Reading comprehension based on visualization of eye tracking and EEG data

Shiwei CHENG*, Yilin HU, Jing FAN & Qianjing WEI

Introduction

Using eye tracking technology can help us understand reading behavior. Furthermore, sharing the teacher's eye tracking features resulted in improving the students' comprehension of the same reading material. On the other hand, a user's intention can be analyzed by physiological data, such as electroencephalogram (EEG). EEG is closely related to human cognition. Recently, researchers have tried to use EEG-based engagement measures to augment learning activities.

Purpose

This study proposed an approach to serve novice readers, *i.e.*, students, and recorded eye tracking and EEG data of the teacher and then converted the raw data into visualized measures. During the reading process, the students adjusted their reading patterns according to their teachers' visualization, and improved reading comprehension.

Method

Reading speed for a single area of interest(AOI)

Reading time for each AOI

Switching frequency between two AOIs

EEG related, measures

 $\frac{E - \alpha + \theta}{\alpha + \theta}$ Normalization

Reading engagement

$$E_{norm} = \frac{E - E_{min}}{E_{max} - E_{min}}$$

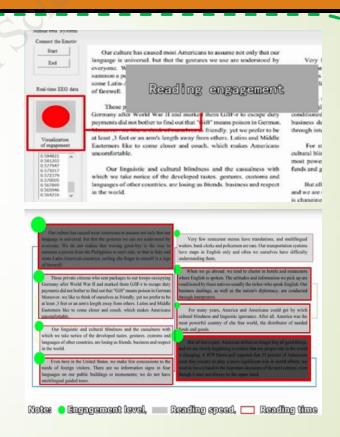
Eye tracking related measures

Method

Teacher module



Data acquisition



Data visualization

Method



The difference in reading time The difference in engagement

age is universal, but that the gestures we use are understoo yone. We do not realize that waving good-bye is the way to waiters, bank clerks and policemen are rare. Our transpo When we go abroad, we tend to cluster in hotels and resta where English is spoken. The attitudes and information we pick up are

Those private citizens who sent packages to our troops occupying many after World War II and marked them GJIF-r to escape duty ents did not bother to find out that "Gift" means poison in Gern over, we like to think of ourselves as friendly, yet we prefer to be least ,3 feet or an arm's length away from others. Latins and Middle

tural blindness and linguistic ignorance. After all, America was the

Gaze fixation

But all that is past. American dollars no longer buy all good thi we are slowly beginning to realize that our proper role in the wor anging. A 1979 Harris poll reported that 55 percent of Americ

Data acquisition

Data visualization

User Study



1 teacher



10 students in experimental group (can watch the visualizations)



10 students in control group (can NOT watch the visualizations)

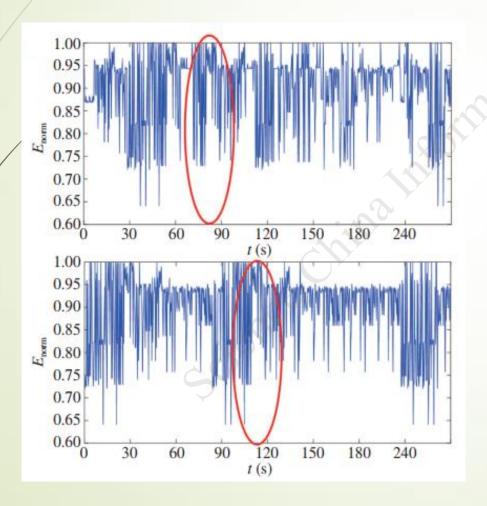
Participants

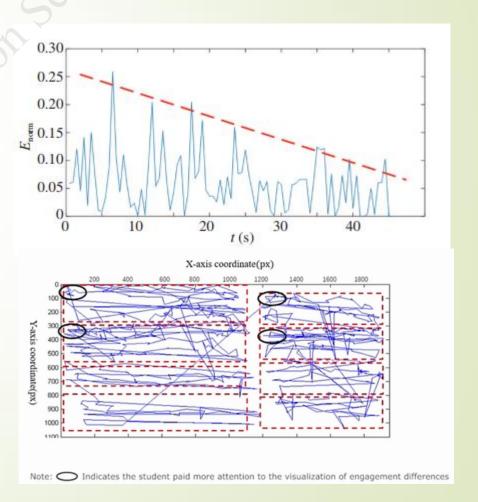
Pre-study: excluding student participants who read very fast or slowly

Formal-study: the teacher's eye tracking and EEG data were recorded and visualized for sharing with the students later. For student participants, all of them read the same paper that the teacher read with/without watching the visualizations.

Study design

Results





Results

Score for comprehension questions (total score is 5) M(SD)

Experimental group	3.3(0.8)
Control group	2.4(0.7)

Answer time for comprehension questions M(SD)

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Experimental group	409.6s(64.2s)
Control group	453.8s(69.3s)

Average engagement across all AOIs

Experimental group	0.84
Control group	0.70

Results

Subjective feedback: we used scale to ask participants to rate each type of visualization. They rated the yellow rectangle (the difference in reading time) to be the most helpful for reading comprehension, and rated the green circle (reading engagement level) and blue rectangle (the difference in engagement) as being "very helpful" for improving their concentration. We also found that students thought the reading time for each AOI and switching frequency between two AOIs were more useful.

Conclusions

We designed the visualizations of the eye tracking and EEG data to provide a guide for the students during their reading process. Our pilot study showed that the visualization provided a good guide for students to help them grasp the important content and to understand the logical structure of the paper, which improved their reading comprehension.