Design and Assessing the Usability of an Interactive Digital Game in Assisting the Older Adult's Prescriptive Medication Behavior

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Abstract. Taking prescriptive medicine has been a major daily routine for many older adults. However, misused medication behavior has been reported as a major safety issue for senior welfare subject to the well-documented decline in cognitive aging. Game-based learning has been demonstrated as an effective media in enhancing cognitive functions but mostly in the fields with young adults as the subject. The present study thus aimed to investigate the usability of digital games in improving the medication behavior for older adults. The results indicated that the older subject who received the game-based learning significantly outperformed the counterpart who received the traditional treatment. Implications for designing appropriate learning media for the older adult's medication behavior were raised.

Keywords: digital games, digital learning, human-computer interaction, cognitive aging, prescriptive medication.

1 Introduction

One of the most common problems facing older adults is the need to take prescriptive medicine due to chronicle diseases. The literature in aging has shown that age is normally associated with declined mental abilities such as working memory [1]. One frequently cited problem of the reduced cognitive abilities is the difficulty for older adults in accurately adhering to the often complex medical prescriptions. As medication behavior bears critical consequences to life safety, providing an assisting mechanism that can assure successful medication particularly for the cognitively disadvantaged older adults thus becomes an important issue [2-3]. Game-based digital learning, powered by computerized interaction technology, has become a major vehicle for the human to facilitate better mental processing of learning material [4-5]. Possibility thus exits where the older adult's challenge in accurately adhering to prescriptive medication can be resolved by learning the prescriptions through interactive procedures led by digital games [6]. The purpose of the present study is to investigate

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the effect of game-based digital learning in assisting older adults in medication behavior as a function of prescription complexity. It is hypothesized that as compared to the traditional prescriptive presentation, the game-based e-learning would more highly motivate the older adult to obtain a deeper comprehension of the medication knowledge, and in turn result in more successful obedience of the prescribed medication behavior.

2 Methodology

2.1 Experimental Design

A 2x3 split-plot factorial experiment was conducted to verify the hypothesis. The learning media was defined as a within-subject factor which consisted of two levels of treatment, namely, game-based e-learning and traditional presentation. The prescription complexity was defined as a between-subject factor in which three levels of prescription matrix were manipulated. The prescription matrix consisted of 18 cells determined by six medication time zones (e.g., after breakfast) and three diseases (e.g., high blood pressure). According to the memory capacity of 5~9 chunks, the three levels of complexity was operationally defined as simple (5 cells of prescriptive information), medium (7 cells), and difficult (9 cells). The subject's medication behavior was measured by test scores concerning how well they were able to accurately assign pills to the associated time zone-disease combination, e.g., taking a green round tablet after lunch for high blood pressure. The subject was also evaluated by their subjective preference over the two learning media by a rating scale of 1 to 10 with 10 representing the most favorable.

2.2 Subjects

15 subjects aged over 65 participated in the experiment with each prescription complexity group receiving 5 subjects. All the participants were at least high school graduates with sufficient computer experiences. Each of the subjects was eye sight corrected, if needed, during the experiment.

2.3 The Learning Material

The game-based e-learning system was developed by Flash CS 5.5 and was presented to the user through a 21.5-inche touch screen (Dell ST2220T). The gaming system adopted a metaphor of railway traveling where the prescribed medicine (pills and tablets) acted as passengers boarding on a train departing at designated schedules (prescribed time zone) for particular destinations (disease-related organs).

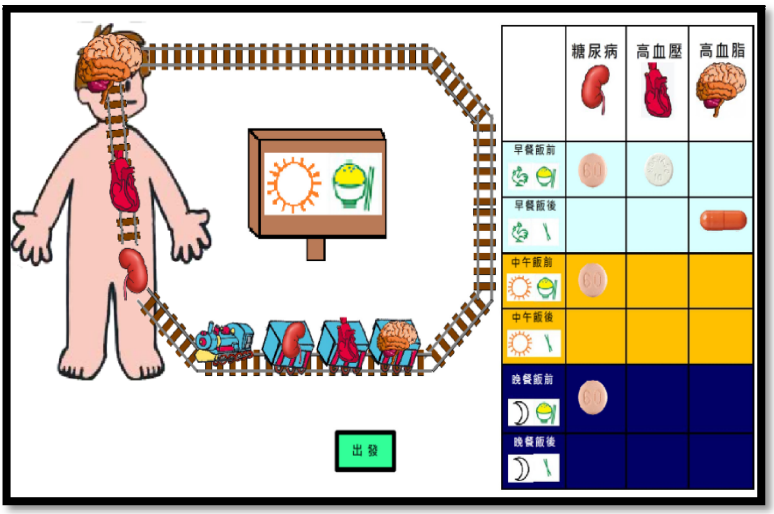

Fig. 1. A snapshot of the game-based digital learning where the prescription was exhibited on the right panel, from which the subject was instructed to drag pills/tablets to the corresponding train cars

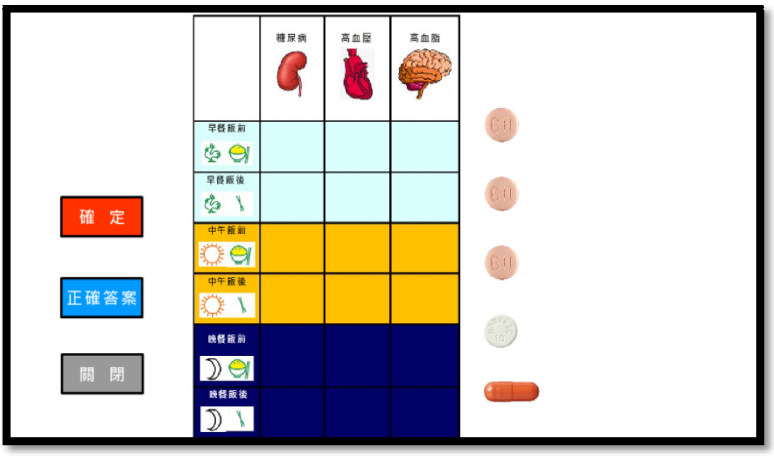

Fig. 2. A snapshot of the online test session where after the learning session, the subject was instructed to drag pills/tablets to the correct corresponding prescription cells

2.4 Procedures

The 15 subjects were evenly assigned to the three complexity groups at random. Following a warm-up exercise, the subject of each complexity group was instructed to interact with the game-based e-learning material and the traditional material whose prescription contents differed from each other but both with the same prescriptive

information load. Each subject was allowed a five-minute break between switching of the two learning media. The order of presentation of the two learning media to each subject was randomized. A 10-minute rest period was offered after completion of the experimental session.

Following the rest period, a test session was administered in which the subject was first asked to rate their preference concerning the two learning media with respect to a variety of user experiences. Immediately after the subjective rating session, the subject was then asked to assign given prescriptions to their associated prescribed time zone and the diseases/organs the prescriptions intended to deal with. The test scores and the time spent on solving the questions were recorded for each subject.

3 Results and Analysis

The descriptive results of the experiment were shown in Table 1. Analyses of data normality (Anderson-Darling test) and variance equality (Levene's test) were performed and the results showed that both prerequisites were satisfied for subsequent ANOVA analysis.

Table 1. Means and (standard deviations) of the hit rates under the manipulation of learning media as a function of medication complexity

Game-based media			Traditional media		
Simple	Medium	Complex	Simple	Medium	Complex
0.902	0.850	0.698	0.778	0.584	0.556
(0.104)	(0.072)	(0.062)	(0.105)	(0.085)	(0.091)

3.1 Performance

ANOVA results indicated that while there was no significant interaction between learning media and prescription complexity ($F[2,12]=3.00$, $p>0.05$), the respective main effects were both significant. The subject who received the game-based e-learning scored significantly higher than the traditional counterpart when associating the prescriptive medicine with correct prescribed time zone and intended diseases ($F[1,12]=47.20$, $p<0.000$). Meanwhile, the complexity effect indicated that the test scores decreased as the prescriptive information load increased regardless of which

learning media was employed ($F[2,12]=10.45$, $p<0.002$). Further post-hoc pair comparisons ($\alpha=0.05$) revealed that the source of significance was derived from the difference between the simple and the difficult levels, with the differences between the simple and the medium, and the difficult and the medium being due to chance results.

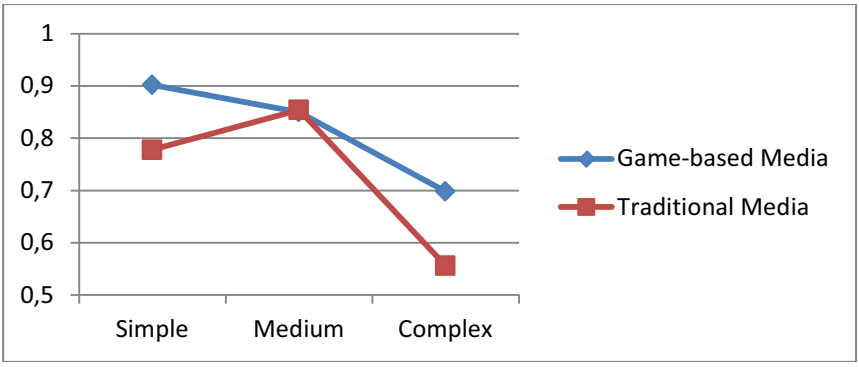

Fig. 3. Interaction plot of the test scores (hit rates) under the two media as a function of medication complexity

3.2 User Experiences

A paired t test ($\alpha=0.05$) was performed to differentiate the subjective preference over the two learning media with respect to the dimensions of pleasure, entertainment, ease of learning, attractiveness, confidence. The results indicated that all the subjects preferred the game-based e-learning to the traditional media, except on the dimension of confidence. It is possible that no learning feedback was provided in the present experiment so that the subject had no reference as to his/her learning performance despite the positive attitude towards the game-based learning materials.

4 Conclusions

It has been well documented that older adults are vulnerable to cognitive activities. As taking prescriptive medication requires mental resources such as memory, it is important that older adults are appropriately supported in this respect to avoid potentially dangerous consequences. The present study found that the older adult exhibited positive preference towards digital games, and significantly improved the medication accuracy after receiving properly designed game-based training.

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References

1. Park, D.C.: The Basic Mechanisms Accounting for Age-related Decline in Cognitive Function. In: Park, D.C., Schwarz, N. (eds.) Cognitive Aging: A Primer, pp. 3–21. Psychology Press, Philadelphia (2000)
2. Chen, C.H., Wu, J.R., Yen, M., Chen, Z.C.: A Model of Medication Taking Behavior in Elderly Individuals with Chronic Disease. Journal of Cardiovascular Nursing 22(5), 359–365 (2007)
3. Wu, J.R., Moser, D.K., Lennie, T.A., Peden, A.R., Chen, Y.C., Heo, S.: Factors Influencing Medication Adherence in Patients with Heart Failure. Heart & Lung 37(1), 8–16 (2008)
4. DeLeeuw, K.E., Mayer, R.E.: Cognitive Consequences of Making Computer-based Learning Activities More Game-like. Computers in Human Behavior 27(5), 2011–2016 (2011)
5. Prensky, M.: Digital game-based learning. McGraw-Hill, New York (2001)
6. Schutter, B.D.: Never Too Old to Play: The Appeal of Digital Games to an Older Audience. Games and Culture 6(2), 155–170 (2012)