Humanities & Social Sciences Communications

ARTICLE

https://doi.org/10.1057/s41599-024-03187-y OPEN

The impact of text type on Chinese-English translation effort: an investigation with reference to translation entropy

Xiao Liu[1] & Ying Cui[2]✉

Various factors affect translation effort. This research aims to explore the impact of source text type on Chinese-English translation effort with reference to translation entropy. An eye-tracking and key-logging experiment was conducted. Thirty-one student translators translated four text types, namely legal, advertising, news, and poetic texts. Data analyses show that there is a significant difference in participants' effort of translating the four texts, which can be seen in such indicators as subjective ratings, fixation, pause, translation time, and edits. We further studied participants' translations and calculated the translation entropy for each text type, which is a measure of uncertainty in translation. Analysis shows that there is a significant difference in translation entropy among the four text types, which provides evidence that source text features affect translation uncertainty and, hence, translation effort to search for appropriate options. The discussions are intended to provide further insight into the impact of text type on the translation process, and the result confirms the reliability of translation entropy as a predictor of translation effort.

[1] School of Translation Studies, Shandong University, Weihai, China. [2] School of Interpreting and Translation Studies, Guangdong University of Foreign Studies, Guangzhou, China. ✉email: cycy@gdufs.edu.cn

Introduction

Different text types demonstrate distinctive linguistic features and perform their own textual functions, and such text features can affect the difficulty of translation and, hence, translation effort (Sun and Shreve, 2014, p. 120). Explorations in this regard are abundant, but they are mostly associated with lexical or syntactic characteristics (Immonen and Mäkisalo, 2010; Liu et al., 2019; Ma et al., 2022; Wang, 2022). We intend to carry it further by examining the mechanisms that influence translators' transfer process and cause translation effort. The translation process consists of source text (ST) comprehension and target text (TT) reformulation. ST is the primary factor affecting translation difficulty, and TT provides evidence for translators' cognitive processes (Campbell, 2000, p. 38). Every ST item may have more than one translation option, and translators have to compare the possible alternatives with regard to their appropriateness (Bangalore et al., 2016, p. 212). During the TT formulation process, a large proportion of translation effort lies with such options since multiple alternatives for an ST item cause translation uncertainty, which mirrors the effort involved in the translation process (Campbell, 2000, p. 38). Translators have to decrease the degree of uncertainty and arrive at a translation solution. Translation effort is lower when there are fewer translation options (Schaeffer et al., 2016, p. 199). In contrast, translation effort is higher when there are more options (Bangalore et al., 2016, p. 212). As the number of options is essentially a matter of translation uncertainty, we intend to describe it in terms of translation entropy in this study. More details will be explained later, but to put it briefly, entropy is a measure of uncertainty, and high entropy indicates more TT alternatives for an ST item (Schaeffer et al., 2016, p. 190). We infer that translation entropy values of different text types may vary, which can be correlated to translation effort. Against this background, we have carried out this research to investigate the impact of text type on Chinese–English translation effort with reference to translation entropy.

Research background

Text type and translation effort. Translation tasks engage effort. The human cognitive processing capacity is limited, and the brain determines the amount of cognitive resources allocated to a task according to its characteristics (Moray, 1967). Effort refers to the demand on cognitive capacities to execute a task (Kahneman, 1973, p. 16). In this vein, translation effort refers to the demand on cognitive resources involved in "thinking about how to translate and how to correct mistranslations, selecting the desired products, and reflecting on the chosen solutions" (Lacruz, 2017, p. 387). During the translation process, ST comprehension and TT production compete for available cognitive resources (Seeber, 2011, p. 187). The cognitive demand remains fairly constant once production begins and slowly decreases with the completion of comprehension and production tasks (Seeber, 2011, p. 192). The process also invokes working memory, which is a set of cognitive processes in the control, regulation and active maintenance of task-relevant information and requires cognitive resources (Gile, 1995, p. 167). In brief, translation effort is associated with ST comprehension, TT production, and working memory. Every kind of effort has its capacity requirements (Gile, 1991, p. 17). Translation problems occur when the capacity available is not sufficient to meet the processing requirements (Gile, 1995, p. 191). The intensity with which these cognitive processes are performed seems to be related to the factors that are inherent either to the task or to the task performer (Gieshoff and Heeb, 2023, p. 3). Accordingly, the ST feature is an important variable determining the complexity of a translation task.

The importance of text type has been highlighted in translation research. The typology of Reiss (2000), despite the criticisms against it (Munday, 2008, pp. 74–75), can provide us with some reference regarding the general categorization of texts based on functions, such as informative, expressive, and operative texts, and their translation criteria. The three textual types are not clearly distinguished. For example, operative texts may also provide information. However, the predominant function distinguishes one text type from another. For instance, news and legal texts emphasize the informative function, poetic texts emphasize the expressive function, and advertising texts emphasize the operative function. Meanwhile, the linguistic features of different text types vary (Reiss, 2000, p. 48). In some cases, the texts playing similar functions may have contrasting linguistic features because of conventions or context. For example, news and legal texts both perform the informative function, yet the former tends to use concrete wording and concise syntactic structure (Buono and Snajder, 2017, p. 138), while the latter is characterized by jargons and complex syntactic structure (Paolucci, 2017, p. 326). Different from informative texts, the priority of expressive texts is not to convey information but to express feelings or thoughts, such as poetry. Poems are creative and often use rhetorical figures to enhance aesthetic effects (El-Shiyab, 1999, p. 208). Operative texts such as advertisements aim to impact recipients' behavior with concise and catchy wording (Leech, 1966, pp. 186–193), and simple syntactic structures such as imperatives, interrogatives, and elliptical sentences (Leech, 1966, pp. 110–119). Linguistic features are the main causes of translation difficulty (Sun and Shreve, 2014, p. 120). For example, research shows that there is a positive correlation between translation effort, the length of linguistic units (Immonen and Mäkisalo, 2010), and text complexity (Liu et al., 2019). Linguistic features of different text types can affect translators' effort of comprehending ST and producing TT, as well as the working memory involved therein. Translators have to grasp the textual functions of different text types and understand the semantic, lexical, grammatical, and stylistic elements of ST (Reiss, 2000, p. 65). In this sense, textual functions and linguistic features of different text types can impact such cognitive processes as monitoring, retrieval of possible translation equivalents, and sentence planning. On these grounds, it can be assumed that text type serves as a key factor determining the complexity of a translation task and translation effort.

Various studies have been conducted to explore text type and translation effort. Researchers have explored how news and legal texts affect semi-professionals' cognitive processes in Spanish–Danish translation (Halskov Jensen, 1999), how business letters and legal contracts impact professional translators' behavior in Danish–English translation (Dragsted, 2004), how news and tourism texts influence translation effort in English–Chinese language pair (Ma et al., 2022), and how allegorical stories and lease contracts affect the cognitive processes in Chinese–English translation (Wang, 2022). It is found that legal texts cause more translation effort than news (Halskov Jensen, 1999), business letters (Dragsted, 2004), and allegorical stories (Wang, 2022). Despite the significance of text type in translation, the types of texts covered in existing studies are limited and selected randomly (Wang and Daghigh, 2023, p. 2). Besides, they have mainly explored the correlation between text type and translation effort, which is based on translation-process indicators, but why text type affects translation effort remains to be further explored. To answer this question, it is necessary to resort to ST and TT features, apart from exploring the translation process. As introduced earlier, a large part of translation effort is attributable to the uncertainty of translation,

which can be described via translation entropy (Carl et al., 2016, p. 29). Therefore, this study explores how and why text type impacts translation effort in Chinese–English language pair with reference to translation entropy by combing process- and product-based indicators of effort.

Measurement of translation effort

Three dimensions of translation effort. Krings (2001) proposes a three-fold framework of effort for post-editing, including temporal, technical, and cognitive dimensions, which is "relatively well established and widely used" (Moorkens et al., 2015, p. 270). We believe that the framework also applies to translation. First of all, temporal effort refers to the time spent on a task, which is regarded as the most direct measurement of effort (Krings, 2001, pp. 178–179) and "the most important aspect" from an economic perspective (Krings, 2001, p. 54). Given the fact that the translation process is complex, the effort experienced by translators cannot be measured by the temporal dimension alone (Vieira, 2016, pp. 2–3). Second, technical effort needs to be taken into account, as technical operations are the direct results of translators' cognitive processes (Cui et al., 2023, p. 2). Technical effort is related to keystrokes and mouse activities such as deletions, insertions, and rearrangements (Krings, 2001, p. 54). Third, cognitive effort is defined as "the type and extent of cognitive processes that must be activated" (Krings, 2001, p. 179), reflecting the mental processes that take place during a task. More difficult texts exert higher cognitive effort (Lacruz, 2017, p. 387). A number of studies have attempted to explore translation effort with reference to the framework (Vieira, 2016; Cui et al., 2023). As the three dimensions of effort are related (Lacruz, 2017, p. 386), this study considers all of them.

Process-based indicators of translation effort. Approaches to assess translation effort include process- and product-based indicators. Process-based indicators include subjective and behavioral ones. To begin with, subjective ratings reveal the traits and experiences of participants, which reflect their cognitive effort (Hu et al., 2020, p. 3). While some researchers suggest that human ratings are not reliable indicators of actual effort (Moorkens et al., 2015, p. 282), some studies find that translators' subjective ratings are significantly correlated to objective indicators (Vieira, 2017, p. 42; Cui et al., 2023, p. 9). Besides, behavioral indicators can be obtained via key-logging and eye-tracking tools. Studies on key-logging have identified such effort indicators as production time, keystrokes, and pause (Koponen et al., 2012; Lacruz et al., 2012). Production time reflects the temporal dimension of effort, and longer time indicates more effort (Koponen et al., 2012; Lacruz, 2017, p. 386). Keystrokes are used as a proxy to predict technical effort, and more keystrokes indicate higher effort (Lacruz et al., 2012, p. 29). Pause is a key measure of cognitive effort, and higher pause duration and counts suggest increased cognitive effort (Jakobsen, 2019). In addition, eye-tracking data are well-established as indicators of cognitive effort (Castilho, 2016, p. 4). It is generally assumed that "there is no appreciable lag between what is being fixated and what is being processed" (Just and Carpenter, 1980, p. 331), so it is possible to track the real-time cognitive process of translation by recording fixation data (Rayner et al., 2006, p. 241). Fixation is defined as "eye movements which stablize the retina over a stationary object of interest" (Duchowski, 2003, p. 43). The indicators of fixation count and fixation duration are used to measure cognitive effort (Hvelplund, 2021, p. 283). Readers tend to make longer fixations on difficult texts (Rayner et al., 2006, p. 242), so higher fixation duration and counts indicate more cognitive effort (Vieira, 2016, p. 44). Meanwhile, it is worth noting that every research method has its disadvantages, and a mixed-method paradigm, triangulating analyses and results, brings about a better understanding of effort. Therefore, this study combines eye-tracking, key-logging, and questionnaire methods to elicit process-based indicators.

Product-based indicators of translation effort. Apart from process-based indicators of effort, translation entropy based on translation products can also reveal translation effort (Carl et al., 2016, p. 29). Translation entropy is derived from information entropy, which measures the uncertainty involved in choosing one message from a set of possible ones in communication (Shannon, 1948, p. 1). Translation entropy describes a certain distribution of translation probabilities "p", which can be estimated based on the number of possible translations (Carl et al., 2016, p. 29).

$$p(s - t_i) = \mathrm{count}(s - t_i)/\#\,translations \quad (1)$$

$$H(s) = \sum_{i=1}^{n} p(s - t_i)^* - \log_2(p(s - t_i)) \quad (2)$$

As in Eq. (1), translation probabilities "$p\ (s{-}t_i)$" of an ST item "s" and its possible translations "$t_{i\ldots n}$" are computed as the ratio of the number of direct transfers over the total number of TT alternatives. Translation entropy can be calculated following Eq. (2) (Carl et al., 2016, p. 31). The information of a probability "p" is defined as "$\log_2\ (p(s{-}t_i))$". For illustration, if a given ST item has only one possible translation, its translation probability "$p = 1$", its information "$\log_2\ (p(s{-}t_i)) = 0$", and thus its translation entropy ($H(s) = 0$) is minimal. It can be seen that translation entropy mathematically describes the uncertainty of which TT item to choose for an ST item (Carl et al., 2016, p. 29). Translation uncertainty, as a cognitive state of indecision, arises as translators are implementing cognitive resources to select the most appropriate option during the comprehension, transfer, or production processes (Angelone, 2010, p. 18). The management of uncertainty is associated with such cognitive processes as problem-solving and decision-making (Angelone and Shreve, 2011, p. 115). Fewer translation alternatives lead to lower entropy, indicating higher inter-lingual similarity and resulting in less translation effort (Carl, 2021, p. 119). In this sense, translation entropy reveals translators' cognitive processes and predicts the effort needed to resolve translation problems (Carl and Schaeffer, 2017, p. 43).

Translation entropy is ST specific and can be influenced by linguistic features (Carl, 2021, p. 115). It is proposed that comprehension uncertainty is related to ST language, transfer uncertainty appears when translators have difficulty choosing an appropriate translation, and production uncertainty is connected with TT language (Angelone, 2010). Accordingly, semantic representations and syntactic constraints contribute to translation entropy (Carl and Schaeffer, 2017, p. 43), which negatively affect translation production (Laxén and Lavaur, 2010). Empirical studies have explored translation entropy on lexical, phrasal, and syntactic levels and found a positive correlation between entropy and effort indicators such as reading time, fixation, translation time, and pause (Bangalore et al., 2016; Schaeffer et al., 2016; Carl, 2021; Lacruz et al., 2021). On the lexical level, researchers have revealed that words with multiple translations are more cognitively demanding to process than those with fewer translations (Laxén and Lavaur, 2010; Tokowicz, 2014; Schaeffer et al., 2016). ST items such as polysemous words (Tokowicz, 2014, p. 171), abstract words (Laxén and Lavaur, 2010, p. 158), and figurative expressions (Ogawa et al. 2021, p. 160) have higher translation entropy and hence require more effort. On the phrasal level, translation variability has been examined in

Japanese–English and Japanese–Spanish translations and the correlation between phrasal translation entropy and effort has been observed even when the ST language (Japanese) is remote from the TT languages (English and Spanish) (Lacruz et al., 2021, p. 295). On the syntactic level, a positive relation appears between syntactic variation and translation time (Bangalore et al., 2015), and higher translation entropy is recorded in passive sentences than in active sentences (Ogawa et al., 2021, p. 160). Based on such observations, we wonder whether the translation entropy of different text types also varies and correlates to translation effort.

Research objectives

The review in research background highlights two research gaps in this field, namely inadequate exploration into the reasons why text type impacts translation effort and insufficient attention to translation products when investigating translation effort. To be more specific, studies have identified text type as a key factor influencing translation effort (Dragsted, 2004; Liu et al., 2019; Ma et al., 2022; Wang, 2022), but they have mostly described how text type is correlated to translation effort and have not explored why text type impacts effort. We believe that translation uncertainty connected with text type is a major cause of effort, which can best be described via translation entropy. Furthermore, current studies have focused on the process of translation by examining the eye-tracking and key-logging data (Dragsted, 2004; Liu et al., 2019; Ma et al., 2022; Wang, 2022). We hold that studying translation products can also provide valuable information about translators' cognitive processes. The studies on translation entropy, as outlined earlier, have shown that analyzing translation products and measuring translation uncertainty shed light on translation effort. Since linguistic features affect translation entropy on lexical, phrasal, and syntactic levels (Laxén and Lavaur, 2010; Tokowicz, 2014; Lacruz et al., 2021; Ogawa et al., 2021), we infer that text type impacts translation entropy. Taking into account the research gaps, this study aims to investigate the following questions: whether there are differences in the translation entropy of different text types and whether such differences are correlated to translation effort.

To answer the above questions, we have conducted an eye-tracking and key-logging experiment to capture translators' behavioral data and explore their effort in translating different text types. We have designed an online questionnaire to obtain their subjective ratings of effort after finishing translation tasks. In addition, we have studied their translations and calculated the translation entropy values to explore whether translation uncertainty is connected with text type and thus affects translation effort.

Experiment

Tools. We used Gazepoint GP3 HD Desktop Eye Tracker for the experiment. The eye tracker weighs about 155 g and is convenient to set up. It is a research-grade eye tracker utilizing a machine-vision camera at the heart of its imaging and processing system with a 150 Hz sampling rate and nine-point calibration. To ensure the accuracy of eye tracking, we placed a chin rest at a distance of 60 cm from a high-definition monitor with 1920 × 1080 resolution. We used Translog II (Version 2.0.1.222) to collect key-logging data.

Participants. We recruited 31 postgraduates majoring in Translation Studies to participate in the experiment. They were Chinese native speakers proficient in English, aged between 22 and 28 ($M = 22.63$, SD = 1.43), with 26 females and 5 males. They had been studying translation for nearly one year. They all mastered touch typing skills. They were right-handed and had normal or corrected-to-normal vision, with no history of neurological or psychological impairment. We informed them of the detailed experiment procedure. They signed the Consent Form and took part in the experiment voluntarily. We gave each participant a gift in return for their participation.

Experiment materials. We chose four types of texts for the experiment based on textual functions and linguistic features, namely news, legal, poetic, and advertising texts. The four texts cover the major textual functions as outlined in text typology (Reiss, 2000, pp. 24–43). The news and legal texts are informative, the poetic text is expressive, and the advertising text is operative. The four texts have distinctive linguistic features, as discussed earlier, with the news text being semantically concrete and syntactically simple (Buono and Snajder, 2017, p. 138), the legal text using jargon and complex syntactic structure (Paolucci, 2017, p. 326), the advertising text being concise and catchy (Leech, 1966, pp. 186–193), and the poetic text using rhetorical figures (El-Shiyab, 1999, p. 208). To sum up, the four texts demonstrate different textual functions and linguistic features. Every text consists of about 50 Chinese characters, which are appropriate for eye-tracking research (Saldanha and O'Brien, 2013, p. 140). We conducted a survey with 28 undergraduates majoring in English to assess the difficulty of the texts on a five-point scale, with "1" meaning "very simple" and "5" meaning "very difficult". The mean ratings of news, legal, poetic, and advertising texts were 1.61, 2.32, 2.61, and 1.64, respectively, which were under "3 (medium difficult)", suggesting that the texts were suitable for the experiment.

Procedure. First, participants got familiar with the lab context and learned about the tasks. Second, participants completed a warm-up translation task in the Translog window. An electronic dictionary was placed on the right of the Translog window. Without dictionaries, participants might find themselves in an "unusual situation in a lab" (Dragsted and Carl, 2013, p. 138). Providing an external resource could help to ease their nerves and improve the ecological validity of the experiment. The electronic dictionary chosen in this study is widely used among Chinese college students. We also asked participants to use the dictionary during the warm-up task. Third, the eye-tracker was calibrated, and participants translated four texts in a random order. There was no time limit, but we asked them to try to finish the tasks as quickly as possible. The experiment generally lasted for about 30 min. Finally, participants were invited to fill out an online questionnaire and provide their subjective ratings (SR) of translation effort. We assured them that their answers would be anonymized, and we only wanted to learn about their truthful perception. All participants shared with us their ratings.

Data processing and results

Data processing. First, we checked the completeness of participants' eye movement data. They were complete and valid. Then, we filtered fixation data. The noise in eye-tracking data is mainly related to fixation duration. Considering that reading plays a key role in translation and fixations in reading range from 100 to over 500 ms (Pavlovic and Jensen, 2009, p. 97), we set the threshold at 100 ms. It is suggested that the total number of fixations normalized by ST words is reliable to reflect translation effort, for it avoids sentence-length effect (Vieira, 2016, p. 52). In this study, we used fixation duration and counts normalized by ST words as effort indicators, namely ST fixation duration divided by ST word number (FDw) and ST fixation count divided by ST word number (FCw).

Table 1 Results of effort indicators.

Variable	*A*		*N*		*L*		*P*		*Q*	*p*
	M	SD	*M*	SD	*M*	SD	*M*	SD		
SR	2.97	0.66	2.68	0.65	4.00	0.68	3.55	1.06	47.35	0.00
TTw	7.89	3.21	6.73	2.07	8.11	2.51	6.99	2.85	10.74	0.01
TEw	9.37	2.71	7.48	1.93	7.64	2.19	7.60	1.85	18.01	0.00
FDw	1.34	0.76	1.10	0.52	1.65	0.79	1.36	0.62	18.06	0.00
FCw	5.45	2.91	4.49	2.04	6.78	3.43	5.17	2.54	18.92	0.00
PDw	7.20	3.18	5.97	2.20	7.32	2.39	6.05	2.06	12.45	0.00
PCw	3.51	1.04	3.28	0.76	4.11	1.51	3.47	1.04	14.07	0.00

Second, the data captured by Translog II were valid. The pause threshold of 300 ms is regarded to be suitable, which "is not too short to be contaminated by normal typing activity, but is sufficiently short to capture much potentially informative pause activity" (Lacruz et al., 2014, p. 82). We followed this criterion to process pause data. Pause count normalized by ST words (Vieira, 2016) and translation time normalized by ST words (Koponen et al., 2012) are found to be reliable in estimating translation effort. It can be seen that normalization by ST words can improve effort indicators' reliability. Therefore, we used the following indicators in this study: total translation time divided by ST word number (TTw), total edits divided by ST word number (TEw), pause duration divided by ST word number (PDw), and pause count divided by ST word number (PCw).

Third, we calculated translation entropy on phrasal and syntactic levels. We chose the two levels because phrase is the basic unit of translation, and syntactic structure can be a major cause of translation difficulty between Chinese and English. To compute translation entropy, an alignment process between Chinese and English texts is necessary, which is complex due to their different structures and orthographies. In this study, we aligned ST and TT manually to count translation variants and calculated the translation entropy according to the equations introduced earlier.

Results

Text type and translation effort. As translation research is characterized by small sample sizes and unknown population distributions, non-parametric tests are recommended to increase statistical power (Mellinger and Hanson, 2017, p. 78). In this study, we conducted Friedman tests on SR, translation time, edit, fixation and pause, and calculated Kendall's W to measure the effect size (Mellinger and Hanson, 2017, p. 147). The results of Friedman tests are summarized in Table 1 (M = mean; SD = standard deviation; A = advertising text; N = news text; L = legal text, P = poetic text).

As shown in Table 1, there are significant differences between the four text types in all effort indicators, namely SR ($p < 0.001$), TTw ($p = 0.01$), TEw ($p < 0.001$), FDw ($p < 0.001$), FCw ($p < 0.001$), PDw ($p < 0.001$), and PCw ($p < 0.001$). The effect size of SR is large ($W = 0.52$), while the effect sizes of TTw ($W = 0.12$), TEw ($W = 0.20$), FDw ($W = 0.20$), FCw ($W = 0.21$), PDw ($W = 0.14$), and PCw ($W = 0.15$) are small. As significant differences appear in all aspects of effort, we did Dunn's tests to make pairwise comparisons and further explore the differences. The results are summarized in Tables 2–4 (MD = mean difference).

As shown in Table 2, all effort indicators of the legal text are the highest except for TEw. Between legal and advertising texts, SR, FDw, FCw, and PCw of the legal text are significantly higher ($p < 0.001$, $p = 0.02$, $p = 0.03$, $p < 0.001$). TTw and PDw of the legal text are higher, but the difference is not statistically significant ($p = 0.18$, $p = 0.23$). The legal text has lower TEw, and the difference is statistically significant ($p < 0.001$). Between legal and news texts, all indicators of the legal text are higher. There are statistically significant differences in SR ($p < 0.001$), TTw ($p = 0.01$), FDw ($p < 0.001$), FCw ($p < 0.001$), PDw ($p = 0.02$), and PCw ($p < 0.001$) except for TEw ($p = 0.41$). Between legal and poetic texts, all indicators of the legal text are higher. There are statistically significant differences in SR ($p = 0.02$), TTw ($p = 0.02$), FCw ($p = 0.01$), PDw ($p = 0.03$), and PCw ($p < 0.001$) except for TEw ($p = 0.46$). The difference is statistically significant at the 0.10 level in FDw ($p = 0.06$).

Table 2 Pairwise comparison between legal and advertising, news, and poetic texts.

Variable	L&A	L&N	L&P
SR/MD(*p*)	1.03 (0.00)	1.32 (0.00)	0.45 (0.02)
TTw/MD(*p*)	0.22 (0.18)	1.38 (0.01)	1.12 (0.02)
TEw/MD(*p*)	−1.73 (0.00)	0.16 (0.41)	0.04 (0.46)
FDw/MD(*p*)	0.31 (0.02)	0.55 (0.00)	0.29 (0.06)
FCw/MD(*p*)	1.33 (0.03)	2.29 (0.00)	1.61(0.01)
PDw/MD(*p*)	0.12 (0.23)	1.35 (0.02)	1.27 (0.03)
PCw/MD(*p*)	0.60 (0.00)	0.83 (0.00)	0.64 (0.00)

Table 3 Pairwise comparison between news, advertising, and poetic texts.

Variable	A&N	P&N
SR/MD(*p*)	0.29 (0.10)	0.87 (0.00)
TTw/MD(*p*)	1.16 (0.09)	0.26 (0.43)
TEw/MD(*p*)	1.89 (0.00)	0.12 (0.45)
FDw/MD(*p*)	0.24 (0.11)	0.26 (0.06)
FCw/MD(*p*)	0.96 (0.09)	0.68 (0.19)
PDw/MD(*p*)	1.23 (0.09)	0.08 (0.44)
PCw/MD(*p*)	0.23 (0.15)	0.19 (0.25)

As Table 3 shows, all effort indicators of the news text are lower than advertising and poetic texts. Between news and advertising texts, the difference is statistically significant in TEw ($p < 0.001$) but not in SR ($p = 0.10$), FDw ($p = 0.11$) and PCw ($p = 0.15$). The difference is statistically significant at the 0.10 level in TTw ($p = 0.09$), FCw ($p = 0.09$), and PDw ($p = 0.09$). Between news and poetic texts, the difference is statistically significant in SR ($p < 0.001$), but not in TTw ($p = 0.43$), TEw ($p = 0.45$), FCw ($p = 0.19$), PDw ($p = 0.44$) and PCw ($p = 0.25$). The difference is statistically significant at the 0.10 level in FDw ($p = 0.06$).

As shown in Table 4, between advertising and poetic texts, the advertising text has higher TTw, TEw, FCw, PDw and PCw but lower SR and FDw. The difference is statistically significant in SR ($p = 0.01$), TEw ($p < 0.001$), but not in TTw ($p = 0.13$), FDw

($p = 0.37$), FCw ($p = 0.34$), PDw ($p = 0.12$), and PCw ($p = 0.35$). As significant differences only appear in SR and TEw and the results are divided, the difference between advertising and poetic texts remains to be further explored.

Text type and translation entropy. As translation entropy is based on the translations of four texts, which are independent of each other, we conducted Kruskal-Wallis equality-of-populations rank tests on translation entropy and calculated η^2 to measure the effect size (Mellinger and Hanson, 2017, p. 136).

As shown in Table 5, the difference between the four texts is statistically significant in phrasal entropy ($p < 0.001$), with large effect size ($\eta^2 = 0.54$), and syntactic entropy ($p = 0.02$), with large effect size ($\eta^2 = 0.29$). Phrasal and syntactic entropy of the legal text is the highest, followed by poetic, advertising, and news texts. It shows that there are differences between text types in translation uncertainty on phrasal and syntactic levels.

In addition, we adopted linear mixed-effects models (LMMs) analyses to study the impact of translation entropy on effort. LMMs can account for high variability among participants and increase the power of tests (Mellinger and Hanson, 2018), and thus compensate for weak control of variables in naturalistic translation tasks (Saldanha and O'Brien, 2013). We built models on SR, TTw, TEw, FDw, FCw, PDw and PCw. The fixed effect is the translation entropy of four texts. The random effect is participants' English proficiency. We built the models from the minimal to maximal by improving model fit, which is recommended for exploratory analyses when there are no clear-cut hypotheses (Meteyard and Robert, 2020, pp. 17–18). We started with a simple model from the fixed effect and obtained the best model with the lowest BIC (Burnham and Anderson, 2004, p. 288). We calculated Cohen's f^2 to measure the effect size. We did model checks by examining the distribution of residuals. The residuals of the models demonstrate approximate normal distribution. The results of LMMs are summarized in Table 6.

Within all the models, the random effect is close to zero and insignificant, implying that the variation of participants' English proficiency did not influence their translation effort. Regarding the fixed effect, the relation between translation entropy and all indicators is significant except for TEw. On the phrasal level, translation entropy is significantly and positively correlated to SR ($p < 0.001$), TTw ($p = 0.01$), FDw ($p < 0.001$), FCw ($p < 0.001$), PDw ($p = 0.03$), and PCw ($p = 0.02$), but not to TEw ($p = 0.11$). The effect size of SR is large ($f^2 = 0.40$). The effect sizes of TTw ($f^2 = 0.06$), TEw ($f^2 = 0.03$), PDw ($f^2 = 0.05$), and PCw ($f^2 = 0.06$) are small. The effect sizes of FDw ($f^2 = 0.15$) and FCw ($f^2 = 0.15$) are moderate. On the syntactic level, translation entropy is significantly and positively correlated to SR ($p < 0.001$), TTw ($p = 0.01$), FDw ($p < 0.001$), FCw ($p < 0.001$), PDw ($p = 0.02$), and PCw ($p = 0.02$), but not to TEw ($p = 0.13$). The effect size of SR is large ($f^2 = 0.42$). The effect sizes of TTw ($f^2 = 0.07$), TEw ($f^2 = 0.02$), PDw ($f^2 = 0.06$) and PCw ($f^2 = 0.06$) are small. The effect sizes of FDw ($f^2 = 0.16$) and FCw ($f^2 = 0.17$) are moderate.

Table 4 Pairwise comparison between advertising and poetic texts.

Variable	A&P
SR/MD(*p*)	−0.58 (0.01)
TTw/MD(*p*)	0.90 (0.13)
TEw/MD(*p*)	1.77 (0.00)
FDw/MD(*p*)	−0.02 (0.37)
FCw/MD(*p*)	0.28 (0.34)
PDw/MD(*p*)	1.15 (0.12)
PCw/MD(*p*)	0.04 (0.35)

Discussion

Text type and effort. As reported in the result section, text type significantly impacts temporal, technical, and cognitive effort in Chinese–English translation. Such impact is reflected in all indicators, namely subjective ratings, fixation, pause, translation time and edits. This result provides further evidence that text type is an important factor affecting translation complexity, thus deserving translation researchers' attention, and ST characteristics such as semantic and syntactic complexity have a bearing on translation effort (Dragsted, 2004; Immonen and Mäkisalo, 2010; Liu et al., 2019; Wang, 2022; Ma et al., 2022). The impact of text types is attributable to their distinct linguistic features and textual functions. Different text types have variant translation requirements (Reiss, 2000, p. 41). Translators are expected to convey the predominant function and produce adequate translations, achieving semantic equivalence, lexical adequacy, grammatical correctness, and stylistic correspondence. Therefore, the linguistic elements in ST can lead to translation difficulty (Sun and Shreve, 2014, p. 120), which imposes different cognitive processing capacity requirements (Gile, 1991, p. 17) and impacts the effort in ST comprehension and TT production (Seeber, 2011, p. 183).

In our study, the difference between legal and news texts is outstanding. The subjective ratings and behavioral indicators, such as translation time, fixation, and pause of the legal text, are the highest, and those for the news text are the lowest. More fixation counts and longer fixation duration, higher pause densities, and longer translation time indicate more translation effort (Lacruz et al., 2012; Vieira, 2016; Lacruz, 2017). It suggests that the effort of translating the legal text is the highest, while that of the news text is the lowest. This result is consistent with previous findings that legal texts cause higher translation effort than news texts to semi-professionals in Spanish–Danish translation (Halskov Jensen, 1999), contract has more impact on professional' translation behavior in Danish-English translation (Dragsted, 2004), and contract is more difficult for student translators than allegorical story in Chinese–English translation (Wang, 2022). As mentioned earlier, news and legal texts both emphasize the informative function, but the former is characterized by lexical concreteness and simple syntactic structure (Buono and Snajder, 2017, p. 138), and the latter features jargon and complex syntactic structure (Paolucci, 2017, p. 326), which are usually difficult to process (Kunilovskaya et al., 2023, p. 46). Besides, legal translation also involves a transformation between

Table 5 Results of translation entropy.

	A		*N*		*L*		*P*		χ^2	*p*
	M	**SD**	***M***	**SD**	***M***	**SD**	***M***	**SD**		
Phrasal entropy	0.39	0.05	0.28	0.05	0.65	0.06	0.50	0.18	18.33	0.00
Syntactic entropy	0.16	0.08	0.11	0.08	0.34	0.14	0.20	0.14	9.80	0.02

Table 6 Results of LMMs.

Model	Effects	β	SE	z	p
SR	Phrasal entropy	0.59	0.09	6.12	0.00
	Syntactic entropy	1.01	0.16	6.24	0.00
TTw	Phrasal entropy	0.56	0.24	2.37	0.01
	Syntactic entropy	1.03	0.39	2.62	0.01
TEw	Phrasal entropy	0.41	0.26	1.58	0.11
	Syntactic entropy	0.65	0.44	1.48	0.13
FDw	Phrasal entropy	0.26	0.07	3.73	0.00
	Syntactic entropy	0.45	0.11	3.85	0.00
FCw	Phrasal entropy	1.06	0.29	3.73	0.00
	Syntactic entropy	1.88	0.48	3.95	0.00
PDw	Phrasal entropy	0.49	0.23	2.13	0.03
	Syntactic entropy	0.92	0.39	2.35	0.02
PCw	Phrasal entropy	0.25	0.11	2.38	0.02
	Syntactic entropy	0.41	0.18	2.28	0.02

two legal systems which have their own terminologies and concepts (Biel, 2017, p. 78). In short, the use of jargon and complex syntactic structure and the difference in legal systems require higher processing capacity and thus add to translation effort.

In addition, the difference between news and advertising texts is prominent. Data analyses show that translation time, edits, fixation count, and pause duration of the news text are lower. As noted earlier, advertising appeals to consumers with concise wording and simple syntactic structure (Leech, 1966, pp. 186–193). News also tends to use concise structure (Buono and Snajder, 2017, p. 138). However, news emphasizes the informative function, while advertising emphasizes the operative function. The result of our study suggests that conveying the operative function in advertising translation to impact recipients' behavior requires more processing capacity.

Furthermore, although advertising and poetic texts vary in textual functions and linguistic features, the difference between the two remains to be further explored, as there is a discrepancy in the results. For one thing, SR of the advertising text is lower, while its TEw is higher. TEw, calculated on the basis of user events, can be influenced by participants' translation behavior, so more technical operations do not necessarily invoke more effort (Vieira, 2016, p. 41). Hence, TEw alone cannot serve as a robust effort indicator. Comparatively speaking, subjective ratings are more reliable (Vieira, 2017, p. 42). Therefore, it can be assumed that the poetic text causes more effort. It is attributable to the fact that poems often use rhetorical figures (El-Shiyab, 1999, p. 208), which are more effortful to translate (Kunilovskaya et al., 2023, p. 46). For another, no significant difference is observed in translation time, fixation, and pause. Two factors might have contributed to this result. One is the overlap between advertising and poetic texts in terms of textual function, for both entail creativity and aesthetic effect. The poetic text performs the expressive function, and the advertising text involves both expressive and operative functions (Reiss, 2000, p. 25). The other is that the experiment materials are short to avoid causing fatigue. The shortness of texts might have weakened the varied linguistic features of the two text types. Consequently, in future studies, longer passages need to be selected to further explore the differences between the two.

To sum up, the impact of text type on temporal, technical, and cognitive effort is significant, which can be attributable to distinct linguistic features and textual functions. However, the above discussions have only shown the differences in translation effort. To explore why text type influences effort, we will further discuss the results in relation to translation entropy.

Translation entropy and effort. First of all, data analyses demonstrate differences among the four text types in phrasal and syntactic translation entropy. This lends support to the fact that translation entropy is associated with ST features on lexical, phrasal, and syntactic levels (Carl, 2021; Lacruz et al., 2021; Ogawa et al., 2021). Translation entropy, as a measure of translation uncertainty, reflects the number of options that translators are faced with (Carl et al., 2016, p. 29). The result of our studies shows that different text types, which embody distinct linguistic features and textual functions, endow translators with various options, thus affecting the degree of translation uncertainty and effort.

Second, positive correlations are observed between translation entropy and such indicators as subjective ratings, translation time, fixation, and pause. This echoes previous findings (Bangalore et al., 2015; Schaeffer et al., 2016; Carl and Schaeffer, 2017). It provides further evidence that translation uncertainty leads to translation difficulty and influences translators' cognitive processes (Angelone and Shreve, 2011, p. 108). High translation entropy indicates high uncertainty, causing more translation effort. Furthermore, this research studies Chinese and English languages, which belong to different language families. It is in keeping with the research focusing on other distant languages, such as Japanese–English and Japanese–Spanish translations, which finds a correlation between translation entropy and effort (Lacruz et al., 2021, p. 295). In this way, it confirms that translation entropy is correlated to translation effort even when the source and target languages do not belong to the same language family.

Third, the legal text has the highest translation entropy on phrasal and syntactic levels, while the news text has the lowest. The same pattern can be seen in effort indicators, as discussed earlier. The result shows that the linguistic features of legal and new texts cause variant degrees of translation uncertainty and, hence, translation effort. The highest translation uncertainty in legal translation arises from the use of jargon and complex syntactic structure (Paolucci, 2017, p. 326) and the asymmetry between legal systems (Biel, 2017, p. 78). Lexical and grammatical knowledge play an important role in text comprehension. The highest translation entropy of the legal text implies that translators may not have sufficient legal knowledge to deal with jargon and complex syntactic structures. Furthermore, every legal system consists of its own terminologies (Biel, 2017, p. 78), which may intensify transfer uncertainty. Faced with such uncertainty, translators have to pay more attention to legal translation. It implies that more training in terms of domain knowledge is needed. In contrast, the lowest translation entropy of news translation is related to the fact that news carries clearer information with concrete wording and simple syntactic structure (Buono and Snajder, 2017, p. 138). Concrete words have lower translation uncertainty (Laxén and Lavaur, 2010, p. 158). It implies that translators are able to understand the concrete information assisted with their general background knowledge and are more certain about how to convey the information.

Fourth, the phrasal and syntactic entropy of the advertising text is higher than news, and the same trend appears in effort indicators. The varied functions of the two text types are the main causes of various translation uncertainty. As mentioned earlier, advertising tends to use concise wording and simple syntactic structure (Leech, 1966, pp. 186–193), and news also uses concrete wording and concise syntactic structure (Buono and Snajder, 2017, p. 138). This suggests that the original meaning of news and advertising texts is easy to understand, and translators encounter lower comprehension uncertainty in news and advertising translation. However, advertising prioritizes the operative function and often uses rhetorical devices such as prosody or rhythm to appeal to consumers (Cook, 2001, p. 105). For this reason, advertising translation entails more creativity, and translators need to deal with higher transfer and production uncertainty.

Finally, it is worth noting that the poetic text has higher translation entropy than the advertising text. It provides evidence that literary translation causes higher translation variability than non-literary translation (Sun and Shreve, 2014, p. 120). Data analyses suggest that translation entropy is positively correlated to subjective ratings. It lends support to the findings that subjective ratings are reliable to measure translation effort (Vieira, 2017, p. 42; Cui et al., 2023, p. 12). Poetry is rated to be more difficult to translate than the advertising text. This is attributable to the fact that figurative expressions in poetic text have higher translation entropy than non-figurative expressions (Ogawa et al., 2021, p. 160). It implies that translators experience higher comprehension and production uncertainty when translating figurative expressions.

Conclusion

This study has investigated the impact of text type on Chinese–English translation effort via an eye-tracking and key-logging experiment and discussed the impact with reference to translation entropy. The major findings include the following. First, the impact of text type on translation effort is significant, and such impact can be traced back to the distinct linguistic features and textual functions of ST. Second, the differences in phrasal and syntactic entropy suggest that different text types cause variant degrees of translation uncertainty, and translators need to make variant efforts to manage the uncertainty. Besides, translation entropy is positively correlated with effort indicators. This provides solid evidence that translation uncertainty is actually the main cause of translation difficulty, and high uncertainty results in more translation effort. Third, the legal text causes the highest translation effort, followed by poetry, advertising, and news texts, as reflected in subjective ratings and objective indicators. The same trend can be observed in translation entropy, which helps to explain why translators experience different efforts when translating the four text types. The findings imply that the text type of ST affects translators' cognitive processes, and translation entropy can provide a new perspective on how and why translators experience effort. Meanwhile, this research has two limitations. Participants were restricted to student translators. While the homogeneity of participants leads to more generalizable conclusions, diversity in sampling will reveal more nuanced differences. Besides, this study used short passages as experiment materials to avoid fatigue on the part of participants, which might have attenuated the varied linguistic features of different text types. In future research, we plan to invite professional translators to participate in the experiment and select longer passages to further confirm the current findings.

Data availability

The datasets generated and/or analyzed during the current study are not publicly available because they concerned individual participants, and we made it clear in the Form of Consent that their data would not be made public, but they are available from the corresponding author on reasonable request. The experiment materials and data analysis code are publicly available at: https://github.com/2236117534/Translation-experiment-.git.

Received: 5 August 2023; Accepted: 14 May 2024;
Published online: 25 May 2024

References

Angelone E (2010) Uncertainty, uncertainty management and metacognitive problem solving in the translation task. In: Shreve GM, Angelone E (eds) Translation and cognition. John Benjamins, Netherlands, pp. 17-40

Angelone E, Shreve GM (2011) Uncertainty management, metacognitive bundling in problem solving, and translation quality. In: O'Brien S (ed) Cognitive explorations of translation. Continuum, London, pp. 108–130

Bangalore S, Behrens B, Carl M, Ghankot M, Heilmann A, Nitzke J, Schaeffer M, Sturm A (2015) The role of syntactic variation in translation and post-editing. Transl Spaces 4(1):119–144. https://doi.org/10.1075/ts.4.1.06sch

Bangalore S, Bergljot B, Carl M, Ghankot M, Heilmann A, Nitzke J, Schaeffer M, Sturm A (2016) Syntactic variance and priming effects in translation. In: Carl M, Bangalore S, Schaeffer M (eds) New directions in empirical translation process research. Springer, Cham, pp. 211–238

Biel Ł (2017) Researching legal translation: multi-perspective and mixed-method framework for legal translation. Rev Lleng Dret 68:76–88. https://doi.org/10.2436/rld.i68.2017.2967

Buono MPD, Snajder J (2017) Linguistic features and newsworthiness: an analysis of news style. Paper presented at the proceedings of the fourth Italian conference on computational linguistics CLIC-IT 2017, Rome, 11–12 December 2017

Burnham KP, Anderson DR (2004) Multimodel inference: understanding AIC and BIC in model selection. Sociol Methods Res 33:261–304. https://doi.org/10.1177/0049124104268644

Campbell S (2000) Choice Network Analysis in translation studies. In: Olahan M (ed) Inter-cultural faultlines. Research models in translation studies 1. Textual and cognitive aspects. St. Jerome, Manchester and Northampton, pp. 29–42

Carl M (2021) Information and entropy measures of rendered literal translation. In: Carl M (ed) Explorations in empirical translation process research. Springer, Cham, pp. 113–140

Carl M, Schaeffer M, Bangalore S (2016) The CRITT translation process research database. In: Carl M, Bangalore S, Schaeffer M (eds) New directions in empirical translation process research. Springer, Cham, pp. 13–54

Carl M, Schaeffer M (2017) Why translation is difficult: a corpus-based study of non-literality in post-editing and from-scratch translation. HERMES 56:43–57. https://doi.org/10.7146/hjlcb.v0i56.97201

Castilho S (2016) Measuring acceptability of machine translated enterprise content. Unpublished Doctoral Dissertation, Dublin City University

Cook G (2001) The discourse of advertising. Routledge, London

Cui Y, Liu X, Cheng Y (2023) A comparative study on the effort of human translation and post-editing in relation to text types: an eye-tracking and key-logging experiment. SAGE Open 13(1):1–15. https://doi.org/10.1177/21582440231155849

Dragsted B (2004) Segmentation in translation and translation memory systems: an empirical investigation of cognitive segmentation and effects of integrating a TM system into the translation process. Dissertation, Copenhagen Business School

Dragsted B, Carl M (2013) Towards a classification of translation styles based on eye tracking and key-logging data. J Writ Res 5(1):133–158. https://doi.org/10.17239/jowr-2013.05.1.6

Duchowski A (2003) Eye tracking methodology: theory and practice. Springer, Heidelberg

El-Shiyab S (1999) The difficulty of translating literary texts. Bable 45(3):205–216. https://doi.org/10.1075/babel.45.3.03shi

Gieshoff AC, Heeb AH (2023) Cognitive load and cognitive effort: probing the psychological reality of a conceptual difference. Transl Cogn Behav 6(1):3–28. https://doi.org/10.1075/tcb.00073.gie

Gile D (1991) The processing capacity in Conference Interpretation. Babel 37(1):15–27

Gile D (1995) Basic concepts and models for interpreter and translator training. Benjamins, Amsterdam

Halskov Jensen E (1999) The translator and the legal text: an empirical study of the effects of linguistic complexity and LSP on the translation of a Spanish Text. Dissertation, Copenhagen Business School

Hu K, O'Brien S, Kenny D (2020) A reception study of machine translated subtitles for MOOCs. Perspectives 28(4):521–538. https://doi.org/10.1080/0907676X.2019.1595069

Hvelplund KT (2021) Translation, attention and cognition. In: Alves F, Jakobsen AL (eds) The Routledge handbook of translation and cognition. Typeset in Bembo by Newgen Publishing, UK, pp. 279–293

Immonen S, Mäkisalo J (2010) Pauses reflecting the processing of syntactic units in monolingual text production and translation. Hermes (44):45–61. https://doi.org/10.7146/hjlcb.v23i44.97266

Jakobsen AL (2019) Segmentation in translation: a look at expert behaviour. In: Li D, Lei V, He Y (eds) Researching cognitive processes of translation. New frontiers in translation studies. Springer, Singapore, pp. 71–108

Just MA, Carpenter PA (1980) A theory of reading: from eye fixation to comprehension. Psychol Rev. 87:329–354

Kahneman D (1973) Attention and effort. Prentice-Hall, Englewood Cliffs, NJ

Koponen M, Aziz W, Ramos L, Specia L (2012) Post-editing time as a measure of cognitive effort. Paper presented at the proceedings of the AMTA 2012 workshop on post-editing technology and practice WPTP 2012, San Diego, 28 October 2012

Krings HP (2001) Repairing texts: empirical investigations of machine translation post-editing processes (trans: Koby GS). The Kent State University Press
Kunilovskaya M, Ilyushchenya T, Morgoun N, Mitkov R (2023) Source language difficulties in learner translation: evidence from an error-annotated corpus. Target 35(1):34–62. https://doi.org/10.1075/target.20189.kun
Lacruz I (2017) Cognitive effort in translation, editing and post-editing. In: Schwieter JW, Ferreira A (eds) Handbook of translation and cognition. John Wiley and Sons, Inc., pp. 386–401
Lacruz I, Denkowski M, Lavie A (2014) Cognitive demand and cognitive effort in post-editing. Paper presented at the proceedings of the third workshop on post-editing technology and practice AMTA 2014, Vancouver, 22–26 October 2014
Lacruz I, Shreve G, Angelone E (2012) Average pause ratio as an indicator of cognitive effort in post-editing: a case study. Paper presented at the proceedings of the workshop on post-editing technology and practice AMTA 2012, San Diego, 28 October 2012
Lacruz I, Ogawa H, Yoshida R, Yamada M, Ruiz MD (2021) Using a product metric to identify differential cognitive effort in translation from Japanese to English and Spanish. In: Carl M (ed) Explorations in empirical translation process research. Springer, Cham, pp. 295–314
Laxén J, Lavaur JM (2010) The role of semantics in translation recognition: effects of number of translations, dominance of translations and semantic relatedness of multiple translations. Bilingualism 13(2):157. https://doi.org/10.1017/S1366728909990472
Leech GN (1966) English in advertising: a linguistic study of advertising in Great Britain. Longmans
Liu Y, Zheng B, Zhou H (2019) Measuring the difficulty of text translation: the combination of text-focused and translator-oriented approaches. Target 31(1):125–149. https://doi.org/10.1075/target.18036.zhe
Ma X, Han T, Li D (2022) A cognitive inquiry into similarities and differences between translation and paraphrase: evidence from eye movement data. PLoS ONE 17(8):e0272531. https://doi.org/10.1371/journal.pone.0272531
Mellinger CD, Hanson TA (2017) Quantitative research methods in translation and interpreting studies. Routledge, London
Mellinger CD, Hanson TA (2018) Order effects in the translation process. Transl Cogn Behav 1:1–20. https://doi.org/10.1075/tcb.00001.mel
Meteyard L, Robert AID (2020) Best practice guidance for linear mixed-effects models in psychological science. J Mem Lang 112:1–22. https://doi.org/10.1016/j.jml.2020.104092
Moorkens J, O'Brien S, Silva IAL, Fonseca N, Alves F (2015) Correlations of perceived post-editing effort with measurements of actual effort. Mach Transl 29(3):267–284. https://doi.org/10.1007/s10590-015-9175-2
Moray N (1967) Where is capacity limited? a survey and a model. Acta Psychol 27:84–92
Munday J (2008) Introducing translation studies: theories and applications. Routledge, London
Ogawa H, Gilbert D, Almazroei S (2021) RedBird: rendering entropy data and source-text background information into a rich discourse on translation. In: Carl M (ed) Explorations in empirical translation process research. Springer, Cham, pp. 141–164
Paolucci S (2017) Foreignizing and domesticating strategies in translating legal texts. Int J Leg Discourse 2(2):325–345. https://doi.org/10.1515/ijld-2017-0014
Pavlovic N, Jensen KTH (2009) Eye tracking translation directionality. In: Pym A, Perekrestenko A (eds) Translation research projects 2. Intercultural studies group, pp. 93–109
Rayner K, Chace KH, Slattery TJ, Ashby J (2006) Eye movements as reflections of comprehension processes in reading. Sci Stud Read 10(3):241–255
Reiss K (2000) Translation criticism: the potentials and limitations: categories and criteria for translation quality assessment. St. Jerome
Saldanha G, O'Brien S (2013) Research methodologies in translation studies. Routledge, New York
Schaeffer M, Dragsted B, Hvelplund KT, Balling LW, Carl M (2016) Word translation entropy: evidence of early target language activation during reading for translation. In: Carl M, Bangalore S, Schaeffer M (eds) New directions in empirical translation process research: exploring the CRITT TPR-DB. Springer, Cham, pp. 183–210
Seeber K (2011) Cognitive load in simultaneous interpreting: existing theories—new models. Interpreting 13(2):176–204
Shannon CE (1948) A mathematical theory of communication. ACM SIGMOBILE Comput Commun Rev 5:3–55. https://doi.org/10.1145/584091.584093
Sun S, Shreve GM (2014) Measuring translation difficulty: an empirical study. Targets 26:98–127. https://doi.org/10.1075/target.26.1.04sun
Tokowicz N (2014) Translation ambiguity affects language processing, learning, an representation. Paper presented at the proceedings of the 2012 second language research forum, Pittsburgh, 18–21 October 2012
Vieira LN (2016) How do measures of cognitive effort relate to each other? A multivariate analysis of post-editing process data. Mach Transl 30:41–62. https://doi.org/10.1007/s10590-016-9188-5
Vieira LN (2017) Cognitive effort and different task foci in post-editing of machine translation: a think-aloud study. Across Lang Cult 18(1):79–105. https://doi.org/10.1556/084.2017.18.1.4
Wang F (2022) Impact of translation difficulty and working memory capacity on processing of translation units: evidence from Chinese-to-English translation. Perspectives 30(2):306–322. https://doi.org/10.1080/0907676X.2021.1920989
Wang Y, Daghigh AJ (2023) Effect of text type on translation effort in human translation and neural machine translation post-editing processes: evidence from eye-tracking and keyboard-logging. Perspectives https://doi.org/10.1080/0907676X.2023.2219850

Acknowledgements

This work was supported by the Humanities and Social Sciences Project Fund of Ministry of Education, P.R. China under Grant [23YJC740007].

Author contributions

The first author participated in the experiment design, implemented the experiment, conducted data analyses, and drafted the paper. The second author designed the study and revised the paper.

Competing interests

The authors declare no competing interests.

Ethical approval

The experiment was carried out at the School of Translation Studies, Shandong University. The School, specializing in humanities research, did not have a review board for experimental research at the time. However, as eye-tracking is noninvasive, the experiment was safe for participants. We tried to uphold research ethics by explaining to participants the detailed experiment procedure, how data would be anonymized, and how their privacy would be protected. We assured them that they could withdraw from the experiment at any time without any consequence. They all signed the Consent Form and participated in the experiment voluntarily.

Informed consent

We confirm that informed consent was obtained from all participants. Participants signed a Consent Form and took part in the experiment voluntarily. We informed them of the purpose of our research, the detailed procedure of the experiment, and the anonymous treatment of data in the Form.

Additional information

Correspondence and requests for materials should be addressed to Ying Cui.