Multifunctional activity designs include body balance training, muscle stretch exercise, physical coordination, and brain training (e.g. memory, calculation, color/shape, sensation, and music rhythm exercise). Relevant research has indicated that physical training can increase physical health while mental training can also increase brain reaction. Moreover, some research has shown that people who play board games, read, play a musical instrument, or do crossword puzzles are less likely to develop dementia than people who engaged in those activities only rarely (Gottlieb, 2003). Previous research has implied that one of the best strategies to reduce the occurrence of dementia syndrome is to develop a game board that stimulates both cognition and physical activity and is also fun to play. In sum, we conclude that designing a dementia device should 1) include a combination of a variety of media in one in order to stimulate both physical interaction and mental cognition. 2) Reduce the occurrence of dementia within the general population and lower social costs. 3) Enhance social interactions through promoting socialization. In this study, we attempt to create a game board to prevent dementia risk by utilizing both mental and physical activities in the design.

PRODUCT DEVELOPMENT

This project began with dementia-related research, including reading journal papers and interviewing professionals (i.e., nursing professors) to enhance our understanding of dementia. According to research results, we have developed a device, the Brain-Tactile Interactive Board (BTIB), an interactive game board for reducing dementia syndrome among the young elderly. The game board is designed to be played by one or two persons over the age of 55 years old. The device needs to be fun to play and should be able to motivate users to play it consistently. Six junior-year students with a design background were invited to participate in this special project. Design thinking (i.e., empathizing, ideation and prototype stages) was utilized for the design process described as follows.

The first stage, Empathizing, began with reading related articles and interviewing experts in order to understand the target user. In this particular multidisciplinary project, we interviewed a nursing professor who has studied and lectured on dementia patients for many years. As mentioned earlier, research results have indicated that, if possible, the device should effectively promote both mental and physical activity for dementia prevention. Accordingly, design criteria were developed to promote the following:
1) Integrate a variety of media, such as physical interaction and mental cognition, in one, if possible.
2) Enhance socialization through interactive play.
3) Prevent boredom. It has to be fun to play.

The second stage, Ideation, is the process by which we generated ideas and solutions through sketching, brainstorming, and discussion. During this stage, we focused on the exploration of as many ideas as possible. In the current market, related products seem to combine only one or two functions into one design. In this study, the big challenge was to explore many different ideas that can cover the three above-mentioned criteria at the same time. Through divergent and convergent brainstorming, the team developed many unique ideas. During this stage, it is important to build a quick mockup to communicate ideas with other team members, particularly for those who depend on visualization to understand relevant concepts. Experts were invited to participate in idea development sessions and to share their professional opinion, which was greatly beneficial to design team members with inadequate knowledge of dementia. The final idea became more valuable through sophisticated discussion.

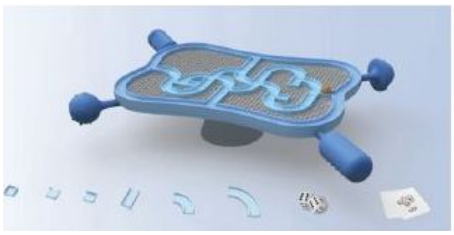
The third stage, Prototype, involved developing a very powerful model to visualize and evaluate the design in detail. For instance, designers are able to re-examine the product's functions and assure its ergonomics and form semantics before manufacture. To assure a top-quality design, experts were invited again to comment on the design to make further improvements. Finally, the BTIB was completed, featuring valuable function, ergonomic satisfaction, and beautiful aesthetic quality.

PRODUCT FEATURES

The BTIB design has two parts: base and platform (See Pic. 1 & 2). The base, which uses an upside-down cone shape, provides secure support for the platform. A spring mechanism located in the cone provides good flexibility and balance for platform movement (e.g., up and down) during game-playing. The platform includes several components: a path unit and a tactile handle with dimples, described as follows.

Path unit: Similar in design to Legos, there are six types of path units (See Pic. 1, bottom), which allow players to build a variety of path routes on the platform before playing. Players are required to use their imaginations to create their own path loops on the game board. A booklet with visual examples was provided for users' reference when needed.

Tactile handles with dimples: Four unique handles (See Pic. 1 & 2) were constructed at each corner of the game board. Each handle uses different



Pic. 1

Pic. 2

types of shape/contour, which demonstrate significant ergonomic fit and are designed to execute palm acupoint stimulation in connection with users' brain activity.

STARTING TO PLAY THE GAME

Step 1 Building a landscape and preparing the game
Before playing the game, players are required to build their own path and route landscape on the platform. To do so, they must use their imagination and problem-solving skills to build a creative landscape. During the creative process, the elderly players will have the chance to discuss their ideas with their playmates. This process enables them to increase their social interactions and activate their brains.

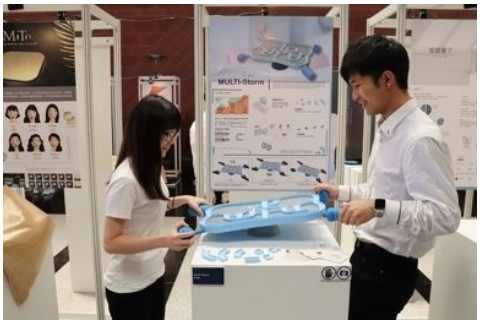
Step 2 Throwing dies and calculating numbers
After throwing the dies, players are required to calculate the sum points of the dies facing up in order to determine the ball's (similar to a Ping-Pong ball) next stop on the path. This calculation exercise forces elderly players to activate math cognition brain activity.

Step 3 Holding handles and controlling the ball
According to the total sum of the die, players follow the number down the path and try to deliver and control the ball towards its stop point. To do so, players have to pay attention to the moving speed and direction of the ball by controlling and adjusting the handles towards high/low, and right/left positions. This step requires precise hand-eye coordination to control the ball, which may activate elderly brain stimulation.

Step 4 Reaching the terminal and winning the game
Finally, whoever pushes the ball to the other side of the starting point first wins the game. The competition provides a sense of excitement and achievement for elderly players, which will help increase their social interaction and promote feelings of greater well-being.

RESULTS AND DISCUSSION

Previous research has suggested that the elderly should be encouraged to read, play board games, and go outside because these activities enhance their quality of life. Similarly, this paper explored theories of dementia, social interaction, and game-playing for the elderly and developed a game aimed



Pic. 3

at preventing dementia. Product development is based on design thinking processes, including empathizing (i.e., research/interviews), ideation, and developing a prototype. The resulting device focuses on enhancing hand-eye coordination, palm acupoint stimulation, and mathematics practice while promoting joy and well-being. Professional researchers have considered the BTIB an effective solution to prevent or delay dementia symptoms among the young elderly.

The BTIB was specifically created for early elderly people. players are encouraged to play alone or with one other person. This device fulfills three main functions: palm acupoint stimulation, eye-hand coordination, and cognitive activation, which involve both physical and mental stimulation with the aim of preventing dementia risk among the young elderly. The device promotes 1) Math calculation as a vehicle to enhance brain cognition, 2) Physical interaction as a vehicle to enhance both palm acupoint stimulation and eye-hand coordination. 3) Social interaction as a vehicle to enhance a positive social life among the elderly. These advantages are discussed below.

Firstly, as professionals have suggested, the elderly should try to activate their brains through a variety of exercises. The BTIB provides an interesting way to encourage the elderly to perform brain cognition activities through planning, organizing, and constructing landscapes on the platform before playing the game. To do so, players are required to use creative thinking in the problem-solving process to develop the theme of the game path/route. This task requires players to estimate the space distance between the two points visually in order to construct a perfect loop path for gaming. Players must solve this complex structure by trial and error, which activates their brain cognition consistently. Furthermore, while starting the game, they are required to throw two dies and sum up the points. This calculation activity enhances math calculation abilities. The prior two activities enhance elderly visual mapping and math calculation in terms of brain cognition training. Later, while playing the game, they must utilize their eye-hand coordination skills, which enables them to consistently activate their elderly neurology system.

Secondly, they experience acupoint stimulation from holding the handles of the board. Particularly, each handle was created with different contours and dimples for batter ergonomic fit. Each contoured handle stimulates different

acupoints on users' palms, which can activate brain stimulation using a variety of acupoints. To accomplish the game task, plays activate not only their brain through palm acupoint stimulation but also their hand-eye coordination through attempting to control the ball's path on the board and stopping its movement at the required spot according to the die-points. Both palm acupoint stimulation and hand-eye coordination activate elderly brain cognition directly and effectively.

Thirdly, this game provides an interesting interactive concept, which may motivate the elderly to play it with their friends, thereby increasing their social interaction directly. In sum, the three significant activities discussed above enhance elderly brain cognition, therefore decreasing their dementia risk.

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