Eye Tracking and ESL Reading Strategies

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This study examined ESL reading strategies through tracking the movements of subjects’ eyes as they read sample texts. The strategy primarily addressed was a right-to-left strategy reportedly used by Japanese students to render English sentences into Japanese word order, thereby making them easier to understand. The results showed that high proficiency learners do not use this strategy when reading lower level texts, but that some lower proficiency students do use this strategy. The results also showed a tendency for low proficiency students to follow the texts with their eyes with little or no attention to meaning.

A number of sources have claimed that Japanese students read English as if they were translating it into Japanese. One such source is Masahiro Moto’s book, Speed Reading in English. Moto claims that almost all Japanese students are taught to read English by rendering it into a word order that resembles Japanese. In other words, they read English by constructing meaning from right to left reforming it into Japanese word order, instead of reading directly from left to right. If they are familiar with the vocabulary, they are still able to comprehend the text, but are hindered from developing the speed necessary for various tasks that depend on reading quickly and fluently such as college entrance examinations (Moto 2012). Moto says that there is a tradition of dealing with foreign language texts this way in Japan and cites a similar method of reading
Classical Chinese still taught and used today.

His claim is supported by Hayashi (Hayashi et al. 2002) who examined the relationship of “return reading” and comprehension in Japanese ESL students. Their hypothesis was that the amount of this return reading, which Rayner (Rayner 1998) calls regression, can indicate reading fluency and has a direct correlation to comprehension. They believe that specialized software could train Japanese students to read English in a native speaker-like manner thereby improving speed and comprehension.

Their study involved the use of eye tracking, and they state that as of the date of their study, there were few studies involving Japanese students that examined this reading strategy with eye tracking devices. A search of the literature shows that this is indeed still true. However, that may be about to change. Duchowski (Duchowski 2002) says that we are now in the fourth era of eye movement research. The first era, 1879–1920 consisted of initial observations of the correlation between eye movements and reading. The second era included more detailed confirmations but was limited by the technology of the time. The third era, beginning in the mid-1970s saw a leap in the field aided by the advance of solid state and digital technology which allowed for highly detailed examination, recording, and analysis of eye movement data. He says the fourth era, in which we are presently, will be characterized by applications of eye tracking. He stresses the importance of eye tracking because by tracking “someone’s eye movements, we can follow along the path of attention deployed by the observer.” (Duchowski 2007) In terms of reading, we can observe what kinds of reading strategies the reader uses in decoding and understanding a text and where the reader focuses their attention.

In the past few years, efforts by researchers primarily in Europe have brought the ability to use eye tracking to anyone with a fairly robust computer and an infrared capable web camera through free open-source software. In terms
of data acquisition, the eye tracking software, GazeTracker from the GazeGroup at ITUniversity of Copenhagen has made the actual recording of eye movements accurate and easy. GazeTracker has been recently interfaced with OGAMA (OpenGazeAndMouseAnalyzer) from Adrian Vobkuherat Freie Universitat Berlin. OGAMA provides tools for data recording, experiment interface design, gaze analysis, attention mapping, and statistical analysis. This combination is more than enough to determine in a precise way the strategies and patterns Japanese students use when reading English. The resulting data could delineate successful reading programs from less successful programs and indicate areas of improvement for the future.

Duchowski lists a number of characteristics concerning eye tracking that have been discovered concerning reading over the initial three periods of eye tracking research. These include the average length of eye fixations being 200–250 msec, the mean viewing chunk or saccade size as being seven to nine letters, and that quality of print including size, font, and line spacing influence eye movements. For the present study, however, regression, the movement of the eye to previous parts of the line or sentence, and especially a “z” regression pattern moving over large portions of the sentence would suffice as an indicator of the reading strategy described by Moto and Hayashi. The purpose of Hayashi’s study was to correlate the native-like reading pattern to greater comprehension, and they seemed to have demonstrated that. Some of the questions that remain, however, are whether the transfer to a native-like reading pattern is a natural progression that comes with proficiency, is the continued reliance on the right-to-left reading pattern necessarily an obstruction to reading success and enjoyment, and finally can eye-tracking patterns be used as a diagnostic tool to access problem ESL readers.
Hypothesis

From Hayashi’s study we would assume to find evidence of a regressive pattern where the reader’s eyes track to the end of a sentence and progress left towards the beginning of the sentence before moving on to the next sentence. It is assumed that this pattern would be prevalent in lower proficiency and problem readers regardless of the difficulty of the reading material. We would also assume that some high proficiency readers have naturally transitioned to a more native-like reading strategy, yet may revert to the regressive strategy with an increase in difficulty of reading material.

Methods

Subjects for the study were university students divided into two groups depending on English proficiency. Those who were considered to have the lowest English proficiency were members of a first year, university required, general English course whose major subject was something other than English. Subjects for the second group were second-year English majors and were members of an intensive English content-based course. These students were placed in the second highest of six proficiency levels according to their performance in the previous year and their TOEFL scores. Those who participated were among the most proficient of that class.

After eye-tracking calibration, each student was asked to read two short stories shown on a laptop computer screen within the OGAMA software. Students were informed that succeeding parts of the stories would appear on the screen when they clicked the mouse, and that they would be required to read two stories. They were told that they would be asked to tell what they remembered about the stories after they finished reading. The first story was listed as being first to second grade elementary school level on Amazon.com, and the second was listed as fifth to sixth grade elementary school level. After
reading both stories, students were asked to verbally summarize the pieces in whichever language they felt more comfortable, either their native language or English. These verbal summaries were recorded and the number of information points for each summary was tabulated as an indicator of reading comprehension. The eye-tracking data was recorded and assessed for presence of the z regression reading time. OGAMA records timestamps, and x and y screen coordinates in a database for each subject. Each subject’s session can be played back at various speeds on screen and the entire session can be displayed at once. Short regressions appearing singularly and involving two words or less were considered either regressions involving discrete word-level semantic processing or possible tracking errors caused by head movement or less than optimal eye-tracking calibration. Those that spanned larger parts of the sentence were considered z-regressions.

Results

Data from the eye-tracking experiment could be broadly divided into two patterns. One was a parallel line-like pattern from left to right following the words of each line (Figure 1), and the other with a number of z-regressions (Figure 2). The example in Figure 2 shows the student beginning with a left-to-
right but changing to a right-to-left strategy in the fourth and fifth line of the
text.

Line-like patterns were observed from both the high English proficiency
group and the low proficiency group. The z-regressions were observed only in
the low proficiency group. The difference between students who exhibited the
line-like pattern in the two proficiency groups was the level of their
comprehension. The total number of information points for the first grade level
story was 10 and the total for the fifth grade level story was 5. An information
point was considered to be a fact or essential aspect of the story. The average
number of information points given for the first grade level story in the low
proficiency group who exhibited the line-like pattern was 1, meaning that on
average students could remember only one aspect of the story. Some after
completing the reading task said they could not remember anything about the
story. Those from the high proficiency group on the other hand, related an
average of 6 information points. Students from the low proficiency group who
exhibited the z-regression pattern related an average of 4 information points for
the first, lower level story.

As for the second story, the high proficiency students who exhibited the line-
like pattern averaged 5 information points, the total number for the story. Those
who exhibited the z-regressions had an average of 1, and those lower proficiency
students who exhibited the line-pattern had an average of 0.4.

OGAMA records the time spent on each screen, and by adding the times for
each student we can see another pattern arising. The average time spent reading
story 1 for the high proficiency line-like readers was 29.5 seconds. The average
time for the z-regression pattern readers was 60 seconds, and the average time
for the low proficiency line-like pattern readers was 47.25 seconds. The average
reading time for the high proficiency readers on story 2 was 31.5 seconds. The
average time for the z-regression readers was 46 seconds and the time for the
low proficiency line-like readers was 38.25 seconds.

Discussion

The hypothesis was proven to be true in certain cases of low proficiency students. The z-regressions seemed to be used as a method of understanding the text as shown in the high number of information points or recall of the events of the story by the users of this reading strategy. This, of course, lowered their reading speed. The assumption that high proficiency ESL readers would use a left to right line-like strategy was also verified. No z-regressions were observed among these students, but if students were required to read higher level texts, z-regressions may appear.

What was not accounted for in the hypothesis was the appearance of the line-like pattern among low proficiency students. It appears that these students were mainly decoding letters of the text word by word but not actually rendering the words into meaning. This strategy will be clearly familiar to anyone who has taught reading or observed students reading aloud. Students with low proficiency will use all of their cognitive processing power to decode the text, and because of their unfamiliarity with the vocabulary, phrasing, and sentence structure, will not be able to spare attention to the meaning of what they have verbalized. This appears to be what happened with this group of students. They followed the text with their eyes, but did not actually interpret the meaning of the text. Time spent on reading also points to this. The reading times of all low proficiency readers were lower than the z-regression pattern students on both texts.

Another unexpected result was the relative low incidence of z-regressions. The assertions of both Moto and Hayashi would lead one to believe that Japanese ESL students all use a right-to-left strategy when reading English. The results of this study show evidence of that strategy, but do not show, at least for the reading difficulty levels used in this study, that it is the dominant strategy.
Possible causes for this are sentence length and level of vocabulary. If sentence length is short, for example 3 to 5 words, and the grammatical complexity of the sentence is also low, the necessity to actively reformulate the sentence into Japanese word order may not be necessary. Personal communication with some of the students after the experiment revealed that this was the case, and that putting paragraphs of these short sentences on one screen encouraged them to keep moving without stopping to understand what they were reading. They advised longer, single sentences on each screen. They also advised having the verbal response directly after the reading the sentences so that the information was fresh in their memories.

Conclusion

We can see from this study that Japanese students use various strategies, some productive and others not so productive when reading English. It became clear that situation, English proficiency and perceived expectation influence what reading strategies students will use. Experimental design, therefore, becomes extremely important in obtaining accurate results. However, even though the design of this study was not optimal in relation to the hypothesis, it did provide insight into ESL reading strategies and direction for further studies.

References
