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研究課題名（和文）Effects of SLTR method using handheld electronic reading devices

研究課題名（英文）Effects of SLTR method using handheld electronic reading devices

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研究成果の概要（和文）：本研究は研究代表者のもと実施され、中学校２年次に在籍する第二言語としての英語を学習する日本人学習者は通常使用するテキストではなく、SLTR方法を用いた場合に読書スピードが格段に速まることが明らかになった。
全体サンプルでの効果量は僅かであったが、発達性難聴障害に関連する音処理問題はSLTRでの治療が効果的であることを示しており、読み取りに関して障害のない被験者と比較すると有効であることが示された。
また、本研究では読解力におけるSLTRの効果も検証した。読書後に各参加者の理解力スコアを回収し、差異を分析した。どちらの書式においても片方に対して著しく高い理解力スコアはでなかった。

研究成果の概要（英文）：The research undertaken by the principal investigator has revealed that Japanese English language learners studying in the second grade of junior high school read with greater speed when using the SLTR method than they do when reading standard printed text. Although the effect size was small among the sample as a whole, those exhibiting the phonological processing problems associated with developmental dyslexia appear to benefit from the SLTR treatment to a greater extent than those who are developmentally normal in terms of reading performance. The study also examined the effect of the SLTR method on reading comprehension. Post-reading comprehension scores were collected from each participant under both treatment conditions (SLTR and standard printed text) and analysed for differences. Neither mode of text presentation resulted in significantly better comprehension scores.

研究分野：　foreign language education

キーワード：　SLTR　dyslexia　electronic readers　L2 reading　oral reading fluency

１．研究開始当初の背景

The phonological processing problems associated with developmental dyslexia impair an individual's ability to divide words into their component sounds (Paulesu et al., 2001). Because of this, writing systems that require readers to analyze phonemes, present substantial challenges for those who struggle with this impairment. The granularity of the smallest orthographic unit is coarser in Japanese than it is in English (Wydell, 2012). This disparity results in cases of monolingual dyslexia, in which learners who are developmentally normal in terms of Japanese reading ability encounter severe difficulties acquiring English literacy (Wydell, 2012).

These difficulties are aggravated further by an imbalance in the orthographic transparency of Japanese and English. Transparent orthography is a feature of languages with a high level of consistency in the way that sounds are represented by the writing system. Opaque orthography, on the other hand, refers to writing systems that exhibit inconsistencies in the relationship between sounds and their graphic representations (Katz & Frost, 1992).

The Japanese writing system consists of three different character types: kanji, hiragana, and katakana. Kanji are logograms that represent whole words or morphemes. Processing logograms activates areas of the brain associated with recognizing visual patterns (Siok, Perfetti, Jin, & Tan, 2004). As such, impairments to the phonological (sound processing) area of the brain do not hinder the reading of kanji and other logographic scripts. Hiragana and katakana are syllabic systems of characters which, because they are completely regular in the way they represent sound, fall within the category of transparent orthographies. English, by contrast, is highly irregular and belongs to the group of languages with opaque orthographies. Variations in orthographic complexity strongly correlate with the prevalence of developmental dyslexia across languages (Lindgren, Renzi, & Richman, 1985). There are, for example, far fewer per capita cases of developmental dyslexia in Italy than there are in the United States (Lindgren et al., 1985), due in large part to the orthographic regularity of the Italian language (Helmuth, 2001).

As in the case of Italian, the nature of the Japanese writing system is such that impaired phonological processing does not severely impact the acquisition of native language literacy. The consequence of this is that the possibility of a neurobiological basis for a learner's struggles with English reading is not widely recognized among educators and other stakeholders.

The impact of monolingual dyslexia on English language learning in Japan is not yet known, and the goal of the research detailed here was to develop methods of identifying phonological processing problems among Japanese junior high school students and assess the efficacy of a mode of text presentation that has been shown to alleviate the reading struggles of native-English-speaking dyslexics.

２．研究の目的

The purpose of the research reported here was twofold: first, to develop Internet-based testing to identify phonological processing problems among Japanese learners of English; and second, to conduct a small-scale replication study of Schneps, Thompson, Chen, Sonnert, and Pomplum (2013) investigating the effects of e-readers on those with developmental dyslexia.

One of the hypotheses pursued by the present research states that, among Japanese English language learners with underdeveloped reading skills, a significant percentage suffers from undiagnosed phonological processing deficits. Confirming this hypothesis required the development and validation of diagnostic tests in order to establish a correlation between poor phonological awareness and difficulties with English reading. Furthermore, without the development of diagnostic tests, it would not be possible to investigate the study's other main

hypothesis that, among those with the symptoms of developmental dyslexia, reading speed and comprehension would be greater when reading from a digital display than when reading from a printed page.

Schneps et al. (2013) have reported significant improvements in the reading skills of certain subsets of those with dyslexia when reading on a handheld electronic device (iPod Touch). The small display size and manual scrolling capabilities of the device enabled the development of a new reading method known as Span Limited Tactile Reinforcement (SLTR). The present study set out to determine whether similar benefits to reading speed and comprehension could be observed in the general population of Japanese learners of English as well as those who exhibit specific reading deficiencies.

３．研究の方法

Prior to investigating the effect of the SLTR reading method on reading speed and comprehension, the principal investigator collaborated with computer programmers to develop online tools for identifying those with chronic reading disorders. The collaboration resulted in the creation of two open source plugins (TQuiz and Read Aloud) for the Moodle virtual learning environment. Read Aloud, which enables administration of the Phoneme Decoding Efficiency (PDE) test, the Sight Word Efficiency (SWE) test, and the Oral Reading Fluency (ORF) test, has been downloaded 89 times and is in use on 144 servers worldwide. It also received the Best Moodle Innovation Award of 2015 from the Moodle Association of Japan.

The software developed during the course of the present research is capable of delivering seven different diagnostics of reading and phonological processing. A website (www.readassist.jp) was also established to make the tests available to participants of the study as well as teachers and schools. While most of the site is password protected, it is possible to browse certain areas as a guest user.

In preparation for the primary experiment, the principle investigator collected reading materials for the eight-session lifecycle of the study. Level appropriate materials were identified by analyzing the vocabulary range, grammatical complexity, and readability of candidate texts and comparing them to materials from the three major English language textbooks for second year junior high school students: New Horizon English course 2, Sunshine English course 2, and New Crown English series 2.

The final phase of the research plan involved the replication of a study conducted by Schneps et al. (2013) comparing the effectiveness of the SLTR reading method using a handheld electronic device (iPod Touch) and reading block text from printed worksheets. The experiment investigated the following research questions:

1. Does the SLTR reading method result in higher reading rates than block text for Struggling Readers*?
2. Does the SLTR reading method result in higher comprehension scores than block text for Struggling Readers*?
3. Does the SLTR reading method result in higher reading rates than block text for Standard Readers*?
4. Does the SLTR reading method result in higher comprehension scores than block text for Standard Readers*?

*For the purpose of the present study, “Struggling Readers” refers to participants whose scores in the Oral Reading Fluency test fell within the bottom 20% of the sample group. “Standard Readers” refers to the remaining 80% of the sample group.

The present study employed the same repeated measures research design as the original experiment, wherein all subjects were measured in all conditions. During each session, subjects read texts in forms A and B, as shown in Figure 1, in a design that controlled for order of presentation as well as for potential differences in the difficulty of the texts.

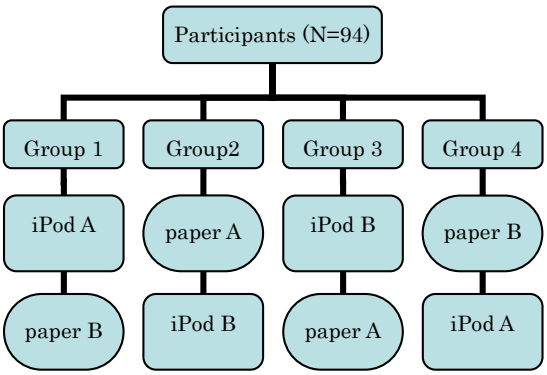

Figure 1. Research design. 94 second grade junior high school students studying English were assigned to one of four groups. Groups read two texts (one paper, one iPod) during each session of the eight-session study.

The participants in the present study consisted of 94 students enrolled in second grade English classes at Nichidai Junior High School in Nagasaki prefecture. All students were considered developmentally normal in terms of Japanese reading ability. Prior to the experiment, the English language reading and phonological processing ability of each participant was measured using the online tests developed by the principal investigator. Results of the test were not used in determining groups for the experiment. Instead, each of the participating classes was randomly divided into four groups. All participants were exposed to the same data collection procedures. For the analysis of the results, however, the population was divided into two groups: Struggling Reader and Standard Reader based on scores obtained from the phonological processing test.

In the paper condition, text was printed on A4 paper with 2.54 cm margins. The font was Times New Roman 14 pt. Single spacing was used throughout and margins were justified on the left side only. The text featured no special formatting such as bolding or italics. Reading material for the iPod condition was presented using a 16GB third generation Apple iPod Touch. The SLTR reading method was implemented via the GoodReader app (http://www.goodiware.com) which had been preloaded onto each device. As in the original study by Schneps et al. (2013), 42 pt Times New Roman font was used with left justification and a right-ragged margin. The background was set to black and text was displayed as grey.

Participants used a timer to record how long it took them to read each text. Following the reading, they were instructed to answer a series of comprehension questions related to the text. During this time, they were not permitted to refer back to the reading. At the insistence of the supervising teacher, participants were allowed a maximum of 10 minutes to complete a reading and the accompanying comprehension questions.

4．研究成果

Reading rates and comprehension scores from both methods of text presentation (SLTR and block text) were compared to see which produced the highest values. Reading speed was measured in words per second (WPS) and comprehension was measured as a raw score.

Results for each of the two groups (Struggling Reader and Standard Reader) indicate a significant difference in the mean reading rates, with the SLTR condition producing higher values than block text. Table 1 presents the results of the correlated samples t-test for the reading rate of Struggling Readers while Table 2 shows the same figures for the Standard Readers.

Table 1. Results of t-test and descriptive statistics for reading rate by method of presentation for Struggling Reader group

SLTR		Block text			Mean Diff		
M	SD	M	SD	n		t	df
1.41	0.33	1.25	0.23	11	0.16	2.70*	10

*results reveal a significant difference between the two methods. p=.01

Table 2. Results of t-test and descriptive statistics for reading rate by method of presentation for Standard Reader group

SLTR		Block text			Mean Diff		
M	SD	M	SD	n		t	df
1.48	0.34	1.41	0.29	54	0.07	4.15*	53

*results reveal a significant difference between the two methods. p<.001

While both the Struggling Reader group and the Standard Reader group produced significantly higher reading rates when using the SLTR method, it is important to consider the magnitude of the observed effects. In the case of the Struggling Readers, Cohen's effect size value (d=.52) suggests a moderate practical significance. The effect size value for the Standard Reader group, however, suggests a small practical significance (d=.21).

Concerning reading comprehension, results for each of the two groups (Struggling Reader and Standard Reader) indicate no significant difference between the two methods of text presentation (SLTR and block text). Analysis of the Struggling Reader group produced a significance value of p=.04 while the Standard Reader group produced a value of p=.05.

The present study hypothesized that a significant percentage of Japanese English language learners with underdeveloped English reading skills would manifest phonological processing problems consistent with those who suffer from developmental dyslexia. Comparisons of Oral Reading Fluency scores with results obtained from phonological processing testing confirms that roughly 90% of those identified as Struggling Readers reveal moderate to severe phonological processing deficits.

It was also hypothesized that the Struggling Reader group would read with greater speed and comprehension when using the SLTR reading method. The experiment revealed that while this group did read faster in the SLTR condition, there was no significant impact on reading comprehension. The magnitude of the effect of SLTR on the reading speed of the Struggling Reader group (d=.52) suggests a moderate practical significance. It is important to bear in mind, however, that these results were obtained from a small sample (n=11) and further research with a larger subject pool is required to truly understand the substantive impact of the SLTR reading method on those exhibiting phonological processing problems.

The effect of SLTR on the Standard Reader group, while still significant, showed an effect size of small practical significance (d=.21). Standard Readers read just over four words more per minute with SLTR, less than half the impact observed among Struggling Readers. As with the Struggling Reader group, no significant enhancement to reading comprehension was observed as a result of applying the SLTR method.

The present study has explored the prevalence of phonological processing problems among Japanese learners of English and investigated the effectiveness of a reading method that has proven beneficial for struggling readers in an L1 reading context. The results reported here, though promising, require confirmation from subsequent studies involving larger numbers of participants in order to establish whether SLTR represents a worthwhile form of accommodation for Japanese learners with underdeveloped English reading skills.

References

Helmuth, L. (2001). Dyslexia: Same brains, different languages. Science, 291, 2064-2065.

Katz, L. & Frost, R. (1992). The reading process is different for different orthographies: The orthographic depth hypothesis. In R. Frost & L. Katz (Eds.), Orthography, Phonology, Morphology, and Meaning (pp. 67-84). Amsterdam: Elsevier North Holland Press.

Lindgren, S. D., de Renzi, E., & Richman, L. C. (1985). Cross-national comparisons of developmental dyslexia in Italy and the United States. Child Development, 56(6), 1404-1417.

New Crown English series 2. (2014). Tokyo: Sanseido.

New Horizon English course 2. (2012). Tokyo: Shoseki.
Paulesu, E., Démonet, J.-F., Fazio, F., McCrory, E., Chanoine, V., Brunswick, N., Cappa, S. F., Cossu, G., Habib, M., Frith, C. D., & Frith, U. (2001). Dyslexia: Cultural diversity and biological unity. Science, 291(5511), 2165-2167.
Schneps, M. H., Thomson, J. M., Chen, C., Sonnert, G. & Pomplun, M. (2013). E-readers are more effective than paper for some with dyslexia. PLoS ONE, 8 (9): e75634. doi:10.1371/journal.pone.0075634
Siok, W. T., Perfetti, C. A., Zhen, J., & Tan, L. H. (2004). Biological abnormality of impaired reading is constrained by culture. Nature, 431, 71-76.
Sunshine English course 2. (2014). Tokyo: Kairyudo.
Wydell, T. N. (2012). Cross-cultural/linguistic differences in the prevalence of developmental dyslexia and the hypothesis of granularity and transparency. In T. Wydell & L. Fern-Pollak (Eds.), Dyslexia – A comprehensive and international approach. (pp. 1-15). Rijeka: InTech. Retrieved from http://www.intechopen.com/books/dyslexia-a-comprehensive-and-international-approach/cross-cultural-linguistic-differences-in-the-prevalence-of-developmental-dyslexia-and-the-hypothesis

５．主な発表論文等
（研究代表者、研究分担者及び連携研究者には下線）

〔雑誌論文〕（計　2　件）

①Elton LaClare, Does dyslexia occur among Japanese English language learners?, The Language Teacher, peer reviewed, Volume 41.4, 2017, 19-23

②Elton LaClare, Assessing the effect of Span Limited Tactile Reinforcement on the reading rate of second language learners, Bulletin of Sojo University, peer reviewed, Volume 42, 2017, 107-111 URL: https://sojo-u.repo.nii.ac.jp/index.php?active_action=repository_view_main_item_detail&page_id=13&block_id=21&item_id=1247&item_no=1

〔学会発表〕（計　8　件）

①Elton LaClare, Can Moodle measure reading speed?, Moodle Association of Japan MOOT, 2017/02/19, Jichi Medical University (Shimono-shi, Tochigi)
②Elton LaClare, Second language dyslexia: Is it real?, JALT International Conference, 2016/11/28, WINC Aichi (Nagoya-shi, Aichi)
③Elton LaClare, Measuring the effects of mobile apps on reading speed, KOTESOL International Conference, 2016/10/15, Sookmyung Women's University (Yongsan-gu, Seoul)
④Elton LaClare, Assessing the effects of mobile apps on reading speed and comprehension, CALL and the Brain, 2016/06/04, Tamagawa University (Machida-shi, Tokyo)
⑤Elton LaClare, Developing and applying Moodle tools to identify reading disorders, Moodle Association of Japan MOOT, 2016/02/22, Toyo University (Bunkyo-ku, Tokyo)
⑥Elton LaClare, Materials design for struggling learners, Sojo University Teaching and Learning Forum, 2016/01/30, Sojo University (Kumamoto-shi)
⑦ Elton LaClare, Using Moodle to diagnose dyslexia in Japanese English language learners, Hokkaido Summer Moodle Workshop, 2015/07/18, Muroran Institute of Technology (Muroran-shi, Hokkaido)
⑧Elton LaClare, CALL approaches to identifying Japanese dyslexics, 2015/06/06, Kyushu Sangyo University (Fukuoka-shi)

〔その他〕
ホームページ等
www.readassist.jp

賞
Best Moodle Innovation Award of 2015, Moodle Association of Japan

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