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THE COMPARISON BETWEEN ERROR-LESS LEARNING AND ERRORFUL LEARNING IN VIRTUAL REALITY ON POKÉMON THEME

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Abstract

We discuss the feasibility of cognitive training in the virtual reality (VR) environment by comparing both error-less (EL) and errorful (EF) ways with Pokémon characters as training material. We developed a VR environment for experiencing the procedural and a questionnaire for collecting data. We tested the performance of this application as a preliminary study and received the feedbacks from participants, who are young student. We found firstly that they could be engaged in the cognitive training with Pokémon theme. Secondly, they showed a better training effect under EL condition although they found the training under EF condition more fun than that under EL condition. Thirdly, participants were fond of the VR device as a presenting way. We plan to carry out another experiment with a modified version to collect feedbacks from

the healthy elderly. Accordingly, we believe that the proposed approach is acceptable in practice. From this perspective, we expect that our work can benefit the elderly by attracting them to take part in such EL-based exercises.

Keywords

Cognitive Training, Error-Less Learning, Virtual Reality, Pokémon

1. Introduction

Error-less (EL) learning refers to completing some learning tasks that with fewer errors during its procedure. The application of EL is a well-known approach owing to benefiting positive effects by cognitive rehabilitation and training ways for people who exhibit mild cognitive impairment (MCI) or live with early stages of dementia (Clare & Woods, 2003; Roberts et al., 2018). Practically, there have been various applications which are in line with the original principle of the EL learning, namely, avoiding making trials on error during the entire memorization process. Since the training effect is reported that can transfer from the particular training task to their lives (Akhtar, Moulin, & Bowie, 2006), such approach has been favored by the elderly who live in the nursing home and see caregivers in their daily life (Clare, Wilson, Breen, & Hodges, 1999; Śmigórska et al., 2019). The cognitive training based on EL learning aims to improve working memory while other cognitive rehabilitations focus on regaining instrumental activities of daily living (Clare & Woods, 2003; Foloppe, Richard, Yamaguchi, Etcharry-Bouyx, & Allain, 2018). In practice, however, the cognitive training perspective is not so interesting and participants are not tempted to keep training everyday (Ma, Lai, & Fujinami, 2019). Thus, training materials for cognitive training by EL learning must include interesting factors so that they are widely accepted among the elderly.

The theme of Pokémon can represent the globalization of children' s popular culture since the first piece of entertaining software released on Nintendo' s Game Boy platform in 1996 (Tobin, 2004). So far, the influence of Pokémon is not limited to children, but also on adults and even the elderly. One of the supporting phenomena is that Pokémon Go, a smartphone app released in 2016, could motivate all age groups of people to keep their outdoor physical activity even in winter (Althoff, White, & Horvitz, 2016; Hino, Asami, & Lee, 2019). Therefore, employing Pokémon characters as the training material for the EL learning may be an alternative solution to the training engagement.

However, one factor to be concerned about is that the Pokémon theme may be too virtual to be focused as cognitive training because the characters are far from living creatures in real life. To approach to this problem, we turn to virtual reality (VR) technology, which has been showing potential in various rehabilitations (Schultheis & Rizzo, 2001; Maggio et al. 2019). Compared to traditional ways of in cognitive rehabilitation by EL learning, the VR method may provide us with the following two advantages (Foloppe et al., 2018). Firstly, VR helps transfer learning effects in virtual tasks to real-world environments. Secondly, VR helps to focus on virtual tasks. Thus, the cognitive stimulation provided in the VR environment may also affect real-life because it involves a similar perception-action feedback loop, which thereby may be the ideal method to present the cognitive training by EL learning.

Therefore, the current study aims to demonstrate an EL learning paradigm for cognitive training using Pokémon characters in the VR environment. This study also invites young adults to experience the entire training process for collecting feedbacks as a preliminary report to ensure that future training runs smoothly for the elderly, especially the elderly who live with MCI or early stages of dementia.

2. Investigation

During the current cognitive training process, participants are invited to experience the training in conditions of both errorless learning (EL) and errorful learning (EF) in a virtual reality (VR) environment, which employs the Pokémon characters as training material.

2.1 Participants

Eighteen postgraduates from *Japan Advanced Institute of Science and Technology* joined this investigation as participants. The male to female rate is 13 to 5, the age distribution is 20 to 31 that with an average of 25.67.

2.2 Materials

The Pokémon models used in the experiment were randomly selected from eight different Pokémon Generations (*Models-resource.com*, 2019). We scrambled the order of appearance to control training effects. As training targets, these Pokémon names are taken from the official version translated into participants' first language (in Simplified Chinese for the current study). The engine used to create the training environment is *Unity 2019.4*, which allows users to interact with objects in virtual reality. A head-mounted display device (HMD) used by the

participants is *Oculus Quest*, which is a 6-Degrees of freedom device that allows participants to move freely to observe things in the virtual reality environment (see Figure 1). In errorless condition, we made the Pokémon 3D models whose name appears in the VR environment. Participants need to memorize both the appearance of the Pokémon and its corresponding name. In errorful condition, a Pokémon model appears firstly, participants then need to guess its name. Correct names are shown in the VR environment when participants fail to answer correct names for three attempts. When participants feel that they can remember the name, they ask experimenters to present the next target.

Figure 1: *A Participant wearing the Oculus Quest during the Errorful Condition. The Picture is taken by the Authors in the Test Site of Laboratory.*

A short questionnaire is also used to collect feedbacks of participants on the current cognitive training, which is composed of questions concerning the attitude of Pokémon, cognitive training conditions, and VR experience. In particular, the subsection of VR experience contents the *virtual reality sickness questionnaire* (VRSQ), whose scores reflect the standardization of VR motion sickness (Kim, Park, Choi, & Choe, 2018).

2.3 Procedure

The entire procedure is within-subject design, say, participants experience the conditions of both EL and EF for one hour. Firstly, participants wear the VR device with interacting adaptation. Secondly, they experience the twenty items of targets in EL condition (Figure 2).

Thirdly, they experience other twenty items of targets in EF condition (Figure 3). Fourthly, they try to complete the post-test. Finally, they report the questionnaire of their experience.

Figure 2: *The Condition of Error-Less Learning.*

The picture is Screenshotted and taken by the Authors from the Testing Scenes.

Figure 3: *The Condition of Errorful Learning. Guessing (left) and Memorizing (right).*

The picture is Screenshotted and taken by the Authors from the Testing Scenes.

3. Result

3.1 Post-Test

After experiencing the current cognitive training process, we implemented a post-test to measure the difference of participants' training effect between the conditions of errorless learning (EL) and errorful learning (EF), which test is by recognizing the forty items of presented Pokémon characters. The results are in the following Table 1.

- "Average Correct Rate" represents the dividing of all participants by the number of participants in particular conditions.

- "Better Performance" represents participants who showed better performance in particular conditions.
- "Equal performance" represents participants who showed the same results in both EL and EF conditions.

Table 1: *Post-Test Score*

	Percentage: %
Average correct rate (for EL)	43.06%
Average correct rate (for EF)	30.28%
Average correct rate (for all)	36.67%
Better performance (for EL)	61.11%
Better performance (for EF)	27.78%
Equal performance	10.53%

3.2 Attitude on Pokémon

We collect participants' attitudes towards Pokémon theme, which as the first subsection of the questionnaire that result are in Table 2.

Table 2: *Familiarity and Interest of Participants on Pokémon*

Familiarity (Number of person)				**Interest (Number of person)**	
Very Familiar	***Familiar***	***Not Familiar***	***Never Heard***	***Yes***	***No***
1	2	12	3	12	6

3.3 Attitude on Cognitive Training

We collect data of participants' attitudes on the cognitive training in conditions of both EL and EF (see Table 3). The column of "Preferred Conditions of Training" only analyzes the "Yes" answers of "Attitude of Training".

- "Interested Content" represents whether participants are interested in the training.
- "Task Challenge" represents whether participants feel memory tasks are difficult.

- "Memory Benefit" represents whether participants believe the training effect on improving memory ability.
- "Recommend to others" represents whether participants will recommend this training to people around them who need to train their memory.

Table 3: *Attitude on Cognitive Training and Related Conditions*

	Attitude on Training		**Preferred Conditions of Training**		
	Yes	***No***	***EL***	***EF***	***Both***
Interested Content	17	1	5	11	1
Task Challenge	11	7	3	7	1
Memory Benefit	16	2	5	10	1
Recommend to Others	15	3	4	9	2
Tired on Content Size	7	11			

3.4 Adaptability on VR

We collect participants' attitudes concerning the VR device as a presenting approach, whose results is shown in Table 4.

- "Presenting by VR" represents whether participants prefer the training material (Pokémon) presented by VR device.
- "VR Experience" represents whether participants have ever experienced VR interactions.
- "VR Enjoying" represents whether participants enjoy VR experiences in any case but other than the current experience of VR cognitive training.
- "VR Training Enjoying" represents whether participants enjoy this time's training.

Table 4: *Feedback of Experience from VR Training*

	Yes	**No**
Presenting by VR	13	5
VR Experience	14	4
VR Enjoying	13	5
VR Training Enjoying	18	0

3.5 Discomforts during VR Cognitive Training

We collect participants' sensitivity of experiencing cognitive training in virtual reality environment, which contents firstly the motion sickness that represents by the *virtual reality sickness questionnaire* (VRSQ) score, and secondly the other discomfort.

- "VRSQ" score is the result of the virtual reality sickness questionnaire, which reflects the standardization of VR motion sickness (Kim, Park, Choi, & Choe, 2018).
- "Other Discomforts" represents whether participants feel discomfort other than VR motion sickness during the training.

Table 5: Motion sickness and other discomforts from VR training

Participants	**VRSQ**	**Other Discomforts**	**Participants**	**VRSQ**	**Other Discomforts**
Participant 1	0	No	Participant 10	0	No
Participant 2	0	Yes	Participant 11	4.17	No
Participant 3	0	No	Participant 12	22.25	No
Participant 4	26.66	Yes	Participant 13	0	No
Participant 5	0	No	Participant 14	0	No
Participant 6	0	No	Participant 15	4.17	No
Participant 7	0	No	Participant 16	0	No
Participant 8	57.5	No	Participant 17	0	No
Participant 9	20	Yes	Participant 18	0	No

4. Discussion

4.1 Analysis

We collected a total of 18 valid feedbacks from young participants that reflect their experience through the current cognitive training process.

Results in Table 3 suggest that 17 young participants are engaged in cognitive training with the Pokémon theme. Among them, 16 participants believe that this training can benefit memory ability and are willing to recommend it to people around them who need to improve their memory. Also, 11 participants feel that the load of tasks (40 items) during the training is reasonable but believe that they are challenging on difficulty tasks for memorization.

Moreover, comparing the conditions of error-less (EL) and errorful (EF) in Table 3, 11 participants prefer the EF way than EL, even if most of them can perform better in the EL condition (reflected by Table 1). This phenomenon may be due to the particularity of Pokémon material, say, characters in this theme may be more stimulating participants' associative memory, which thereby motivates them to share their guessing.

According to the result in Table 5, there are 12 participants who have no feeling of VR motion sickness. Moreover, only three participants feel discomforts other than the sickness, and two of them think the size of the VR head-mounted display cannot fit in their face contours. The other one participant thinks the training brings frustration due to the task difficulty. Additionally, the results shown in Table 4 suggest that all participants enjoy the cognitive training by the Pokémon theme but only 13 of them enjoy ordinary VR experiences. This phenomenon may suggest that the attractiveness of the current training paradigm is better than common VR applications.

4.2 Limitation

This study only focuses on collecting feedback from participants after their experience, whose training procedure, therefore, is difficult to ensure the effects due to the impacts as mentioned in the following factors. Firstly, EL condition is employed for the first twenty tasks that memorizing results may be affected by primacy effect (a phenomenon that people perform better on recalling the objects presented earlier to them, in our case, participants performed better on retrieving the first few of Pokémon items in the EL condition), but EF condition is the last twenty tasks that the effect may be affected by recency effect (a phenomenon that people perform better on recalling the objects presented more recent to them, in our case, participants performed better on retrieving the last few of Pokémon items in the EF condition) (Burdock Jr, 1962). Secondly, the presenting targets for memorizing in the VR environment are three-dimensional models but for the post-test are two-dimensional pictures, which may affect the recall performance to participants, especially for those with cognitive progressively declined (Piaget & Inhelder, 1948/1967). Finally, all the feedback is collected from young participants, which may not accurately represent the opinions of the elderly.

4.3 Future work

The current study is the first step of the preliminary investigation. The future work involves collecting feedback from the healthy elderly for a modified version of the current

paradigm. We expect that the cognitive training with the Pokémon theme in the VR environment by EL way can practically contribute to eventually improving on working memory for people who live with mild cognitive impairment in early stages of dementia.

5. Conclusions

As the preliminary investigation, the results of this study indicate that the entire training procedure is both risk-free and attractive to the vast majority of young participants. Accordingly, it may also reflect that the training is at least acceptable for the family members as well, especially for those who are children of the elderly.

REFERENCES

Akhtar, S., Moulin, C. J., & Bowie, P. C. (2006). Are people with mild cognitive impairment aware of the benefits of errorless learning?. *Neuropsychological Rehabilitation*, 16(3), 329-346. https://doi.org/10.1080/09602010500176674

Althoff, T., White, R. W., & Horvitz, E. (2016). Influence of Pokémon Go on physical activity: study and implications. *Journal of medical Internet research*, 18(12), e315. https://doi.org/10.2196/jmir.6759

Burdock Jr, B. B. (1962). The serial position effect of free recall. *Journal of experimental psychology*, 64(5), 482. https://doi.org/10.1037/h0045106

Clare, L., Wilson, B. A., Breen, K., & Hodges, J. R. (1999). Errorless learning of face-name associations in early Alzheimer's disease. *Neurocase*, 5(1), 37-46. https://doi.org/10.1080/13554799908404063 https://doi.org/10.1093/neucas/5.1.37-a

Clare, L., & Woods, B. (2003). Cognitive rehabilitation and cognitive training for early- stage Alzheimer's disease and vascular dementia. *Cochrane database of systematic reviews*, (4). https://doi.org/10.1002/14651858.CD003260

Foloppe, D. A., Richard, P., Yamaguchi, T., Etcharry-Bouyx, F., & Allain, P. (2018). The potential of virtual reality-based training to enhance the functional autonomy of Alzheimer's disease patients in cooking activities: A single case study. *Neuropsychological rehabilitation*, 28(5), 709-733. https://doi.org/10.1080/09602011.2015.1094394

Hino, K., Asami, Y., & Lee, J. S. (2019). Step Counts of Middle-Aged and Elderly Adults for 10 Months Before and After the Release of Pokémon GO in Yokohama, Japan. *Journal of medical Internet research,* 21(2), e10724. https://doi.org/10.2196/10724

Kim, H. K., Park, J., Choi, Y., & Choe, M. (2018). Virtual reality sickness questionnaire (VRSQ): Motion sickness measurement index in a virtual reality environment. *Applied ergonomics,* 69, 66-73. https://doi.org/10.1016/j.apergo.2017.12.016

Ma, Y., Lai, K. C., & Fujinami, T. (2019). Public figures as training material for error-less learning for MCI. *SIG-SKL-27*. 1-5.

Maggio, M. G., De Luca, R., Molonia, F., Porcari, B., Destro, M., Casella, C., ... & Calabro, R. S. (2019). Cognitive rehabilitation in patients with traumatic brain injury: A narrative review on the emerging use of virtual reality. *Journal of Clinical Neuroscience,* 61, 1-4. https://doi.org/10.1016/j.jocn.2018.12.020

Models-resource.com. (2019). Nintendo Switch - The Models Resource. https://www.models-resource.com/nintendo_switch/ Accessed December 22 2019.

Piaget, J., & B. Inhelder (1948/1967). *The child's conception of space. (F. J. Langdon & J. L. Lunzer, Trans.)*. New York: Norton.

Roberts, J. L., Anderson, N. D., Guild, E., Cyr, A. A., Jones, R. S., & Clare, L. (2018). The benefits of errorless learning for people with amnestic mild cognitive impairment. *Neuropsychological rehabilitation,* 28(6), 984-996. https://doi.org/10.1080/09602011.2016.1216000

Schultheis, M. T., & Rizzo, A. A. (2001). The application of virtual reality technology in rehabilitation. *Rehabilitation Psychology,* 46(3), 296. https://doi.org/10.1037/0090-5550.46.3.296

Śmigórska, A., Śmigórski, K., & Rymaszewska, J. (2019). Errorless Learning as a method of neuropsychological rehabilitation of individuals suffering from dementia in the course of Alzheimer's disease. *Psychiatria polska,* 53(1), 117-127. https://doi.org/10.12740/PP/81104

Tobin, J., Acereda, A., & Derusha, W. (2004). *Pikachu's global adventure: The rise and fall of Pokémon,* Duke University Press. https://doi.org/10.1215/9780822385813