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Bioinformatics of Serious Leisure in Playing Video Games and Learning English as a Sustainable Activity †

Li-Shiue Gau [1,*], Chung-Hsing Huang [2] and You-Ni Gau [3]

[1] Department of Leisure and Recreation Management, Asia University, Taichung 413305, Taiwan
[2] Department of Business Administration, Asia University, Taichung 413305, Taiwan; xing888@gmail.com
[3] Chu-Jen Junior High School (CJJH), Taichung 403002, Taiwan; garygautw@gmail.com
* Correspondence: lsgau@asia.edu.tw; Tel.: +886-4-23323456 (ext. 20057)
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Abstract: This study aimed to investigate why video gaming tends to become a serious leisure activity more easily than English learning, using a bioinformatics approach. Methods included interviews with 13 students aged 10–13 and an experimental research design with EEG (electroencephalograph) data from five students during rest, gaming, and English learning prior to and after a 4-week treatment. Interviews revealed that cram schools, school assignments, and future career aspirations influenced English learning habits. EEGs showed greater situational involvement in video games, but no significant improvement in English learning after the treatment. Encouraging English learning was challenging, perhaps due to participants' busy schedules.

Keywords: EEG; learning English; serious leisure; video game; elementary school

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1. Introduction

In December 2019, several cases of coronavirus disease (COVID-19) were reported, raising global concerns about the threat of the new pandemic to public health [1]. In order to prevent the epidemic, governments imposed a series of strict prohibitions on gatherings [2], thereby increasing the chance for people to stay indoors or study from home. This has had a huge impact on changes in leisure patterns and likely led to a higher demand for digital leisure [3].

During the COVID-19 pandemic, pupils tend to be involved with digital leisure activities such as video games too seriously and hurt their eyesight. Given the development of digital technologies with unlimited access to the Internet, people's leisure lives have been changed greatly. Computers, video game consoles, smartphones, and other devices are adapted to daily leisure and entertainment activities [4]. However, the concern is that such video or online games are like a paradise to escape, causing pupils to become hooked and lose all notion of time.

Parents are worried about this type of unhealthy leisure habits and try to ask children to engage in other more positive leisure activities such as learning English. However, pupils wailed reluctantly at this request because seemingly learning English causes little pleasure, but rather induces pressure and is more like a job, a task, or a duty than leisure for children. This inspires the current research to examine why video gaming is an activity that more easily becomes a serious leisure activity than English learning from an aspect of bioinformatics. Biological data from electroencephalographs (EEGs) were collected while playing video games and learning English along with participant interviews.

2. Literature Review

2.1. Sustainable Serious Leisure

Serious leisure is the systematic pursuit of a hobbyist core activity that people find so interesting and fulfilling that they launch themselves on a career centered on acquiring and expressing a combination of knowledge, affective involvement, and skills [5]. Previous studies indicated that serious leisure may generate flow experience [6], increase leisure satisfaction [7], and positively associate with eudemonic or subjective well-being [8]. However, those who are deeply involved in serious leisure may, on the other hand, face a risk of indulging in an excessive amount of such leisure participation [5]. Maladaptive patterns of excessive leisure activities might negatively influence health and ordinary lives.

If a strategy of balanced leisure patterns in various leisure activities can be adopted, multiple leisure activities may provide a healthy balance for distraction from some possible excessive leisure [9]. Since bilingualism is one of the major education policies to be implemented by the year 2030 by the Taiwanese government because of globalization, the cultivation of serious leisure in learning English for children or young teenagers seems a good choice. Comparison of these two different types of serious leisure in terms of playing video games and studying English is rare in prior studies. This study tries to fill the literature gap with two major objectives. First, it explores why cultivating a leisure habit of studying English is not an easy task. Second, it uses bioinformatics to compare these two leisure activities and derive useful information about how to design sustainable serious leisure.

Sustainable serious leisure refers to endurable leisure benefits of good health and well-being that are essential to sustainable development [10]. Earlier studies have shown that serious leisure could be practices of social sustainability [11,12]. For example, a group of old volunteers who participated in performing traditional Korean dance as their serious leisure activities reported positive experiential characteristics of the involvement including a perceived self-achievement of perseverance and enhancement of self-identity, leading to successful aging [12].

2.2. Learning English as a Serious Leisure Activity

Leisure experiences can be referred to four types of a 4-E model [13]: Educational, Entertainment, Esthetic, and Escapist experiences. While playing video games is more likely seen as a way of seeking refuge to escape from daily hassles, pupils learning English might experience educational epistemic satisfaction, as it is more like one of the liberal arts hobbies. The intrinsic goal of learning English is to acquire the knowledge and understanding of the language as an end in itself [6].

Within this type of cognitive liberal arts leisure, it is hard to generate a flow experience and therefore usually attracts little attention [6]. Without practices of perseverance, there would be little chance of cultivating a habit of learning English as serious leisure. In addition to the inherent value, however, some other possible practical reasons and instrumental purposes can become aspirations for learning English. For instance, fluency in English can facilitate social inclusion, allowing individuals to become a part of a preferred or envisioned community [14]. This would serve as a compelling incentive for an individual to learn English. Another possible example is to pursue a desired career where English competence is required.

2.3. Advantage and Disadvantage of Electroencephalograph

Little or lack of research thus far was conducted to investigate alterations in electroencephalogram (EEG) power spectra when playing video games and studying English. EEG power spectra are typically examined through frequency range consisting of delta (0.5–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), and beta (13–30 Hz) [15–17]. An alpha frequency range is considered relevant to a feeling of relaxation without attention whereas beta power is related to the activation of the brain in active processing when on task [15,16,18,19]. The theta rhythm is brought on by early drowsiness or in a state of deep meditation [17,18]

while the delta rhythm has been associated with the absence of consciousness or seen in the state of deep sleep [18,19].

The advantage of EEG is its noninvasive neuroimaging technique to investigate electrical activity in the brain [16,18,20], providing objective evidence. This is safe and straightforward to perform with the useful advantage that EEG can synchronously measure changes in brain activity in real time [18]. However, EEG's disadvantage is that the brain's activity at the individual neuronal level cannot be easily captured, causing failure to understand the nuanced and complex cognitive processes happening in the brain [20]. Another disadvantage is the sensitivity of EEG to the participant's facial movements, body shaking, state of consciousness, physical and mental activity, and the presence of different biological and environmental stimuli [17].

3. Research Method

3.1. Equipment and Software

A ProComp Infiniti encoder manufactured by Thought Technology Limited was utilized to acquire 1-channel EEG data from an electrode cup placed on the forehead and referenced to linked clip electrodes fixed on two earlobes. Before the electrodes were secured, a small amount of NuPrep gel was applied to abrade the skin, removing dead skin, sweat, and other impurities that might interfere with the EEG signal. Then, Ten20 conductive paste was filled in the electrode cup and put on the ear clips to help affix the electrodes on the forehead and ear lobes to improve the quality of the perceived EEG signal.

The EEG signal was transmitted by electrode cables and a DIN cable to the EEG-Z sensor, which was then connected to the encoder, TT-USB interface device, and ultimately to a personal computer [21] (Figure 1). Prior to recording the EEG signal, impedance checks were conducted for all electrodes. Data analysis was performed using Thought Technology Limited's BioGraph Infiniti software (Version 6.1).

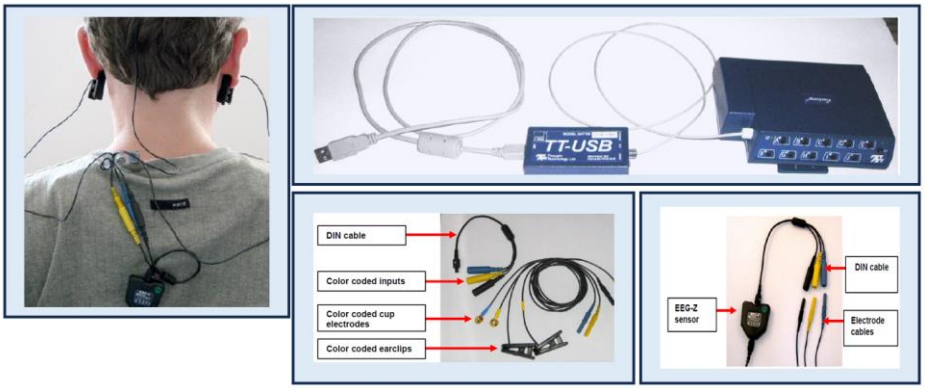

Figure 1. EEG data collection equipment reference [21], on pages 4, 12, 13, 18.

3.2. Data Collection

Two methods were used for data collection. First, 13 students between 10 and 13 years old were recruited for interviews. Second, among the 13 interviewees, 5 students participated in an experimental study with consent from their parents. In the interviews, outline questions (Table 1) attempted to determine the first thing that participants would like to do upon returning home from school and whether this was recognized as a positive or negative habit. The next question tried to understand participants' leisure habits and see whether the habits involved learning English. For answering the third question, participants recalled their memories to describe the process of how those habits were developed and to compare whether there were differences between good and bad habits. The final question focused on participants' interests, attitudes, and opinions toward the pursuit of learning English as a leisure habit and requested some explanations about the responses.

Table 1. Interview outline.

1. What is the first thing you would like to do when you come home after school? Are you aware of any good or bad habits?
2. What is your leisure habit? Is there any related to learning English?
3. How do you cultivate these habits? Is there any difference between good and bad habits?
4. How do you think of the cultivation of learning English as a leisure habit? Are you interested in this type of leisure habit? Why or why not?

For the experimental research design, EEGs were collected while resting, playing video games, and learning English. Each time, the duration was one and a half minutes, and, in total, there would be four collection times for every participant: resting with eyes closed, resting with eyes open, playing video games, and learning English. During the EEG recording, participants were instructed to be quiet, remain still, and maintain a comfortable posture without moving or shaking their body or facial muscles.

Prior to and after the four-week period of treatment, data collection was executed. For a period of four weeks, the treatment was provided with studying materials of English extracted from Studio Classroom Magazine in reading, speaking, listening, or writing five times a week. It was expected to take approximately between 20 and 25 min every time to study the materials. Participants were encouraged to cultivate a habit of learning English.

3.3. Data Analysis

A mode of auto-rejection setting in the software BioGraph Infiniti was used to keep or reject segments of sections for EEG analyses. This procedure primarily placed artifact rejection segments over sections of noisy signals for the purpose of generating reliable statistics [21]. A rejection threshold of 20 was entered initially as the upper limit for normal EEG microvolt levels. If the percentage of rejection durations were higher than 50% (included), the threshold was made more lenient to, for example, 25 or 30.

4. Results and Conclusions

4.1. Interviews

The results of interviews showed that most children started to do homework first thing when they arrived home after school. Bad habits included the overuse of smartphones. Some participants mentioned that a habit was developed day by day and gradually formed over time. It appeared that seemingly acquiring a negative habit was easier than establishing a positive one. The major factors influencing a habit of serious leisure in learning English included whether students went to a cram school, whether there were assignments required by their schools, and whether students had a vision of using English in their future careers.

4.2. Experimental Study

For the experiment, participants showed that it was hard to change their habits in learning English through encouragement from others because their schedule was tight. Two participants studied 75% of the treatment materials while the other three participants only studied approximately 25%. All participants mentioned that they went to English cram schools regularly.

The EEG results demonstrated higher theta and alpha wave activity when participants closed their eyes compared to when their eyes were open (Table 2), indicating that the equipment used was valid and possessed nomological validity. Alpha waves are most prominently observed when the eyes are closed, and their presence is typically attenuated through eye opening [17]. Paired sample t tests between eyes open and eyes closed in the ratio of alpha to beta showed statistical significance ($p < 0.05$) with higher ratio values when eyes were closed than those when eyes were open.

Table 2. EEG in resting.

Case	EEG	Resting (Prior)		Resting (After)	
		Eyes Open	**Eyes Closed**	**Eyes Open**	**Eyes Closed**
case 1	Delta	12.25	15.87	10.57	16.51
	Theta	9.17	11.71	7.74	11.26
	Alpha	6.91	18.64	5.67	18.97
	Beta	10.52	11.40	8.75	10.41
case 2	Delta	17.5	16.34	16.61	14.61
	Theta	9.36	10.93	9.89	10.75
	Alpha	6.98	9.64	6.92	7.95
	Beta	7.25	6.98	6.77	6.39
case 3	Delta	13.59	19.76	11.17	16.1
	Theta	16.29	27.22	15.26	21.54
	Alpha	14.84	22.08	14.18	19.91
	Beta	11.74	11.80	11.78	8.61
case 4	Delta	10.51	11.72	10.73	11.75
	Theta	8.90	12.04	9.48	12.70
	Alpha	6.70	13.41	7.62	12.93
	Beta	5.69	6.37	5.83	6.57
case 5	Delta	11.34	14.68	10.39	14.46
	Theta	9.68	15.35	10.39	15.39
	Alpha	7.91	13.82	8.10	14.31
	Beta	9.22	10.63	8.25	8.38

The comparison between playing video games and learning English in EEGs showed that participants tended to be more easily involved with playing games. The threshold and rejection percentage due to noise in data analysis were lower in playing video games than those learning English because it seemed unconsciously three male participants quickly concentrated on games. However, it seemed to be on a case-by-case basis whether the pupils would feel relaxed or excited when playing video games or learning English when checking the ratio of beta to alpha. One participant seemed to space out when learning English because the materials were difficult.

The prior and after comparison showed no significant difference, perhaps indicating it was not easy to cultivate a habit of learning English and have it become a serious leisure activity within four weeks. Further analyses showed that one participant had very high consistency between prior and after data (correlation coefficients between 0.971 and 0.994) and among the three conditions (for prior data between 0.992 and 0.997; for after data between 0.987 and 0.991). This seemed to indicate that this participant might have a stable personality, which might play the role of a disturbing factor in EEG research. Figure 2 was an example showing the relationship (0.997) between the EEG of prior data about learning English (prior_Eng) and EEG of prior data about playing a video game (prior_video) for this participant. Figure 3 was another example showing the relationship (0.971) between prior and after EEG data about learning English (prior_Eng, after_Eng) for this participant case.

4.3. Conclusions

Whether participants have already had regular habits in learning English or playing video games after school would influence the results of this research. Additionally, playing video games might more easily and quickly generate a state of flow experiences with high concentration than learning English. However, it seemed unclear that concentration in flow would cause relaxation or a feeling of stimulation [18]. As for learning English, it seemed also unclear if it caused stress or if students just spaced out. These various possible reasons would make it complex and difficult to interpret EEG data. A more strict research design is required to overcome these limitations.

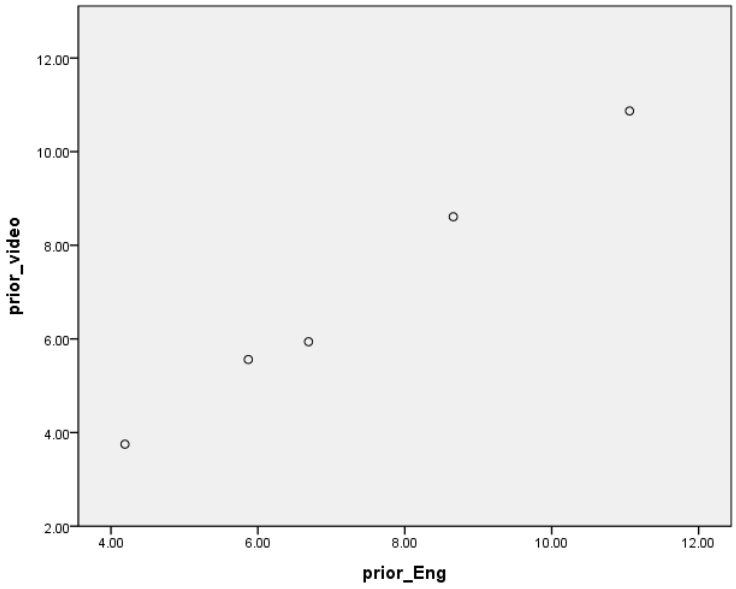

Figure 2. Correlation between prior EEG in learning English (prior_Eng) and playing a video game (prior_video) for one of the participants.

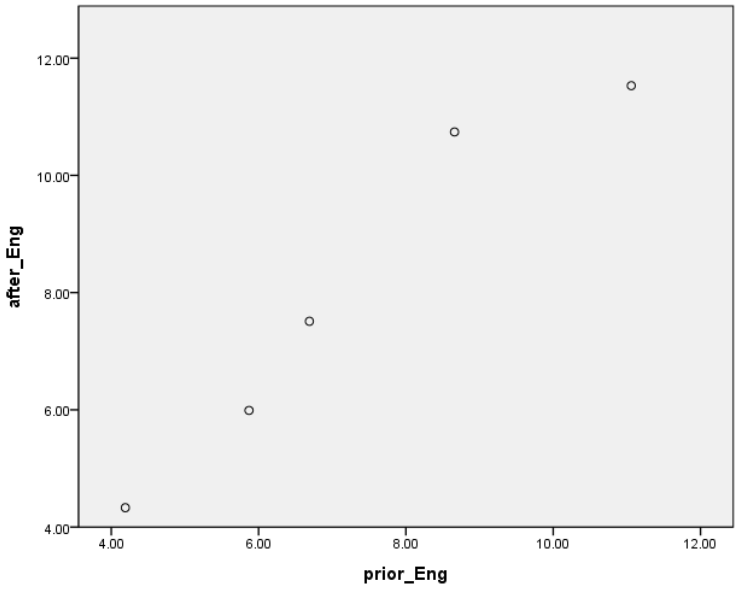

Figure 3. Correlation between prior and after EEG in learning English for one of the participants.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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References

1. Zeydi, A.E.; Ghazanfari, M.J.; Sanandaj, F.S.; Panahi, R.; Mortazavi, H.; Karimifar, K.; Karkhah, S.; Osuji, J. Coronavirus disease 2019 (COVID-19): A literature review from a nursing perspective. *BioMedicine* **2021**, *11*, 5. [CrossRef]
2. The News Lens. "Taiwan's Level 3 COVID-19 Alert Expanded Nationwide. Available online: https://international.thenewslens.com/article/151210 (accessed on 13 March 2023).
3. López-Sintas, J.; de Francisco, L.R.; Álvarez, E.G. The nature of leisure revisited: An interpretation of digital leisure. *J. Leis. Res.* **2015**, *47*, 79–101. [CrossRef]
4. López-Sintas, J.; Rojas-DeFrancisco, L.; García-Álvarez, E. Home-based digital leisure: Doing the same leisure activities, but digital. *Cogent Soc. Sci.* **2017**, *3*, 1309741. [CrossRef]
5. Stebbins, R.A. Leisure reflections—Addiction to leisure activities: Is it possible? *LSA Newsl.* **2010**, *86*, 19–22.
6. Stebbins, R.A. Leisure reflections—Flow in serious leisure: Nature and prevalence. *LSA Newsl.* **2010**, *87*, 21–23.
7. Song, W.I.; Ahn, B.W. Effect of outdoor leisure activity participation on leisure attitude, serious leisure, recreational specialization, and leisure satisfaction. *Societies* **2023**, *13*, 155. [CrossRef]
8. Kono, S.; Ito, E.; Gui, J. Empirical investigation of the relationship between serious leisure and meaning in life among Japanese and Euro-Canadians. *Leis. Stud.* **2020**, *39*, 131–145. [CrossRef]
9. Gau, L.S.; Chen, M.I.; Chu, H.Y.; Chu, H.T.; Liu, M.S. EEG and ECG in reducing smartphone overuse by multiple leisure activities. In Proceedings of the 2020 IEEE 2nd Eurasia Conference on Biomedical Engineering, Healthcare and Sustainability (ECBIOS), Tainan, Taiwan, 29–31 May 2020. [CrossRef]
10. UNDP. Goal 3: Good Health and Well-Being, Sustainable Development Goals. Available online: https://www.undp.org/sustainable-development-goals (accessed on 13 March 2023).
11. Heley, J.; Jones, L. Growing older and social sustainability: Considering the 'serious leisure' practices of the over 60s in rural communities. *Soc. Cult. Geogr.* **2013**, *14*, 276–299. [CrossRef]
12. Lee, S.; Heo, J.; Chun, S.; Lee, J.H. Voluntary dance performance as serious leisure and successful ageing. *Leis. Stud.* **2020**, *39*, 1–15. [CrossRef]
13. Pine II, B.J.; Gilmore, J.H. *The Experience Economy*; Harvard Business School Press: Boston, MA, USA, 2011.
14. Kubota, R. Learning a foreign language as leisure and consumption: Enjoyment, desire, and the business of eikaiwa. *Int. J. Biling. Educ. Biling.* **2011**, *14*, 473–488. [CrossRef]
15. Ceccarelli, L.A.; Giuliano, R.J. Elevations in EEG power spectra during the recall of sport failure amongst University athletes. *Psyarxiv* **2020**. [CrossRef]
16. Jebelli, H.; Hwang, S.; Lee, S.H. An EEG signal processing framework to obtain high quality brain waves from an off-the-shelf wearable EEG device. *J. Comput. Civ. Eng.* **2018**, *32*, 4017070. [CrossRef]
17. Nayak, S.; Anilkumar, A.C. EEG Normal Waveforms. Available online: https://europepmc.org/article/nbk/nbk539805#free-full-text (accessed on 13 March 2023).
18. Lim, S.; Yeo, M.; Yoon, G. Comparison between Concentration and Immersion Based on EEG Analysis. *Sensors* **2021**, *19*, 1669. [CrossRef] [PubMed]
19. Frohlich, J.; Toker, D.; Monti, M.M. Consciousness among delta waves: A paradox? *Brain* **2021**, *144*, 2257–2277. [CrossRef] [PubMed]
20. Agarwal, S.; Dutta, T. Neuromarketing and consumer neuroscience: Current understanding and the way forward. *Decision* **2015**, *42*, 457–462. [CrossRef]
21. Thought Technology Limited. *EEG Suite: Reference Manual, for Use with BioGraph Version 6.1 or Later*; Thought Technology Ltd.: Montreal West, QC, Canada, 2019.