Eye Tracking Study of Reading and Sight Translation

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Abstract. This paper presents the results of a pilot eye tracking study involving reading and sight translation. Seventeen participants with one year of sight translation training were asked to read and sight translate two texts from B language (English) into A language (Russian). The texts included such independent variables as abbreviations, position titles, references to historic and cultural events and phenomena as well as direct speech, epithets, metaphors. The dependent variables included measures assumed to indicate cognitive load of lexical units, such as fixation count and saccade count. The application of the eye tracking method to the research of the translation process may be helpful in understanding the difficulties of sight translation as a particular form of transposing the message from one language into another and help to make appropriate pedagogical conclusions.

1 Introduction

Cognitive processes that underlie interpretation and translation have been the object of scientific study for many decades. Development of the eye tracking method provides better understanding of cognitive processes [1] in the mind of an interpreter / translator that are associated with translation.

The study of oculomotor activity during the reading process has been numerous and focused on various aspects (eye movement characteristics, eye movement control, perceptual span, etc.). The eye tracking data have mostly focused on the readability and processing effort for the given text type and thus on empirical research in neurophysiology [2-5]. Eye tracking is a powerful tool in scientific research and starts to pave the way into applied linguistics and translation studies [6].

This paper presents the results of a pilot eye tracking study involving reading and sight translation of texts from English into Russian performed by students. It was the researchers' first attempt to investigate sight translation process using eye tracking methodology. We expected to find out what difficulties the students would have and what text features would require more cognitive load.

2 Sight translation

Sight translation is a form of transposing a written text in the source language into a text in the target language orally. In the studies of Russian and foreign scientists the concept of sight translation is understood in a different way. One of the disputable issues concerns the status of this form of translation, whether it is considered as a separate form of interpreting or as a training exercise for other forms of interpreting. One of the first definitions of this concept belongs to H. van Hoof, the Dutch researcher who described sight translation as a special form of simultaneous interpreting when the written text was translated via a microphone [7].

Most of the current research support the idea that the key characteristic features of sight translation include the following:

- limited time for text comprehension,
- minimum time for finding the translation decisions,
- high speed of speaking,
- self-corrections are not allowed,
- strict self-control [8 - 10].

In cognitive terms, sight translation is a complex set of brain operations including processing visual input in one language, creating the oral message in another language and control of translation process at the same time.

The actual application of sight translation takes place in a number of professional settings and, despite this fact, it seems to be rarely taught on its own. The research of the translation process with the use of the eye tracking method may be helpful to understand the difficulties of this form of transposing the message and help to make appropriate pedagogical conclusions [11]. In particular, the findings of eye tracking research may supply interpreting teachers with solutions in terms of text selection, determining text complexity and other text parameters.

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3 Research design and methodology

The study was conducted at Northern (Arctic) Federal University, Arkhangelsk, Russia in March and April 2018. In the study a group of participants with one year of sight translation training were asked to read two source texts in English and sight translate them into Russian. What follows is the description of the texts, participants, equipment and setting, eye tracking metrics, and procedure.

Eye tracking methodology was selected for the research. Eye movements serve as constant component of psychophysiological processes involving obtaining, transposing and utilisation of visual information [12]. Quantitative and qualitative analysis of oculomotor activity is indicative of text complexity, the individual strategy of processing the visual information, and the efficiency of task performance [13]. Saccades (eye movements) take place during the search for new visual information and are alternated by fixations (when the eyes remain relatively still for a short period of time).

3.1 Source texts

The English texts (further referred to as Text 1 and Text 2) used as a source of cognitive load were news items taken from the *bbc.com* website. The texts consisted of 108 and 100 words correspondingly, the font type and size was Times New Roman 32. The texts in English were about Arctic convoys of 1941-1945. As Arctic convoys are a topical issue of Arkhangelsk, we assumed that the participants were familiar with the subject matter.

Text 1

Scarborough WWII convoy veteran gets Russian medal
A Royal Navy veteran who served on Arctic Ocean convoys to the Soviet Union in World War Two has received a medal from the Russian government.

Norman Waller, 90, from Scarborough, was awarded the Medal of Ushakov during the town's Armed Forces Day commemorations. He served aboard destroyer HMS Westcott escorting merchant ships from Scotland.

Mr Waller said the medal was recognition for "all those who went out there and the ones who were lost." The medal was presented by the Mayor of Scarborough Tom Fox and the town's Conservative MP Robert Goodwill, on behalf of the Russian Ambassador Alexander Yakovenko.

Text 2

More than 3,000 men died during the maritime campaign that wartime Prime Minister Winston Churchill was said to have called the "worst journey in the world". The convoys transported crucial supplies and munitions to the Soviet Union between 1941 and 1945.

Mr Waller said that while there was the risk of attack from German submarines and aircraft, the weather was the biggest danger. "These convoys didn't sail in the summer months they were only from the end of October," he said. "The weather up there was diabolical." "Spray coming over would be frozen by the time it hit the ship."

The texts were offered to the participants for reading silently and sight translating them after. Text 1 was more factual. It contained such elements as abbreviations, position titles, references to historic and cultural events and phenomena. Text 2 was more descriptive. It contained such elements as direct speech, epithets, metaphors etc.

3.2 Participants

Seventeen participants, average age 21, voluntarily took part in the study. All the participants denied having suffered any brain injuries, neurological conditions and eyesight pathology. They all are full-time bachelor and master students of Linguistics, specialty "Translation and Translatology" at Northern (Arctic) Federal University (with Russian as their A language and English as their B language). They possess the skill of sight translation which they master during interpreting training. The group of participants included students with B2 / C1 level of the English language. The level of the English language was tested before the experiment (www.cambridgeenglish.org).

3.3 Equipment and setting

Gaze behaviour of the participants was recorded on the basis of saccades and fixations in the infrared radiation spectrum. For the recording of eye tracking the system iView X^{TM} RED (SMI, Germany) for non-contact measurement was used. The collected data were analysed by BeGaze software. The frequency of the system was 500 Hz; the viewing distance was 55-60 cm from the screen. The experiment was conducted in accordance with the ethical standards, represented in Declaration of Helsinki (DoH) and European Community directives (8/609 EC).

3.4 Procedure

The setting of the experiment was similar to the real-life situation of translation as the participants had to sight translate in front of three researchers. Each participant was tested individually. They were seated in front of the screen at the required distance and their eyes were calibrated to the eye tracker. They were presented with the same instruction in Russian orally.

The participants were asked to read the source text for two minutes and then to sight translate the text from English into Russian. The time for translation was not limited. The participants' translations were recorded for further linguistic analysis and the participants were informed about this. On average, each session lasted approximately fifteen minutes.

3.5 Hypotheses

The objective of the research was to find out language units in the texts causing the biggest difficulty for translation. Study was conducted to test the following four hypotheses:

- Abbreviations, words referring to cultural and national phenomena and events will result in more numerous and longer fixations.
- The text containing more precise information (presumably known to the participants) will be translated efficiently and quickly.
- The text containing metaphors and epithets will demonstrate more cognitive load for processing and present more difficulty in translating.
- Translation speed of Text 2 will be higher because the participants will have known the subject matter better after translating Text 1.

4 Data analysis and results

Statistical analysis of the parameters under research was made with the use of SPSS (Statistical Package for the Social Sciences. Data processing included a complex analysis of the normality of the distribution and a correlation analysis to determine the dependence of the samples, after which a non-parametric Wilcoxon test for paired samples was used. To describe the data, the median (Me) and the first and third quartiles (Q1; Q3) were taken. Differences were considered statistically significant with the probability of erroneous acceptance of the null hypotheses about the equality of general means $p < 0.05$ [14].

Eye tracking showed that all the participants had enough time to read the texts more than once within two minutes that were allowed to them. Majority of participants demonstrated linear reading, which was not characteristic of the translation process. Thirty percent of the participants repeatedly looked away while translating which was seen in the saccades going beyond the text boundaries.

The analysis showed the highest fixation count during reading was on low frequency lexical units. On average the participants fixated on "Scarborough" 10 times when it was seen for the first time; and the number of fixations remained as high for the whole Text 1.

Another word causing difficulties in comprehension was the polysemantic word "destroyer" (average fixation count equals 7.3), which in this context serves as a term for a type of military ship. This was reflected in a great number of mistakes made by the students while translating this word.

A similar comment can be made concerning the abbreviation HMS that was not recognised by the participants and often skipped in the translation.

We have used the heatmap tool to visualise the above data. The heatmaps are visualisations in which individual fixation counts are presented as colours on a scale from green to red. They demonstrate effects of word frequency, length, predictability, and the resolution of lexical ambiguity related to the perceptual span determined by attention, reading and translation experience, and linguistic variables.

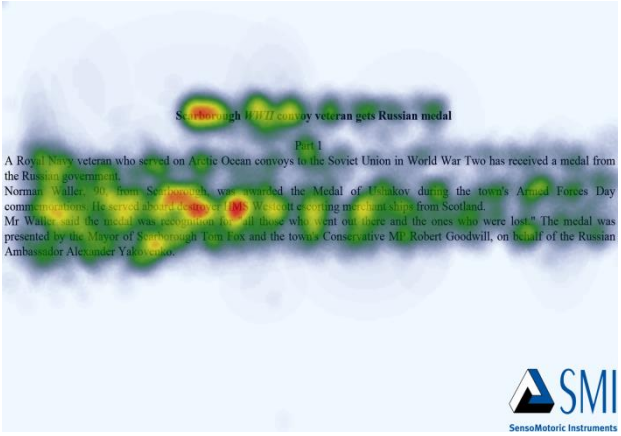

Fig.1. Heatmap for the reading of Text 1.

Fig.2. Heatmap for the reading of Text 2.

One word that attracted researchers' attention was the word "aboard" which was mistakenly interpreted as "abroad" and translated by the equivalent Russian word "*за границей*" ("abroad"). This observation proves the opinion of neurophysiologists that the visual word recognition depends on its frequency [15-16]. The participants appeared to choose the more frequent word for the translation due to the word frequency effect as such words are recognized more quickly.

No statistically significant differences in velocity, average saccade and fixation time during reading and sight translation of two texts was found. However, such differences were identified for fixation count and saccade count during the sight translation (Table 1), which may be indicative of different strategies of translation with relatively similar strategies of reading the text. Fixation and saccade count during the sight translation of Text 2 was significantly less. Surprisingly, one lexical unit, that caused more cognitive load with the students while sight translating, was "aircraft". Some participants used the equivalent Russian word "вертолет" ("helicopter") as a translation variant thus forgetting the time of the events referred to in the source text (Text 2). We assume that the same explanation could be given to the fact that the metaphor "spray" was

mistakenly translated by same participants as Russian word "спрей" (a can or container holding a spray).

Table 1. Statistically significant eye tracking measurements for sight translation of Text 1 and Text 2.

Metric	Me (Q1; Q3)		Wilcoxon test, achieved p-value
	Translation Text 1	Translation Text 2	
Fixation count	360 (255; 507)	309 (200; 391)	0.019
Saccade count	383 (272; 551)	289 (221; 413)	0.026

5 Discussion

It may be assumed that lower fixation and saccade count for sight translation of Text 2 reflects, first of all, the effect of the warming-up period. After finishing Text 1 the participants were more adapted to stressful situation and, as both texts have the same subject matter, the general context could become a factor that made translation easier.

Secondly, Text 2 was more descriptive and it could be easier to visualise the images and verbalise them in the translation, while Text 1 contained more precise terminology that is usually more difficult to visualise, it requires wider vocabulary and more cognitive effort to extract the meaning of such lexical units from the memory to provide translation equivalents.

Hypothesis 1 was confirmed since abbreviations and words referring to cultural and national phenomena and events did result in more numerous and longer fixations. It was also reflected in the quality of translation as most participants either skipped abbreviations like HMS or gave wrong equivalents for the abbreviation MP. A similar observation was made in regard the translation of the lexical unit *town's Armed Forces Day commemorations*.

Hypothesis 2 was rejected since lexical units referring to precise information (Scarborough, destroyer, conservative) caused more cognitive effort demonstrated by fixation and saccade count. Presumably, these lexical units were either unknown to the participants or they could not remember them at the moment of translation.

Hypothesis 3 was rejected since epithets and metaphors contained in Text 2, while presented a significant cognitive load, were translated by the majority of participants. This allows the researches to make a conclusion that more descriptive information provides for a better visualisation and more variants for translations equivalents. On the contrary, more precise information can be translated easier and quicker only when it is known to the translator. It is not easily visualised and can only be taken from the memory with the exact translation equivalent.

In addition, during the experiment, it was observed that some students made mistakes in translating the numeral 3,000, giving as equivalents in Russian such numerals as three, three million, thirty thousand, three hundred. This may be explained by attention and perceptual span. Curiously, the heat map shows no focusing on the numeral by the participants, while reading and translating.

Hypothesis 4 was confirmed as the participants did translate Text 2 quicker (which firstly was demonstrated by the time of translation on the recorder and secondly supported by lower fixation and saccade count). So we can conclude that the factor of the context plays an important role for the translation speed and quality.

For further research, it is planned to use two texts that can be interchangeable to eliminate warming-up effect and context effect.

The study also revealed that sight translation puts more pressure on short-term memory and the cognitive resources of an interpreter since most participants made mistakes in translating the name of Norman Waller, which was mentioned more than once in Text 1. For example, some participants could give different variants of translation of the person's name within the boundaries of one text.

6 Conclusion and further research

This pilot eye tracking study involving reading and sight translation produced some interesting results although it did not corroborate all the hypotheses made by researchers. Yet, it contributed to further investigation of translation process and cognitive processes in the translator's mind.

The study revealed that texts containing precise information potentially could present more difficulty for students than descriptive texts. This finding is directly applicable to training when teachers determine the text complexity selecting texts for training and assessment. The language of the source text can also be variated, for example, sight translation in the course of the following study can be made from Russian into English.

Prospects for further research can include the comparative study of reading and sight translation involving two groups of participants. One group will consist of professional interpreters and the other group will include trainees.

Results of the experiment showed the possibility to reduce the time given to read the texts as well as to limit time for translation. Another possibility can be to variate the syntactic structure of sentences in the source texts in order to find out the interrelation between complex / non-complex syntax and sight translation speed and quality.

Sight translation does not usually take a place of its own in interpreter training though actively applied on its own in the professional world.

Eye tracking is a promising interdisciplinary method of Translatology and further research in this field can shed more light on the translation process and provide teachers with more tools for students' skill development.

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