A MOBILE PSYCHOTHERAPY GAME FOR ELDERLY WITH MEMORY DISORDER ISSUES

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ABSTRACT

Realizing the current pharmacological approach in treating memory disorder patients has its side effects, concerns on how to treat elderly suffering with memory disorder diseases like Dementia and Alzheimer have been a growing issue of discussions over a decade. Discussions are focusing on understanding the most efficient way of treating them. Throughout the past years, various researchers and scientists have come up with various ways to help in stimulating the brain and one of them is using games. Although various games have been created for elderly, most of the games were not developed specifically for memory disorder patients. Most of the games are not created to suit these audience because there are no known guidelines to help in creating a proper game. This article aims to discover criteria that can help in the development of games to be used in psychotherapy for memory disorder patients. Combination of extensive literature review and interview were conducted in identifying suitable features and criteria needed in a game for psychotherapy treatment. There are total of 20 guidelines have been discovered and are categorized into four main sections; gameplay, device, interface and game features. Based on the criteria obtained, a mobile psychotherapy game is designed and developed in Android environment and called as [Neuro]-therapy game. The game has been successfully evaluated through both verification and validation involving 55 respondents among elderly. Findings show that the proposed [Neuro]-therapy game is useful and easy to be used for psychotherapy purposes. This design guideline and the game itself are believed to benefit many parties; the scholars, practitioners, caretakers, and patients. It is hope that it will give directions to developers on developing more games for memory disorder patients towards improving the quality of life among the elderly with memory disorder issues.

Key words: elderly, game design guidelines, psychotherapy game, memory disorder

INTRODUCTION

A brain disease that causes a slow decline in memory, thinking and reasoning skills are usually referred as memory disorder (or memory loss) is. It involves disorders of cognition, remember, make decisions and communicate. This disease which can be caused by many factors including aging, trauma, tumor or even vitamin deficiencies. There are variety type of memory disorder disease including Alzheimer's and dementia (Gardner Neuroscience, 2019; Alzheimer's Association, 2019). Alzheimer's Disease is a neurodegenerative disease of the brain tissue that causes progressive and irreversible loss of mental functions (Alzheimer's Association, 2012; Ewers et al., 2012). It has been projected that by the year 2050, over 100 million people worldwide will be diagnosed with Alzheimier's disease (Brookmeyer, Johnson, Ziegler-Graham & Arrighi, 2007). Even though Alzheimer's disease was first discovered more than 100 years ago, but research on its symptoms, causes, risk factors, and treatment has been paid attention to, only in the past 30 years (Alzheimer's Association, 2012).

A widely used treatment for memory disorder issues are the use of traditional treatments, which is the of pharmacological treatments. Drug treatment has been based on cholinesterase inhibitors and the N-methyl-D-aspartate (NMDA) receptors such as memantine. Memantine seems to avoid the neurotoxic effect of the excessive level of glutamate present in AD. The goal of memantine is to avoid the development of the disease and increase the general cognitive capacity. However, the drug, as a single treatment or together with anticholinesterase, does not seem to work in the very first stages of the disease. Its efficacy on the last stage of impairment seems to also be limited (Schneider et al., 2011; Vigil & Tataryn, 2017).

On top of this, extreme overdose could lead to a lack of consciousness (Kitagawa & Sakurai, 2016). The meta-analysis of Matsunaga, Kishi, and Iwata (2015) finds that a memantine monotherapy produces a small improvement in cognition, behavior, and daily activities in studies with patients with an average age of 76 years old (Matsunaga et al., 2015). Recently, some companies have had to abandon anti-amyloidal drugs due to failures in efficacy and issues with toxicity, such as in solanezumab and verubecestat trials (Hardy & De Strooper, 2017), which is very bad news for the advancement of the pharmacological treatment of the disease.

Recently, multiple evidences have shown positive impacts of game on patients with memory disorder. Psychotherapy through games require mental concentration, memory, and quick motor reaction in simulating brain to work and gain memory back. Game-based intervention not only can help in motivating patients during therapies, it can also improve physical, sensory and cognitive functions, diagnosis, targeted treatments and remote monitoring (Costa, Soares, Reis and Bublits, 2015; Vázquez, Otero, García-Casal, Blanco, Torres & Arrojo, 2018). They seem to improve some physical health variables in the older adults, for whom aging-related progressive degeneration in muscle strength and balance control system can lead to motor impairment, disability and falls. Nevertheless, psychotherapy through games is yet to be systematically incorporated in treatment plan for those suffering with the disease, particularly in Malaysia.

There are also games designed to train both motor and cognitive abilities, however such video games that require physical activity are not suitable for dementia patients to practice especially the elderly. Furthemore, the video game-based interventions for physical health and cognition in older adults are only focused on personal computers or Nintendo Wii video games. On the other hand, digital games are easy to use and engage as it simplifies the interaction with users. Hence, digital games could be more useful technological solution for treatment. They can be simply run on one and only sma11 device (e.g. tablet or smartphone), without the need of many tools as required in some non-digital games (Xenakidis, Hadjiantonis, & Milis, 2014; Cardullo et al, 2015). The game software can be always updated and adjusted, manually by the caregiver or automatically by the system itself based on history of user actions.

It can be concluded that the psychoteraphy game should be designed carefully to meet the purpose of psychoteraphy treatment intervention. A proper design should consider content appropriateness with regards to cognitive stimulation, simplicity of rule games and user control and precise monitoring of cognitive performance (e.g. neurofeedback). Hence, this article proposes the design and development of a mobile psychotherapy game specifically to cater the mentioned purposes.

PSYCHOTHERAPY GAME DESIGNS

Due to the side effects of pharmacological treatments, the use of non-pharmachological treatment is considered as the alternative solutions in treating memory disorder patients. Digital games are introduced as a supplementary tool to the traditional rehabilitation as they are easy to use and simple in terms of interaction with the patients (Benveniste et al., 2010). This technological solution of treatment is more convincing due to its ease of use and simplicity such as a tablet device (Cardullo et al., 2016; Costa et al., 2016; Xenakidis et al., 2014) due to the limited understanding and executive memory of the elderly patients (Pyae et al., 2016).

Review had shown that little studies developed games that benefit as a promising technology in postponing the decline of cognitive functions in aging such as serious games and exergames (Zheng et al., 2017). However, concrete and robust evidence is required to acquire the effective designs and implementation of appropriate game-based intervention to serve its purposes in the most effective way (Zheng et al., 2017).

The use of games as a cognitive assessment or therapy tool for dementia patients is an emerging area of research. New game concepts are required for people with memory disorder disease. Games for these patients need to be designed with simpler rules of play and more accessible user controls particularly for those with limited physical movement ability. From the game content perspective, Lee et al., (2018) found that late-life participation in intellectual activities (e.g reading books, newspapers, or magazines; playing board games, Mahjong, or card games; and betting on horse racing) was associated with lower risk of incident dementia several years later. In addition, playing music can also provide functional assistance such as reminders for people with dementia (Lazar, Thompson and Demiris, 2018).

Due to the large number of people that are entering the rehabilitation games industry, we can find many small, single purpose games, often targeted at one impairment and available to one platform only. In these cases, the costs in terms of time and resources of creating a rehabilitation game from scratch can be quite large due to the special care that must be taken in making sure that the games are efficacious, accessible and fun. In order to reduce the costs and guarantee that all the needed features are supported, the next logical step in the games for cognitive impairment field is the creation of a game engine specifically designed for cognitive rehabilitation (Pirovano, Lanzi, Mainetti and Borghese, 2013).

It is also recommended that games for cognitive stimulation and assessment to be ambient and continuously available in the environment. While considerable research is needed to craft and evaluate appropriate interventions, there is a major opportunity to leverage the integration of games into long term care environments, so that cognitive performance can be tracked over time. Such

tracking will allow rapid identification of substantial changes in functionality that may be the result of external factors (such as dehydration or changes in medication), as well as monitoring of cognitive capability (Wilkinson, Tong, Zare, Kanik and Chignell, 2018).

Among studies that incorporated game-based cognitive training and neurofeedback protocol include Madani, Heydari-nasab, Yaghoubi, and Rostami (2016). Madani et al. combined computerbased cognitive tasks and NF on ADHD adults in Iran. They showed that this method led to a significant reduction in attention and concentration deficit. Nevertheless, they also reported the shortcomings of their design that cause ambiguity in the interpretation or generalization of the results. This include the lack of mixed multiple intervention strategies or an adequate control group, the use of self-reported measures only, and the absence of the report of changed brain waves. Therefore, more research is needed to determine the efficacy of such treatment.

Another study conducted by Zheng, Xue and Yu (2017) has reviewed seven studies on game-based intervention for dementia. The findings suggest that game-based intervention tended to bring in benefits in cognition, gait and balance, and positive impact on BPSD for older people with dementia. The flexibility of individualized deployment, the broad range of effects, and the entertainment value suggest that game-based intervention is among the best choices for delivering non-pharmacological interventions to people with dementia (Zheng et al., 2017). Studies have shown that increased cognitive activity may stimulate (or increase) cognitive reserve and have a buffering effect against rapid cognitive decline (Stern & Munn, 2010) as well as a significant reduction in the risk of dementia or AD diagnosis in those who reported high compared with low levels of cognitive activities (Yates et al., 2016).

Serious games may be also very useful for people with Alzheimer's disease, which is one of the most important challenges for healthcare systems with an aging population (Wegrzyn, 2015). Current non-pharmacological treatment games trains them with simple daily activities like cooking and house chores in order to train and simulate their memory which also known as serious games (Laskowska et al., 2013).

METHODOLOGY

To design a mobile psychotherapy game for memory disorder patients particularly for elderly, this study has been conducted involving five main phases which are research formulation, the identification of criteria for psychotherapy games, the design and development of psychotherapy game, game evaluation, and performance analysis as well as user's feedback of the game. The phases involved are shown in Figure 1.

Figure 1: Phases of research methodology

Phase 1: Research formulation

This phase is focusing on planning and designing how this study should me conducted by emphasizing on methods to identify the games criteria, sampling frame, sampling method, as well as the design of the game. Instruments to be used in the study was also planned in this phase.

Phase 2: Identification of games criteria

Combination of interview and systematic literature review have been conducted in identifying the criteria for Psychotherapy games. These activities have produced three sets of criteria of psychotherapy games. The first set of criteria is produced through interview which has been conducted in the northern area of Peninsular Malaysia involving 40 respondents among elderly (aged more than 60 years old). While the second set of criteria has been produced through systematic literature review involving three main databases; Scopus, Web of Science and ACM Digital Library (Sie-Yi & ChePa, 2020). The third set of criteria is produced through another round of systematic literature review involving another three databases which are Wiley, ProQuest, and EBSCOhost.

These three sets of criteria have been thoroughly studied, compared, and analyzed. Duplicates have been removed followed by categorization of the criteria. Four main categories of the criteria are device, games interface, game features, and gameplay elements. The categories and its attributes are shown in Figure 2.

Figure 2: Criteria for Psychotherapy game

Phase 3: Game design and development

Based on the criteria that have been finalized in Phase Two, a psychotherapy game has been designed and it is named as [Neuro]-therapy, as illustrated in Figure 3. This design caters every aspects of the criteria by focusing on its suitability to the main target users, who are the elderly. The layout, combination of colours, size and arrangement of buttons are carefully designed to suit the elderly.
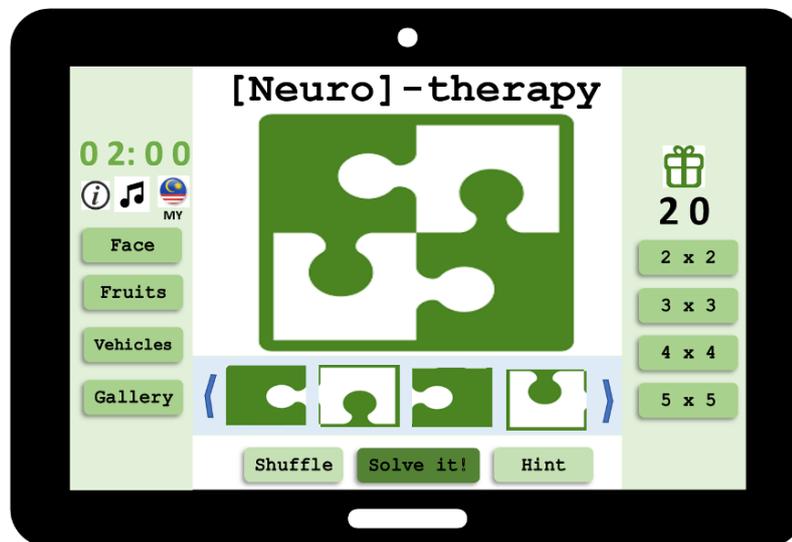

Figure 3: Basic design of Psychotherapy game

This design is then translated into a workable game and fit the layout of tablet size as guided in the criteria. As the first version of the game, this [Neuro]-therapy consists of three main categories which are familiar to elderly; face, fruits, and vehicles. [Neuro]-theraphy has been developed for users who would like to exercise memory therapy. The game is designed with a set of jigsaw puzzles. The users are required to assemble the puzzles of particular image to provide a complete picture. The puzzles are prepared with variety of difficulty levels to reflect the ability of memory recall. There is also a button to provide a hint of image, and a button to choose image type to provide option of preferences to encourage more user engagement. Additionally, the background music attached to the game also provides calm and peaceful environment of exercise. Figure 4 illustrated two interfaces of [Neuro]-therapy game.
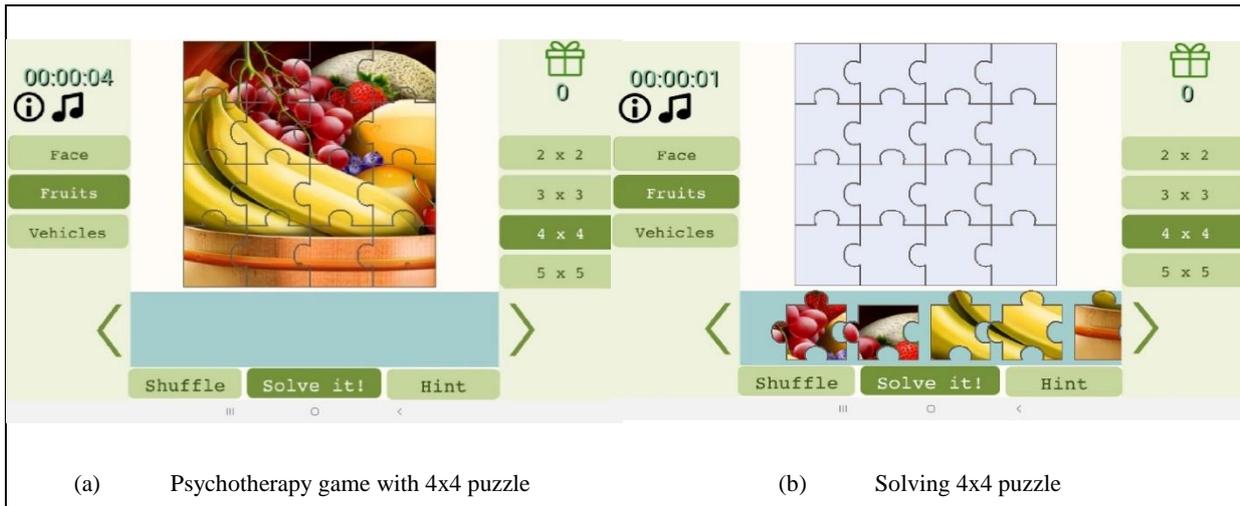
| (a) | Psychotherapy game with 4x4 puzzle | (b) | Solving 4x4 puzzle |

Figure 4: Interfaces of [Neuro]-therapy game

The exercises incorporated in the game are extremely useful for everyday training of memory. They not only improve memory recall, but also strengthen the problem solving and logical thinking abilities, and boost attention. For example, the game gives a time duration for each puzzle to be solved, hence this to perform mental computation relatively quickly. The goal is to play the jigsaw puzzle with less time required indicating the memory and recall improvement.

Phase 4: Evaluation

To ensure that the game is working correctly, meets the identified requirements, and can be accepted by the target users, verification and validation have been conducted. This article will be focusing on validation involving 55 respondents. Figure 5 shows demography of the involved respondents located at the Northern part of Kedah.
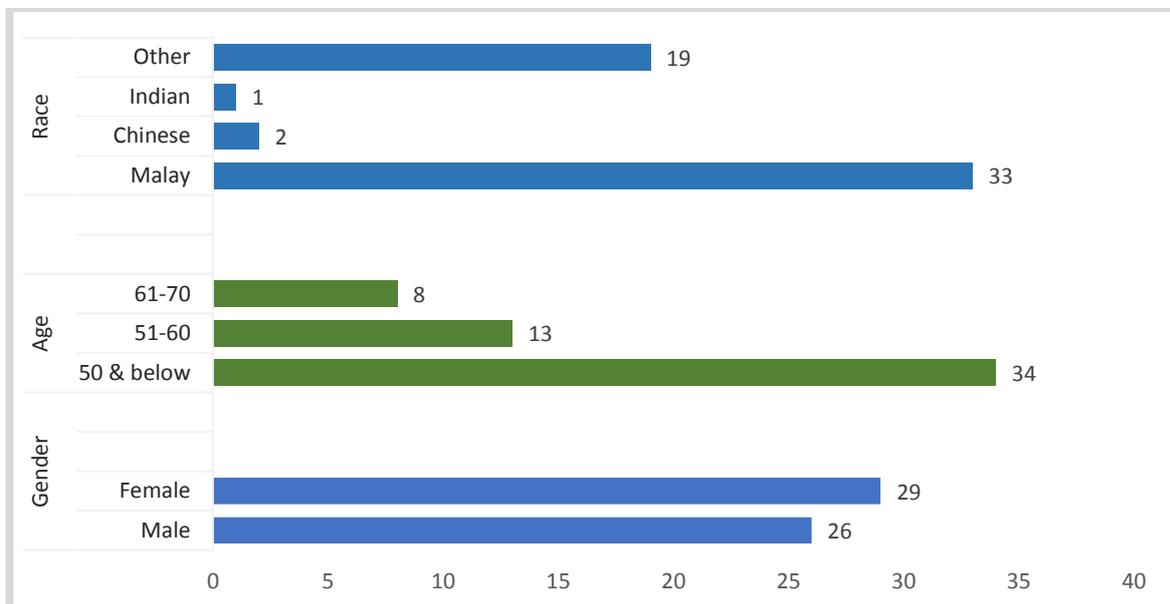

Figure 5: Demography of respondents

Prior validation process with the respondents, a game demo is conducted. Respondents are then given opportunity to play and experience the game by testing all level of difficulties and three categories of the puzzle. A systematic face to face interview is conducted to gather their response and feedback based on their experience of the game.

Phase 5: Analysis

Evaluation in Phase Four has emphasized on eight dimensions of testing; usability of the game (both usefulness and how easy to use the game), memorability, satisfaction of playing the game, enjoyability when playing the game, accuracy, and respondent's overall feedback as shown in Figure 6. However, this article only focuses on usability test and overall feedback of the game.
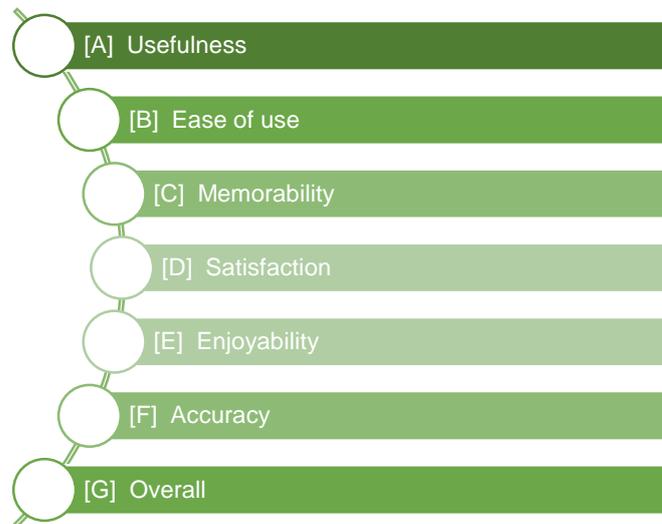

Figure 6: Components of evaluation

Four items have been included in measuring how easy to use the game. Measurement focuses on simplicity of using the game (PEU1), easiness in reading characters on game screen (PEU2), the flow of the game (PEU3), and easiness in understanding instructions of the game (PUE4).

Results show that most respondents (81.8%) agreed that the game is simple to use by choosing to agree and strongly agree for this item. The same trend also shown for characters on game screen and flow of the game where 90.9% of respondents (50 respondents) agreed that both elements are easy. Only 7% of the respondents (4) stated that they disagree that the instructions of the game are easy to understand, while majority of them also agreed that the game instructions are simple and easy. Detail results of measuring ease of use are shown in Figure 7.
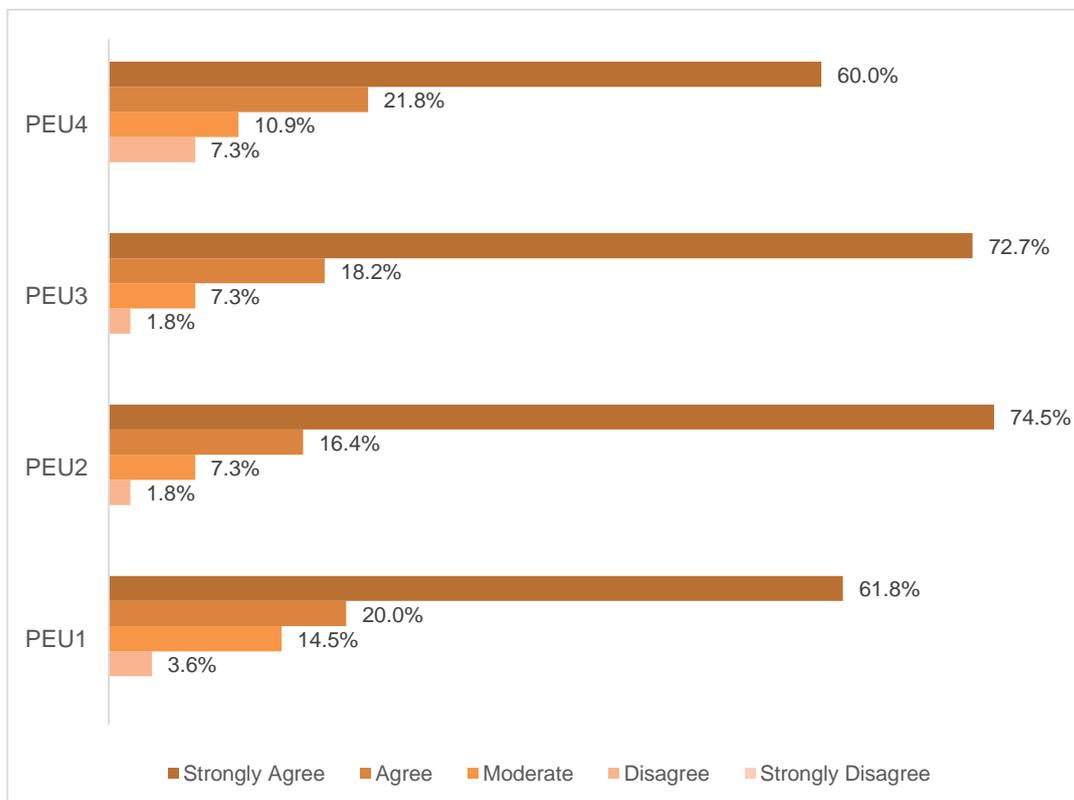

Figure 7: Response on ease of use of [Neuro]-therapy game

Results also show that mean score for all four items are high (more than average score). It can be concluded that respondents agreed that [Neuro]-therapy game is easy to use and to be understood. In measuring usefulness of the game, three items have been included to be measured; game illustrations (PU1), help messages in the game (PU2), and overall conclusion on how useful the game is (PU3). Results of the items are shown in Figure 8.
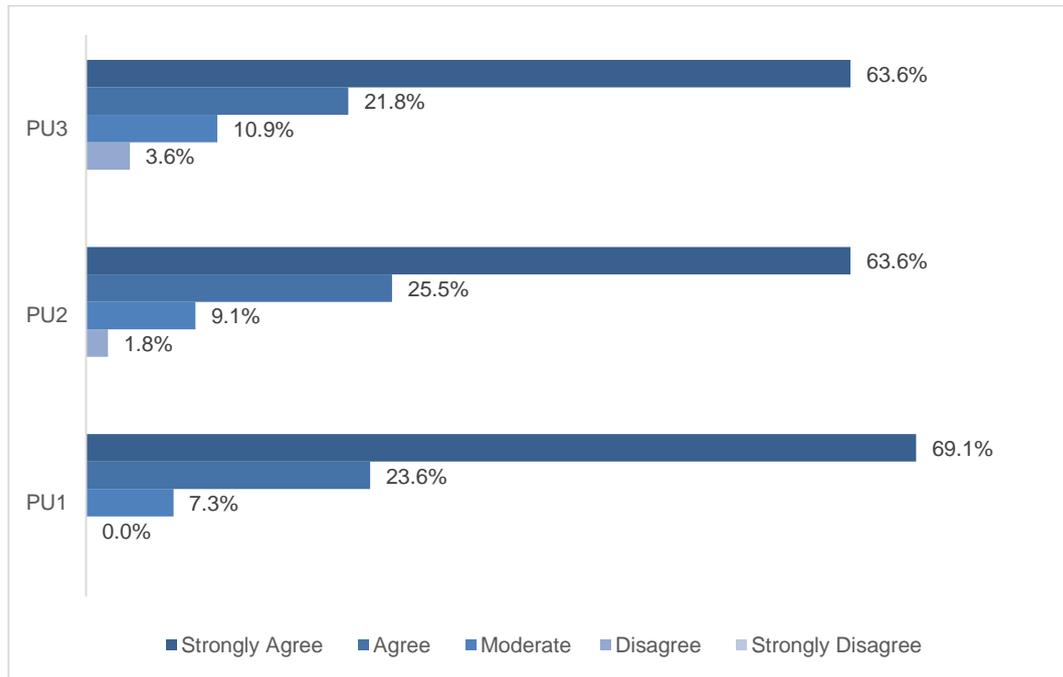

Figure 8: Response on usefulness of [Neuro]-therapy game

Results show that 85.5% of the respondents (47 respondents) concluded that they agreed [Neuro]-therapy game is useful. Only two respondents (3.6%) claimed that they disagree that the game is useful. When asked further on their answers, they claimed that they do not even have smart devices to play the game. Respondents also agreed that game illustarations and help messages provided in the game are useful with the percentage of 92.7% and 89.1% respectively. Positive feedbacks on all items of uselfulness have proven that respondent agreed that the proposed [Neuro]-therapy game is useful for elderly in psychotherapy process.
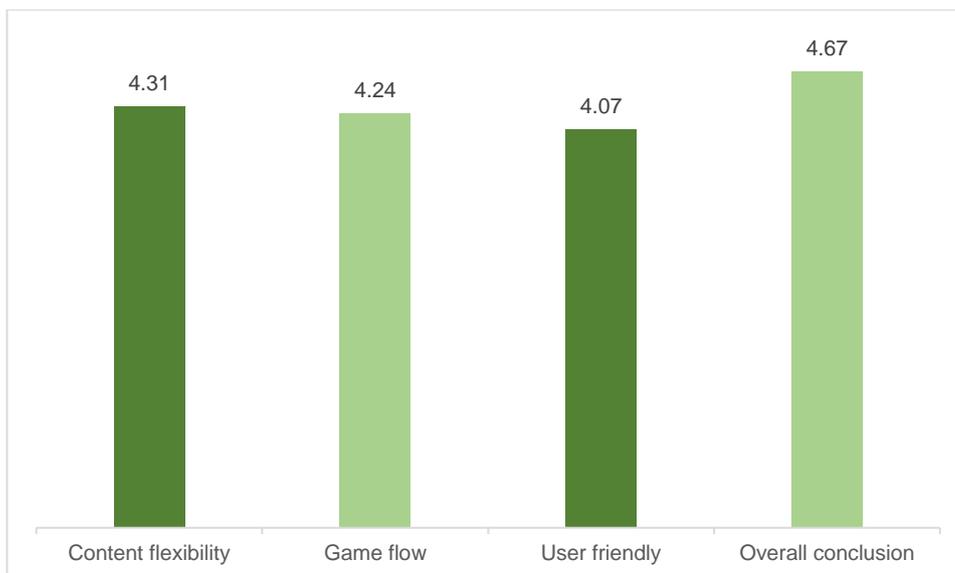

Figure 9: Overall feedback on Psychotherapy game

Overall feedback shows that mean score for all four items used are high (more than average score) with the highest mean is 4.67 for overall conclusion (they agreed that [Neuro]-therapy game is usable, followed by content flexibility with the value of mean is 4.31. Average mean score for all four items are shown in Figure 9. High value of mean score for overall conclusion of the [Neuro]-

therapy game shows that respondents are happy and accepted that the game is usable. This is proven by the high values of mean score for another three items on the content flexibility, game flow, and user friendly with its mean score are above 4.0.

CONCLUSION

Based on the issues and concerns that have been addressed, a mobile psychotherapy game, [Neuro]-therapy is successfully designed, developed, and evaluated. It is a simple puzzle game that has been designed and developed based on the identified criteria through combination of methods as discussed in methodology section. As the first version, the game has some limitations that can be further improved. As a beginning, the game only caters four difficulty levels based on the puzzle size; 2x2, 3x3, 4x4, and 5x5 with the minimum puzzle pieces of four (2x2 size) and its maximum number of puzzle pices is 25 (5x5 size). Early observations showed that some respondents managed to solve 5x5 level and expecting for tougher levels of the game. Customizable puzzle size would be an alternative solution to make this game more challenging. Another limitation is regarding the category of the puzzles. Based on the defined criteria, we only included three main categories which are familiar to the elderly; face, vehicles, and fruits. On top of it, we included more pictures in the gallery that can be generated as puzzle pieces.

Although there are some limitations of the game, evaluation shows that the game is perfectly functioning and has been accepted in terms of its usability as discussed in the findings. The game itself and the design guildeline are believed to benefit many parties; the scholars, practitioners, caretakers, and patients particularly the elderly. It is hope that it will give directions to developers on developing more games for memory disorder patients towards improving the quality of life among the elderly with memory disorder issues. More psychotherapy game-based applications can be developed by adopting the same criteria with the hope can benefits the elderly such as game-based zikir and game-based tasbih.

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