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Comparison of Note-Taking Efficiencies when using Standard- and Paperlike-Films Installed on Tablet-PC with Stylus Pen

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ABSTRACT

This study investigates eight IT and English-fluent undergraduate students' writing performance in two tasks; 1) tracing, and 2) note-taking speed, when using Standard-Protective-Film (SPF) and Paperlike-Film (PLF). The results demonstrate no significant differences in tracing or note-taking speeds, however, user preferences were dispersed, suggesting that variety is required for personal use.

1 Introduction

In the era of COVID-19, the importance of digital devices such as Tablet-PCs (touchscreen) and digital pens (stylus) has been greatly increased to permit the exchange of information in real time; most college or university students use these devices in day-to-day learning but usability must be improved. Digital devices such as Tablet-PCs can enhance the student's level of understanding, as they allow educational materials to be accessed at any time. The question is whether users take full advantage of these devices.

Tablet-PCs, such as those from Apple, Samsung, Huawei, and Lenovo, are used worldwide 2021–2022 [1]. Also, Apple has gained a good reputation [1]. These devices are user friendly, easy to carry, and can be easily used for online learning regardless of location. These Tablet-PCs support both stylus and finger inputs, which facilitates users taking hand-written notes to aid learning. The next three paragraphs discuss the effects of notes taken by hand, a comparison of traditional note-taking and notes taking on Tablet-PCs and/or note-PCs, and the scope of this study.

Obviously, notes taken by hand significantly enhance learners' creative thinking abilities and learning. Recent research shows that taking notes during lectures is critical but difficult task for students [2]. Jansen et al. (2017) revealed that taking notes during lectures is beneficial [3]. Kiewra (1985) reviewed the note-taking literature and claimed the benefit of traditional note-taking [4]. Additionally, these studies indicated that note taking benefited learners in two ways; (i) improving active listening during the lecture, and (ii) the information could be re-used later when needed. Further, our previous study introduced a novel self-learning method of acquisition information using a two-stage-note-taking technique; it consists of three-stage processes [5]. It also employed the conventional "note-taking-tool" of a traditional pen and paper; it significantly benefited young students and enhanced their creative thinking abilities.

A study comparing the longhand to laptop (typed notes) revealed that hand-written note-takers take visually understandable notes, yielding greater enhancements in learning although those who typed notes on a laptop took more notes [6]. Another study suggested that students who took hand-written notes during lectures performed better than those who typed on a laptop computer [7]. A previous study found that notes taken using a Tablet-PC and stylus were not clean and might have errors compared with typing or traditional pen and paper [8]. However, modern Tablet-PCs are one of the most convenient tools as their high input sampling rate (60 Hz to 120 Hz depending on the device), giving users a natural writing experience.

This study investigates eight IT and English-fluent undergraduate college students' writing performance in two tasks; (1) tracing speed, in which they were asked to trace two independently generated pangrams and (2) note-taking, in which they were asked to take notes as they do in their day-to-day life, on a standard protective film (SPF) as well as a paper-like film (PLF). These experiments examined whether there were any significant differences in tracing, and note-taking speeds in both interfaces, SPF and PLF. This study also investigates users' preferences by administering a post experiment questionnaire.

2 Experiment

2.1 Observers

Eight participants (7 males, 1 female; aged 18–22 years; mean 18.88 years), students at the National Institute of Technology, Kagoshima College (NITKC), voluntarily took part in this study. All reported that they were right-handed and had normal or corrected to normal vision and were fluent users of the Apple iPad and Apple pencil. Also, most of them have been learning English as a second language for more than 10 years (M=10.64, SD=3.02). Additionally, their writing scores, in Benesse's GTEC [9], were in the top group of the NITKC students (M=233.62, SD=18.63) in 270. The reason why IT and English-fluent students were recruited was because English stimuli were used in the experiments. Also, experience with the Apple iPad with Pencil simplified the overall experiment. All the participants accepted the study protocol with written consent.

2.2 Apparatus and stimuli

In this study, two Tablet-PCs (iPad 10.2" 9th generation, with iPadOS 15), Apple Pencil 1st generation and a Toshiba Regza TV (IPS LED-panel 3840 × 2160 pixels) were employed. Both Tablet-PCs had the following specifications: 250.6 × 174.1 × 7.5 mm and weighed 487 g. Additionally, they had LED multi-touch IPS retina displays (refresh rate at 60 Hz) that had a 2160 × 1620 pixel resolution of 264 ppi. Two compatible LCD protective films were attached to the touchscreens of both devices. One was a standard protective film (SPF) with 3-H hardness, and the other was a paper-like film (PLF) which was specially designed for writing. Both films were selected after a thorough review of the protective films on the market. The stylus; Apple Pencil (with an ability to produce various artistic work, just like a conventional pen and paper, with pixel-perfect precision) is 175.7 mm long, 8.9 mm diameter and weighed 20.7 g.

The stimuli for task one were created using PowerPoint and executed using Apple's Notes App, which is placed in the Productivity category in the Apple App Store. Additionally, two TED Talks for free-hand note taking were displayed on the Toshiba Regza TV (IPS LED-panel 3840 × 2160 pixels). Figure 1 shows a schematic illustration of the experimental setup for this study.

2.3 Procedure for the Task 1: Tracing pangrams

The participants completed two tasks in two sessions including practice. Each lasted approximately 3 min. Observers were divided into two groups; odd and even. All with odd IDs used the SPF first, and then the PLF. All with even IDs accomplished these tasks in reverse order. Before the task, they were familiarized with the current setup by a practice task (tracing lines on the iPad with Stylus).

In these tasks, they were asked to trace two pangrams. (1) "The quick brown fox jumps over the lazy dog" which was written on a white background using light gray Comic sans MS font. (2) "A quick movement of the enemy will jeopardize six gunboats" which was written in light gray with a white background using Mono-type Corsiva font (see Fig. 2).

2.4 Procedures for Task 2: Number of Characters written

All the apparatus used in this task were the same as those in Task 1 except for the following amendments, two independent Ted talks in the education category were selected and presented on the Toshiba Regza TV in two sessions [10], [11]. Each session lasted approximately 8 min. The order of the videos was randomized based on the subjects' IDs. The contents were in English language. To ensure all the participants understood them, the videos were played at a speed of 0.75x and Japanese subtitles were turned on. All the participants were asked to use the Apple pencil with the iPad as they do in their day-to-day activities.Also, they were allowed to take notes in either Japanese or English.

Physical data were recorded using (1) the iPad's screen recording functionality, and (2) a digital video camera, for quantitative analysis. After completing both tasks, participants were asked to fill in a questionnaire for subjective data.

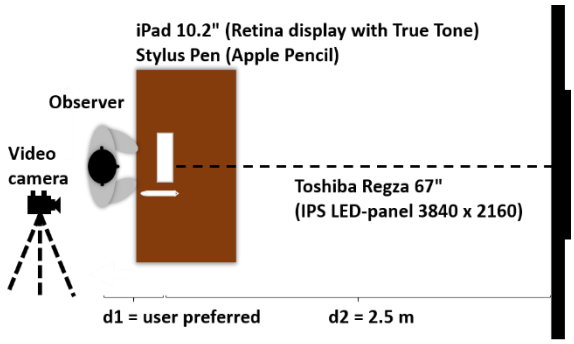
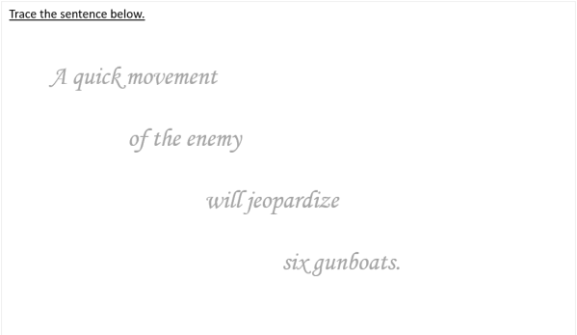


Fig. 1 Schematic illustration of the experimental environment. Two distances were employed, (d1) observer to touchscreen which was user preferred, (2) observer to display which was fixed at 2.5m.

(a) Visual stimuli for tracing activity, Comic Sans MS



(b) Visual stimuli for tracing activity, Monotype-Corsiva

Fig. 2 Schematic illustration of the visual stimuli for Test 1, tracking pangrams.

3 Results and discussions

3.1 Task 1: Tracing pangrams

A paired samples t-test was performed to compare tracing speed on SPF and PLF. Wait time before each phrase were excluded from analysis. These results suggest that there were no significant differences of tracing in SPF (M=86.15, SD=13.91) and PLF (M=81.38, SD=12.98); t(7)=1.09, p=.30. The results indicate that users' tracing speed was not affected by the different interfaces (see Fig. 3). However, if the to-be-traced font is of a difficult font family such as Monotype Corsiva, the process of tracing may become slower.

3.2 Task 2: Number of Characters written

Note-taking speed was computed by averaging the total number of Kanji characters written (see Fig. 4). Two participants took notes in English. The total number for two participants were converted to Kanji characters by multiplying the total number of English words x 0.52 [12]. A paired samples t-test was performed to compare notes produced on SPF and PLF. There were no significant differences in the number of notes produced in SPF (M=152.78, SD=59.50) and PLF (M=143, SD=44.52); t(7)=1.06, p=.32.

These results indicate that notes taken while watching short videos were not affected by the interface used (see Fig. 4). Two example notes of two independent participants are shown in Figure 5.

4 User preferences and general discussion

A post-experiment questionnaire was administered to examine users' preferences regarding SPF and PLF. Preference differences were also calculated by subtracting SPF from PLF. A one sample t-test was performed to compare preference difference for SPF and PLF. The mean for PLF (M=1.00, SD=1.06) was significantly different than the population mean; t(7)=2.64, p<.05. The results suggest that 1) observers tended, on average, to prefer PLF over SPF, however, 2) preferences were widely dispersed (i.e., scores were scattered from 5, indicating completely satisfying, to 2, poor, even in the case of PLF) (see Table 1).

In this study, two tests were conducted to examine the tracing, and note-taking speeds when using SPF and PLF. In the first test, the results indicate that users' tracing speed was not affected when using either interface. However, difficult fonts such as Monotype Corsiva, hinder the tracing process, suggesting that further study will be needed for precise analysis of complexity. Additionally, in the freehand note-taking task, the results suggest that the SPF and PLF interfaces yielded significant differences in subjective performance.

5 Conclusion

This study investigated the tracing and writing performance of eight IT and English-fluent undergraduate students. We employed two tasks; (1) tracing speed, in which subjects were asked to trace two independently generated pangrams and (2) note-taking, in which they were asked to take notes as they do in their day-to-day activities, on an SPF as well as PLF. The results suggest that 1) observers tended to prefer PLF over SPF on average, however, 2) preferences were widely dispersed (i.e., scores were scattered from 5, indicating completely satisfied, to 2, poor, even in the case of PLF).

In summary, our experiments suggest that more variation of surface type on attached film need to be developed for users to improve their subjective performance, even though physical performance is equivalent. Further experiments are needed to examine individual preferences for such interfaces.

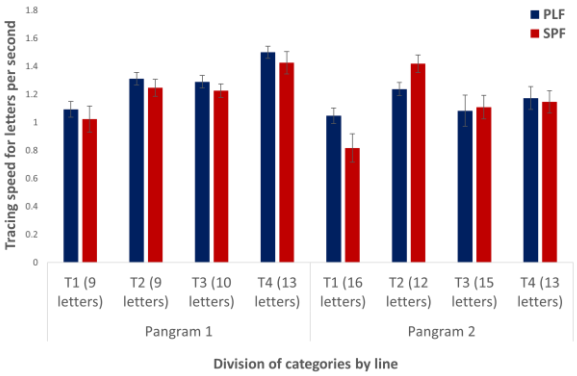


Fig. 3 Results of tracing pangrams on two interfaces PLF and SPF. Error bars indicate standard error.

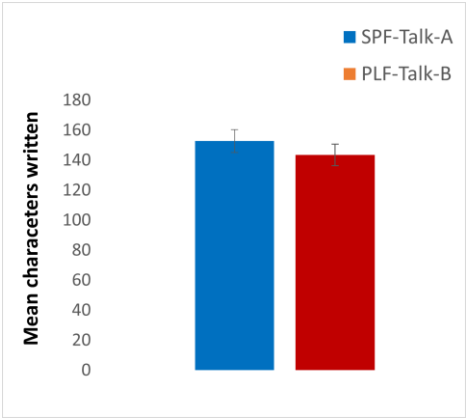


Fig. 4 Results of note taking when SPF and PLF were used. Error bars indicate standard error.

Table 1 Users' preferences and number of notes recorded in SPF and PLF.

	SPF		PLF		
Subject-ID	Talk-A	Preference	Talk-B	Preference	Difference
1	108	3	111	3	0
2	155	3	115	4	1
3	240	3	189	4	1
4	190	3	188	3	0
5	83	2	94	5	3
6	125.4	3	140.8	5	2
7	223.85	4	206.25	5	1
8	97	2	104	2	0

Note. SPF=Standard Protective Film, PLF=Paperlike Film. The values in column difference are preference in PLF - preference in SPF.

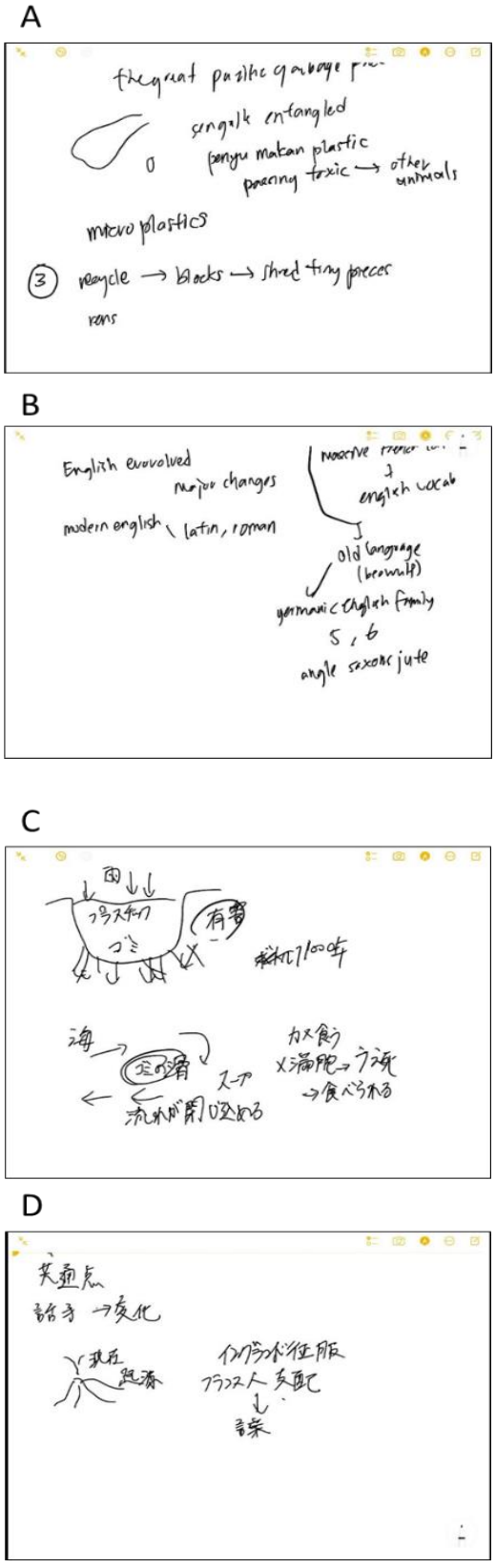


Fig. 5 Screen shots of two independent participants taking notes in English (A and B) and in Japanese (C and D).

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