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A Critique of Eye-Tracking Approach in Translation Process Research

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With the rapid growth of eye-tracking studies in translation process research, concomitant methodological problems have become increasingly prominent. This paper starts with the discussion of the controversial "eye-mind assumption", and then focuses on various threats to experimental validity in research design and problems with eye-tracking data filtering and analysis. It is hoped that this discussion would be beneficial to those who are now or will be engaged in eye-tracking based translation studies.

Keywords: critique, eye-tracking studies, translation process research

Introduction

Over the past two decades, translation process research has witnessed a stimulating and ever-growing development thanks to the recent innovation in research methods. And eye-tracking, with the advantage of high temporal resolution, is probably the most popular technique used in translation process research. With the rapid growth of eye-tracking studies in translation process research, concomitant methodological problems have become increasingly prominent. The urgent task now is to reflect the way of using eye-tracking as a new approach to translation studies, rather than conducting more ambitious and experimental research.

This paper focuses on the methodological problems and challenges in eye-tracking translation studies: the weaknesses of "eye-mind assumption", threats to experimental validity in research design, and problems with data filtering and analysis.

Weaknesses of "Eye-mind Assumption"

Over the years, the "eye-mind assumption" formulated by Just & Carpenter (1980) has been used as the theoretical basis of eye-tracking studies. According to Just & Carpenter, "the eye remains fixated on a word as long as the word is being processed" and "there is no appreciable lag between what is being fixated and what is being processed" (Just & Carpenter, 1980, pp. 330-331). That is to say, there is a direct link between visual focus and cognitive focus and the readers will cognitively process whatever they are looking at. The eye-mind assumption best explains the relationship between eye movement and cognitive processing, but it is still a controversial issue due to the inherent weaknesses.

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The first weakness of the assumption lies in the frequently occurred dissociation between visual attention and cognitive processing. Based on the eye-mind assumption, a fixation on a word will continue until all the cognitive processes complete. However, the fixation could be influenced by the previously fixated words or reader's knowledge, and "a reader may spend an unusually long time gazing at a full stop at the end of a sentence while reflecting upon the meanings recently encountered or even upon some personal memories triggered by those meanings" (Underwood & Everatt, 1992, pp. 112-113). In this case, what is being fixated is not identical with what is being processed. And the dissociations between eye movements and cognitive processes are more common in translating. During translation, translators do not keep staring at the source text or target text. Instead, they would read them consecutively and sometimes even look at the keyboard or somewhere else. When reading the source text, the translators may probably be thinking about how to translate it into the target; and when fixing on the target text, they could still be engaged in understanding the source text. Occasionally, the translators may think of something totally irrelevant with what they are looking at, and such mind wandering implies thoughts can shift independently from cognitive focus (Posner, 1980).

And the other weakness is the potential non-synchronization between cognitive focus and visual focus. It is claimed that the eye movement and cognitive processing are not entirely synchronous, and "sometimes the mind is ahead of the eyes and is already processing information represented by a word the eyes have not yet fixated. Sometimes the eyes move ahead so fast that the mind lags behind and has to catch up" (Jakobsen, 2014, p. 74). The claim was echoed by Hveplund (2014, 2017), which suggests the mind is up to 250 milliseconds ahead of the eye. In translating, when a translator fixes on a word, he or she may use the peripheral vision to obtain part of the information to the right side of that word. That is to say, the processing of a neighboring word has already been performed before it is being fixated. So, the total gaze time does not accurately reflect the time required for the word processing. With regard to the potential non-synchronization, most of eye-tracking research is conducted and interpreted as though attention and fixation were synchronous events… they probably are not (Holmqvist, Nystrom, Andersson, Dewhurst, Jarodzka, & Van de Weijer, 2011, p. 379). Therefore, the practice of directly equaling the gaze time spent on the text segment to its cognitive load could possibly be misleading.

Threats to Experimental Validity

Threats to Internal Validity

Internal validity is the extent to which a cause and effect relationship is established within a study. According to Frey, Botan & Kreps (1991), threats to internal validity may be due to the participants and how research is conducted.

Threats to internal validity posed by the participants can be easily found in eye-tracking research. For instance, some participants would alter their normal behavior in translation process because they are aware that they are being studied. This is the well-known "Hawthorne Effect", which can be caused by the presence of the researcher, eye tracker or some other recording devices. As eye-tracking experiments are usually time-consuming, the participants can easily get tired or hungry, so it is impossible to rule out the possibility that the effects are simply due to the function of time. In addition, the participant's performance would also be affected by their motivation and willingness to take part in the study.

Threats to internal validity may also be posed by how research is conducted. In translation process research, it is a common practice to use eye-tracking in conjunction with other data collecting methods to triangulate the research findings. However, the use of multiple techniques in the experiment may reduce the internal validity of the research. For example, a number of studies have shown the think aloud protocol (TAP) may exert effect on the translation process (Angelone, 2010; Jakobsen, 2003). If we use eye-tracking together with TAP in the experiment, the participant's gaze data (such as fixation duration and fixation count) on the target items are probably higher than that using eye-tracking alone. Besides, improper experimental procedures and operations may also threaten internal validity. One of the most important variables in experimental design is task sequence, which is believed to have a priming effect on the research results. For example, Alves (2009) research results show that task order has a systematic impact on the duration of the task for most participants in the experiment showed a tendency to allocate more time to the execution of the first task. Other than that, cautions must be exercised in collecting and analyzing pupil size data. While pupil size is usually taken as an indicator of cognitive load in eye-tracking studies, this measurement is sensitive to light intensity, alcohol, medicine and emotions. And it has been found there is a pupillary delay in response to stimulus, with 150-400ms in response to light (Holmqvist, Nystrom, Andersson, Dewhurst, Jarodzka, & Van de Weijer, 2011), 120ms in reading during translation (Hveplund, 2011) and 300-500ms in interpreting (Hyönä, Tommola & Alaja, 1995). With respect to the potential delay, Hveplund (2014) cautions that "changes in the pupil size may erroneously linked to the wrong word or object" (Hveplund p. 215). What's more, the size of AOI (Area of Interest) would also have impact on the collection of gaze data. If the AOI is too large in size, the total fixation duration and fixation count are likely to be higher because the gaze data on the neighboring words could probably be included. On the contrary, if the AOI is too small in size, the fixation duration and fixation count might be lower for some gaze data may not be calculated.

Threats to External Validity

In contrast to internal validity, external validity refers to how well the conclusions of a study can be generalized to the real world. In discussing external validity threats, the top concern is the ecological validity. Though most translation setups intended to imitate an authentic setting, it is not uncommon that some claims are made on artificially designed scenarios, instead of real-life situations. Specifically, ecological validity in eye-tracking research can be affected by environment settings, text selection and task requirements.

First of all, the environment settings may have strong influence on the generalizability of findings. For many reasons, most of the experiments are conducted in laboratory where the participants may feel nervous or ill at ease because all the settings are quite different from what they are familiar with. And to ensure the eye movements can be captured by the eye tracker, the participants are reminded time and again to keep looking at the screen but at the same time keep a certain distance from it. The unfamiliar settings and movement restriction may potentially cause the participant to be aware of the environment settings, and less likely to perform in the same way as they normally do.

Secondly, the limited length of the testing text is also a potential threat. In most eye-tracking studies, the texts used in the experiment are very short (usually less than 300 words) due to the limited space or for the sake of facilitating data collection. However, translating such short texts is not a common practice for both students and

professional translators. And the use of short texts in experiments could probably lead to less predictable translation behavior on the part of the participants.

What's more, the use of external resources is often forbidden in the experiments because it is believed to interfere with eye movement data collection and analysis. On the one hand, when the participants use hardback dictionaries or printed reference materials, they would inevitably look away from the screen and their eye movement data could not be captured by the eye tracker. And on the other hand, when they use online resources, the frequent consultation activity would affect the collection and analysis of gaze data on AOIs. Although the requirement of "no consultation" makes good sense in simplifying the procedure of data collection and analysis, the findings generated from such "clean" data recordings are questionable because nobody would translate without any aids except in taking an examination.

Problems with Data Filtering and Analysis

Data Filtering

In translation process research, data filtering is a very challenging task because the duration of fixation is usually shorter compared to other fields of scientific research. When it comes to identifying fixations, filters of different sorts can be used to calculate fixation data, such as fixation duration, count and location. However, the selection of fixation filters has strong impact on the research results. For example, Alves, Pagano & da Silva (2009) found different results are obtained for average fixation duration when two different fixation filters (Tobii studio and ClearView) are applied. The finding gains further support in Alves, Pagano & da Silva (2011) study on different kinds of translation reading, which is a replication of Jakobsen & Jensen's (2008) study, but research results from the two studies are not inclusive. The differences in between, they argued, are likely to be related to data filtering configurations. To ensure comparability of the findings across studies, Alves, Pagano & da Silva (2009) recommend the standardization of fixation filter settings in the experiments, which highlights the importance of reporting details of filter selection and configuration in research design. Hveplund (2014) agree with the recommendation, but meanwhile he points out a uniform setting might be problematic if eye trackers used in the research work at different recording speed. That is to say, if eye trackers with different sampling rate are used in the experiment, there might be a slight difference in the distance that the eye travels between two samples.

Moreover, eye selection is also an important issue in data filtering. As there is often a slight difference between the two eyes with regard to the start time and end time of fixations, the selection of eyes will affect the identification of fixations. If either eye is selected, only the data from the left or right eye is used for classifying fixations and if both eyes are selected, an average will be made on the data from both. But If only one eye was used during the calibration and both eyes are selected in fixation identification, large offset errors may be introduced into the data.

Data Analysis

Currently, the discussion of eye-tracking data analysis mainly focuses on how to improve data reliability (Hveplund, 2014) and select a powerful statistical technique (Balling, 2008). Less attention has been paid to the specific process of data analysis and interpretation, during which translators often encounter problems.

The biggest challenge with data analysis lies in the fact that the significant effects are probably driven by other factors rather than the independent variables. Even if we use the robust regression designs, which allows statistical control of a number of variables that cannot be controlled experimentally, we still cannot rule out the possibility that the significance is due to collinearity or outliers. On the one hand, if two or more independent variables are highly correlated in a regression model (high collinearity), they cannot independently predict the value of the dependent variable. In other words, it is difficult to assess which of the variables in the model have significant effects on the dependent variable. In response to this, various remedies have been proposed against the harmful collinearity. On the other hand, the significant effects may also be caused by outliers, which are the data points significantly distant from other samples in the data set. For example, if a participant's gaze data on a certain item is excessively higher or lower than the rest of the samples, it may be considered as an outlier. The presence of outliers may mislead the algorithm and obscure the effects or trends that characterize the majority. Baayen (2008) better explains this problem with a metaphor of flock of sheep, "Consider a flock of sheep, moving north, and one sheep moving west. One would like to say that the sheep are actually moving north, but the one exceptional sheep may cause the model to report the sheep are moving to the northwest" (pp.189-190). A simple solution to protect the model against the outliers is to entirely remove them from the data set. But the drawback of outlier exclusion is obvious: the exclusion of data points heavily depends on the researcher's subjective assessment and personal experience. Therefore, we have to be very careful in outlier exclusion. Particularly when dealing with those naturally occurred in the experiments, one should try to understand why they appeared and whether or not their presence could have effect on the research results. And possibly, the investigation of these anomalies may lead to unexpected discoveries.

Conclusion

Based on the discussion of the above issues, we may draw the following implications: First of all, each method has its strong points and weaknesses, and the same is true with eye-tracking. When using eye-tracking in translation process research, we need to acknowledge its limitations and deficiencies and try to make up for them by taking various measures. In this regard, triangulation can be a good option in overcoming weaknesses of individual method. As discussed above, the cued retrospection can be used together with eye-tracking to eliminate the dissociation segments in recordings, thus increasing the likelihood that the eye fixation data could reflect the real cognitive activity. Secondly, further efforts should be made to improve the eye-tracking research design so as to reduce the potential threats to experimental validity. On the one hand, we can draw from the experimental design in the fields of psychology and cognitive science, which have a longer tradition of using eye-tracking in scientific research, to increase the internal validity of our studies. On the other hand, much emphasis should be placed on ecological validity, which is particularly important in translation process research. Undoubtedly, it is no easy task to guarantee ecological validity and reliability at same time, but we need to keep striving for it and be cautious in making generalization. Last but not least, with the help of powerful statistical tools and models, we are now able to generate regularities or patterns of cognitive process from massive eye-tracking data. But the urgent task now is to search for strong and commonly accepted models for translation process research. And it would be exciting if we could confirm or falsify theories and hypothesis that haven't

been empirically investigated or validated. Or even better, some new theories or assumptions could be drawn from our studies to guide the future eye-tracking research.

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