# Employing Information Entropy in Literary Translation: Evaluating Fuzziness Equivalence[1]

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**Abstract:** This paper proposes a new method of measuring text fuzziness in equivalence between a target text (TT) and its source text (ST) by employing Claude Shannon's information entropy theory. The method is demonstrated through a four-step algorithmic process using illustrative examples from the novel *The Da Vinci Code* and its two Chinese translations. Specifically, information entropy is applied to measure the uncertainty associated with readers' understanding of the ST and its corresponding TTs. The underlying hypothesis is that the probability distribution of which readers will understand identified fuzzy text can be measured and that the intrinsic uncertainty of a fuzzy item can also be evaluated by calculating its corresponding entropy value in Shannon's information theory. The paper thus offers both an alternative approach and a supplement to conventional analyses and evaluations of translated texts in literary studies.

**Keywords:** fuzzy language, translation, equivalence, measurement, information entropy, *The Da Vinci Code*

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## 1. Introduction

The use of fuzzy language is a key feature of literary works. But what exactly is "fuzzy language?" Fuzziness is essentially about indeterminacy or, simply, "vagueness." The notion arises in a number of disciplines, such as literary criticism, philosophy, psychology, cognitive science, and linguistics (Channell; Dompere; Furkó et al.). C. S. Peirce's definition of the concept of vagueness is commonly referred to when discussing fuzziness, and is incorporated in various ways into more recent definitions of fuzzy or vague language. The first part of his definition is quoted below:

Indeterminate in intention. A proposition is vague when there are possible states of things

> concerning which it is intrinsically uncertain whether, had they been contemplated by the speaker, he would have regarded them as excluded or allowed by the proposition. By intrinsically uncertain we mean not uncertain in consequence of any ignorance of the interpreter, but because the speaker's habits of language were indeterminate. (Peirce 748)

The concept of "intrinsic uncertainty" is of interest to our study as it suggests that there are propositions or linguistic items, be they words or expressions, that are inherently "vague," and do not lend themselves to precision. This vagueness is not about "information" or "overgeneralization," but concerns general indeterminacy in the language itself. Ronald Carter and Michael McCarthy's work suggests that vague language is a feature of spoken English and is primarily used for interpersonal reasons in order to "soften" what could be taken as an "unduly authoritative and assertive" tone (19). The examples they give are expressions such as "or something, or anything, or whatever" in requests such as "can you get me a sandwich or something?" or "sort of" or "kind of" in situations where speakers do not wish "to commit themselves completely to the truth value of a proposition" (19). In contrast to these vague expressions are expressions which convey preciseness, such as a meeting date and time, the length of a piece of land, or a person's blood pressure. Literary works may employ a variety of types of vague language, including "spoken language" in dialogic moments, and through which the personality of a character may be constructed, as well as other types of vague language which, as Peirce suggests, hold an intrinsic uncertainty.

When it comes to discussing vague language, Joanna Channell's seminal work is often referenced. Her definition of vague language is: "An expression or word is fuzzy if: 1) it can be contrasted with another word or expression which appears to render the same proposition; 2) it is 'purposely and unabashedly fuzzy'; 3) its meaning arises from the 'intrinsic uncertainty' referred to by Peirce" (20). In literary works, that which is unsaid or said unclearly (or vaguely, ambiguously, etc.) often brings about the verve of a literary work. This is because vagueness may trigger or evoke a memory, an idea, a feeling, that may not be the same for every reader. This allows flexibility and scope for different readers to interpret and identify with what is read due to the different "storehouses of background knowledge" that readers bring to the work (Gerrig 362).

While fuzziness in literary works may allow the essence and meaning of the work to be differentially relatable across a wide readership, the handling of fuzziness in translation is not easy and requires painstaking efforts on the part of the translator. In a similar manner, translation principles do not break down into uniform, discrete units. Notions such as "faithfulness," "equivalence," and "adequacy" are always difficult to define. In addition, methods of measuring a translation vary among translation scholars. For instance, some scholars treat "modulation" as distinct from "oblique translation" (van Leuven-Zwart), while others (Vinay and Darbelnet) consider it a special type of oblique translation. In some cases, it is difficult to decide whether one should opt for particularizing translation to reproduce subtle "fuzzy" meanings of the ST, or zero translation so that the fuzzy items of the ST and its TT are interchangeable to the maximum degree. Probably more serious than this is the Pandora's box of deciding when and how a culture-specific fuzzy expression can be adequately transformed into the target language-culture.

In view of its complex nature, translators generally believe that fuzzy language is hard to assess precisely, and that conventional translation theories and criteria are inadequate in providing solutions to measuring the fuzziness of translated texts. Thus, it seems, one must go beyond the conventional territories of translation and translation theory and look for new ways

to assess fuzziness in translation. In this paper I incorporate ideas from the field of information theory and the concept of information entropy. Information theory itself is from the general field of mathematics and was first introduced by Claude Shannon. The theory has to do with the quantification, storage, and communication of information. The concept of information entropy concerns characterizing the uncertainty, ambiguity, and disorder of stochastic processes.

To stay abreast of the ever-growing blurred margin between translation studies and other areas of scholarly inquiry, Maria Tymoczko (141, 143, 145) argues that everyone in the field must commit to a broad reading program that reaches widely into the humanities, social sciences, and natural sciences in search of material relevant, even essential, to their own specialties in translation. Furthermore, a mastery of the basics of scientific inquiry is crucial. Whatever one's position on science, she suggests that insofar as one's research in translation studies involves gathering and interpreting data—assembling a corpus, undertaking numerical analysis, offering an explanation, or recommending translation practices—one will be operating in a domain that cannot be dissociated from what has traditionally been called the "scientific method." One can see that insofar as scholars attempt to define types of translations in terms of sensible effects and to outline habits of action in terms of those effects, these scholars and teachers of translation are implicitly appealing to scientific reasoning in translation studies. Because such arguments permeate all translation studies, it is not, therefore, a matter of injecting scientific thinking into the field or fighting to keep it out; rather, it is a question of better understanding the particular characteristics of scientific reasoning in translation studies and honing methodologies in order to improve research protocols already used in the discipline. This approach underlies the research reported in this paper.

The main objectives of this paper are: (1) to discuss the fuzziness in readers' understanding of the information content of a given text, either an ST or a TT; (2) to study the functional dimension of information entropy; (3) to illustrate the application of the concept of information entropy to the handling of fuzzy items in translation; and (4) to argue for an objective way of assessing the equivalence between a TT and its ST in terms of fuzzy language. The aim is to ensure that the translator develops confidence in formulating his or her solutions to problems of fuzzy-language handling in terms of Shannon's information theory, thus enriching the literature in translation studies where such applications are deemed appropriate.

The main questions that are addressed are: (1) What has previously been done in the study of fuzzy language in translation? (2) What is information entropy and how can we employ this concept to measure fuzziness in literary works? And (3) how do we determine which TT is closer to the ST in terms of linguistic fuzziness?

## 2. The Study of Fuzzy Language in Translation

Fuzzy language has been studied widely by translation scholars. However, through logging into such databases and indexes as Scirus, SSCI, A&HCI, Translation Studies Abstracts, Translation Studies, and Translation and Literature, I find that most of the research is solely focused on computer science and fuzzy matching, for example in Zadeh, Pirkola et al., Verkeyn and Botteldooren, and Toivonen et al. Since our study considers fuzziness in relation to the

translation of literary texts, and specifically translations from English to Chinese, I briefly review research which deals with fuzzy language and translating from English to Chinese.

In China, according to CNKI (China National Knowledge Infrastructure), as of 20 January 2021, 581 articles have been written on the fuzziness of language and translation. Although the first Chinese translation scholar in this particular field is said to be Fan Shouyi, who applied fuzzy mathematics to translation assessment, for a long time previously, translation evaluation in the Chinese tradition was based on a qualitative analysis which had evolved from Yan Fu's[2] three translation principles *xin* (信; fidelity/faithfulness/truthfulness), *da* (达; fluency/expressiveness/intelligibility/comprehensibility) and *ya* (雅; elegance/gracefulness). However, these translation principles were rather vague and subjective, and although some scholars proposed quantitative analyzes of translations using these principles, problems still persisted due to a lack of elaboration on how to make use of these three principles. Facing this problem, Fan employed basic theories and methods from fuzzy mathematics to conduct preliminary quantitative analyzes of translations, thus calling for a more scientific and quantitative approach to translation criticism. Other scholars who have contributed to this kind of research include Hou Guojin, Mu Lei, and Fan Wuqiu.

Hou critiques translation equivalence using "Markedness Theory," proposing a "Pragmatic Markedness Equivalence Principle" (PMEP)—an approach to translation evaluation. According to Hou (viii), the highest standard for PMEP is full representation of the ST in "markedness" value, that is, in "M-Term" numbers and degrees, so that a TT is read by TT readers in the same manner as the ST is read by ST readers. This standard, like E. A. Nida's theory on reader response (Nida; Nida and Taber), is but an ideal, as explained by the 12 Axioms of PMEP and the pragmatic-markedness equivalence model. Therefore, to complement this work, Hou also proposes a model for calculating a numerical (pragmatic-markedness) equivalence value (NEV) in translation. Taking into account a number of pragmatic parameters (e.g. wording, structure, rhetoric, politeness, etc.) of the ST and its TT(s), and on the condition that the general meaning, intention, and attitude of the ST are adequately conveyed in the TT(s), Hou explores how the quality of a translation can be evaluated when there is only one TT, and how to distinguish a good translation from a bad translation when there is more than one TT. He also discusses how to compare translation styles when two TTs are both "good"; and how to determine which TT outperforms the other. Hou applies his ideas by examining two English versions of the Chinese novel *The Story of the Stone*. However, his study is somewhat subjective in nature[3] and its results are thus difficult to quantitatively verify.

Mu examines methods of marking text-based translation tests in translation teaching. Based on a fuzzy synthetic evaluation, she has devised a model which invites a more quantifiable way to define the fine variables that translation teachers tacitly work with but seldom make overt in their marking. However, her model mainly focuses on evaluating translations from the teachers' point of view, with no way of understanding the reader's or test taker's perspective on fuzziness. This is disappointing since the aim of her research is to find a way to judge the translation quality of a translated work, where the evaluators play a key role. The model also does not provide a mechanism for comparing or analyzing the fuzziness of an ST against its TT, or the fuzziness arising in the translation process itself.

In an attempt to define fuzzy language from the perspective of aesthetics, Fan Wuqiu offers an interesting study on the aesthetic features of fuzziness, referring to them as constituting the most important characteristic of Chinese writing. In his discussion of fuzziness in Chinese texts, Fan refers to such notions as linguistic dialectics, semiotic aesthetics, reception aesthetics, and

Gestalt psychology. He also interprets the aesthetic ablation of fuzziness in Chinese–English (C–E) translation by comparing Chinese with English textual features, and proposes compensating mechanisms (such as resorting to creative thinking to retain the elegance of the fuzziness of the original). He thus provides macroscopic and directive ideas for C–E translation. However, there are several limitations to his study. For example, there is a lack of analysis of a complete work, which makes his analyses seem too piecemeal or isolated-sentence based; there is also a heavy use of indirect translation (e.g. the English TTs used for his case study were English versions from Swedish instead of directly from the Chinese original); and his definition of fuzzy language is not very operational, thus making it difficult for others to use.

Shao suggests that fuzzy items can be viewed mainly from three levels: the temporal and spatial dimensions of the language, the culture, and the rhetorical features of the novel. Each dimension could be further divided into two aspects: one involving the denotative and connotative meanings of the language used and the other involving its pragmatic meanings or significance. Shao argues that a dialectical relationship exists between what is fuzzy and what is "accurate" or "precise" in literary language, and this applies to the process of translation as well. Shao proposes that fuzzy logic and fuzzy linguistics, which derive from multi-valued, rather than binary logic, have convincing explanatory power for the fuzzy nature of language and translation. Through introducing the notion of "fuzziness" into translation research, Shao contends that on both the operational level of translation practice and at the abstract level of translation theory, there is "fuzziness"; on the one hand, the translator is faced with the need to handle fuzzy language in texts during the translation process; and on the other, there is the problem of a theoretical fuzziness when the translator tries to decide or discuss what approaches to take in solving the problem of fuzzy items and texts. Based on this understanding, Shao maintains that the traditional binary division in translation theory and methods, such as "literal" and "free translation," is defective because such a dichotomy does not correctly reflect the "fuzzy" nature of translation and its related methodology. She suggests that the best approach to the translation of fuzzy items is not advocating for a "literal" or "free" translation but to match "fuzziness" with "fuzziness." From this basic approach, a whole series of strategies and techniques may derive, including the matching of different types and degrees of fuzziness. Therefore, Shao's work contributes to an enhanced understanding of fuzzy language in literature and creates a foundation for developing a theoretical account of literary "fuzzy language" within translation studies in general.

Some of the innovative ideas presented in Shao are explored in this paper. That is, I go beyond the conventional type of textual analysis of a TT and search for a "scientific" and less subjective way of assessing the fuzziness of language and the extent of equivalence in fuzziness between a TT and its ST. Ultimately our paper proposes a more comprehensive marking scheme based on Shannon's concept of information entropy.

## 3. Information Entropy as a New Approach

As already mentioned, the concept of information entropy derives from Shannon's information theory. Entropy can be used to determine the minimum channel capacity required to reliably transmit information in binary digits. The formula is derived by calculating the mathematical

expectation of the amount of information contained in a digit from the information source. Information entropy measures the information contained in a message as opposed to the portion of the message that is determined (or predictable). Examples of the latter include redundancy in language structure or statistical properties relating to the occurrence of frequencies of letter or word pairs, triplets, etc. When applied to translating, the uncertainty being measured is the readers' understanding of the ST and the TT(s).

In order to test the suitability of the application of information entropy to translation, I first recruited 20 subjects to record their answers to two questions focused on the overall degree of fuzziness in an ST and a TT. It was found that the subjects' responses were always subjective and largely unsuitable for comparison because their understanding of fuzziness varied and there was no objective means against which they could base their evaluation. The two questions are shown below:

**Question 1**

Please select one answer from the following options that most represents your feeling about the ST: (_____).

A. not fuzzy B. somewhat fuzzy C. rather fuzzy D. very fuzzy

**Question 2**

On a scale of 0 to 100 points, where 0 represents not fuzzy and 100 represents the fuzziest, please measure the fuzziness of the TT: (_____).

The subjectivity of the responses can be explained in the following way. For Question 1, if $S_1$ chose option B while $S_2$ chose option C it did not mean that $S_2$'s understanding of the ST is necessarily fuzzier than that of $S_1$'s, because it is difficult to conduct an objective comparison between the understanding of $S_1$ and of $S_2$, respectively, since their answers reflect their personal understanding of the notion of "fuzziness." Similarly, for Question 2, if $S_1$'s answer is 75 points and $S_2$'s answer is 70 points we cannot say for certain that $S_1$'s understanding of the ST is necessarily fuzzier than $S_2$'s. Therefore, it becomes difficult to find an objective and feasible way to assess the fuzziness of the readers' understanding of the texts using typical translation evaluations.

Our next step was to select terms and expressions from a text which had previously been assessed as fuzzy in translation evaluations. The fuzziness evaluation was based on the uncertainty of the readers' understanding of those terms and expressions. These were then considered from the point of view of information entropy. That is, the terms and expressions were measured in terms of the amount of information that would be missing before reception.

The formula for information entropy is derived by calculating the mathematical expectation of the amount of information contained in a digit from the information source. The entropy $H(X) \equiv H_n(p)$ of the ensemble $\{(x_1, p_1), (x_2, p_2),...,(x_n, p_n)\}$ as defined by Shannon is given in the following expression:

$$H(X) \equiv H_n(p) = H_n(p_1, p_2, \ldots, p_n) = -c\sum_{i=1}^{n} p_i \log p_i.$$

In the above expression, $c$ is an arbitrary positive constant, generally taken as unity when the logarithm base is 2 and entropy is measured in bits. To provide for impossible events, 0log0 is taken as zero. It is important to note that entropy $H_n(p) = \sum_{i=1}^{n} p_i h(p_i)$ is the average information

(Karmeshu and Pal 3–4) where $p = \{p_1, p_2, \ldots, p_n\}$ and $h(p_i) = -c\log p_i$.

In applying this to ascertaining the degree of fuzziness of a translation and its relation to the source text, the formula is reinterpreted as follows:

Let $S$ be a given text, $S = \{X_1, X_2, \ldots, X_i, \ldots, X_n\}$ , where $X_i$ is the $i$ -th fuzzy item in $S$, $i \in [1, \ldots n]$. Suppose there are $m_i$ different forms of understanding of a single fuzzy item $X_i$ from the point of view of a group of readers $R$:

$R(X_i) = \{\langle X_{i,1}, \mu_{i,1}\rangle, \langle X_{i,2}, \mu_{i,2}\rangle, \ldots, \langle X_{i,m_i}, \mu_{i,m_i}\rangle\}$

In the above expression, when $\mu_{i,j} \geqslant 0$ and $\sum_{i=1}^{n} \mu_{i,j} = 1$, $x_{i,j}$ is the $j$ -th form of understanding of $X_i$ and $\mu_{i,j}$ is the probability of $X_i$ on the condition of $x_{i,j}$ in view of $R$, according to Shannon's theory, for the readers $R$, the entropy of $X_i$ is:

$$H_R(X_i) = -\sum_{j=1}^{m_i} \mu_{i,j} \log \mu_{i,j}$$

If the fuzzy items in $S$ are mutually independent, for the readers $R$, the entropy of $S$ is:

$$H_R(S) = -\sum_{i=1}^{n} H_R(X_i) = -\sum_{i=1}^{n} \sum_{j=1}^{m_i} \mu_{i,j} \log \mu_{i,j}$$

When the distribution of the readers' understanding of $X_i$ is in a continuous interval, $R(X_i) = \langle x_i, p(x_i)\rangle$, $x_i \in [L, U]$, $L$ is in the lower boundary of the interval (all of the elements in the interval should be larger than or equal to $L$) and $U$ is in the upper boundary of the interval (all of the elements in the interval should be less than or equal to $U$). According to the information entropy measure, for the readers $R$, the entropy of $X_i$ is an integral of $[L, U]$:

$$H_R(X_i) = -\int_L^U p(x_i) \log p(x_i)\, dx_i$$

For the sake of convenience, the value $H_R(X_i)$ can be calculated approximately by using a piecewise integration and the mean value theorem as follows:

$$H_R(X_i) = -\int_L^U p(x_i) \log p(x_i)\, dx_i = \sum_{j=1}^{m_i} \left[-\int_L^U p(x_i) \log p(x_i)\, dx_i\right]$$

$$= -\sum_{j=1}^{m_i} [\log p(\xi_{i,j}) \int_L^U p(x_i)\, dx_i], \text{ where, } \bigcup_{j=1}^{m_i} [L_j, U_j] = [L, U], \quad [L_j, U_j] \bigcap [L_k, U_k]$$

$$= \phi : \forall j, k \in [1, \ldots m], \ j \neq k, \text{ and } \xi_{i,j} \in [L_j, U_j].$$

When the interval is divided equally and small enough, it can be proved that

$$H_R(X_i) \approx -\sum_{j=1}^{m_i} (\mu_{i,j} \log \mu_{i,j}) - \log \Delta \text{ where } \mu_{i,j} = \int_{L_j}^{U_j} p(x_i)\, dx_i, \ \Delta = U_j - L_j.$$

The above equation indicates that when the interval is divided equally and is small enough, the value of $H_R(X_i)$ is only dependent on $-\sum_{j=1}^{m_i} (\mu_{i,j} \log \mu_{i,j})$. As the value of $\mu_{i,j}$ can be estimated by a questionnaire, I use $-\sum_{j=1}^{m_i} (\mu_{i,j} \log \mu_{i,j})$ to measure the degrees of fuzziness of a text.

Backtracking a little, the Entropy Law is a statement that all energy in an isolated system

moves from an ordered to a disordered state. The minimum entropy state, where concentration is highest and where available energy is at a maximum, is the most ordered state. By contrast, the maximum entropy state, where available energy has been totally dissipated and diffused, is the most disordered state. Thus, for our purposes, the more entropy a text has, the fuzzier the items will be, whereas the least amount of entropy, where perspicuity and available energy are highest, will produce the most understandable (least fuzzy) items.

For the research reported in this paper, I developed a four-step algorithm for measuring the entropy of fuzzy text as follows:

1. Identify the fuzzy items in a given text;
2. Analyze the different forms of understanding a single fuzzy item may have for a group of readers and count the probability of "fuzzy understanding";
3. Calculate the fuzzy degree of a single item from the point of view of those readers;
4. Calculate the degree of fuzziness for the entire text, contrasting the various TTs being studied so as to determine which of these is closer to the ST in terms of the fuzziness of its items.

The following sections follow these steps using two passages and their translations from *The Da Vinci Code* by Dan Brown. The translations of the novel are those by Zhu Zhenwu, Wu Sheng, and Zhou Yuanxiao (TT1) and You Chuanli (TT2), both in Chinese.

## 4. Illustrating the Application of Information Entropy in Translation

### 4.1 Introduction

To measure the degrees of fuzziness regarding the readers' understanding of a text using information entropy entails precise calculation of the probability distribution of the readers' understanding of the text. For this study, I recruited 20 bilingual (English–Chinese) readers from amongst students and teachers at a tertiary institution and from different departments in the institution with the students from different years. Each participant was asked to read the ST and its two TTs. Their different understandings regarding several items and expressions in the TTs were obtained using a set of questions, such as "Please mark the interpretations of 'X' after you have read the ST," using points between 0–6 (incorrect, mostly incorrect, somewhat incorrect, somewhat correct, mostly correct, correct). While there were several fuzzy items I could have chosen to illustrate the information entropy method, in this paper I focus on the responses to a select few which represent a range of grammatical structures: a lexical item, a name, an interrogative sentence, and a noun phrase with modifiers. Specifically, the ST terms and expressions were: *keystone*, *Vittoria*, *have you mounted her?*, and *diminutive insecure leaders*. Section 4.2 focuses on the term "keystone" (Item Ⅰ) and section 4.3 focuses on the other three items (Items II, III, IV) since they occur in close proximity with each other in the text.

### 4.2 *Keystone*

The question and answer format for analyzing the entropy of "keystone" is shown in Figure 1.

Question:
Please mark the interpretations of "keystone" after you have read the ST, using points between 0–6 (incorrect, mostly incorrect, somewhat incorrect, somewhat correct, mostly correct, correct).
The central stone at the top of an arch that keeps all the other stones in position; ( )
The most important part of a plan or argument that the other parts depend on; ( )
The wedge-shaped stone; ( )
I have other understandings of "keystone":
_____ ( ).

Figure 1. The Question and Answer Format for Item I, *Keystone*

The probability distribution of the readers' understanding of fuzzy items in the ST and its TTs can be found through a normalization and calculation based on their responses to the question. For instance, if a reader's responses to the four understandings above are as follows: somewhat correct, mostly incorrect, mostly incorrect, incorrect, their answers will be: 3, 1, 1, and 0, then after normalization, the distribution of this reader's understanding is: 0.6, 0.2, 0.2, and 0.

The term "keystone" is presented below in the paragraph in which it occurs in the ST and the two TTs—TT1 (Zhu et al.) and TT2 (You). The term is highlighted in bold in each text.

ST: According to lore, the brotherhood had created a map of stone—a *clef de voûte* […] or keystone—an engraved tablet that revealed the final resting place of the brotherhood's greatest secret […] information so powerful that its protection was the reason for the brotherhood's very existence. (Brown 28)

TT1: 据传，郇山隐修会制作了一个石头地图，即拱顶石，或曰**塞缝石**。这是一块铭文石板，上面揭示着郇山隐修会最大的秘密被隐藏的地方。这秘密太重要了，郇山隐修会就是为了保护它而存在。(Zhu et al. 10)

Pinyin of TT1: Jùchuán, Xúnshān Yǐnxiūhuì zhìzuòle yī gè shítou dìtú, jí gǒngdǐngshí, huò yuē sāifèngshí. Zhè shì yī kuài míngwén shíbǎn, shàngmian jiēshìzhe Xúnshān Yǐnxiūhuì zuì dà de mìmì bèi yǐncáng de dìfang. Zhè mìmì tài zhòngyào le, xúnshān yǐnxiūhuì jiùshì wèile bǎohù tā ér cúnzài.

TT2: 根据传说，这个兄弟会制作了一个石头地图——法文称为clef de voûte，**英文是**keystone，**亦即拱心石**——这块雕刻过的石板，上面有该兄弟会最大秘密的最后栖身之地……这个讯息的力量之大，以至于该修会存在的目的，就是为了要保护这个秘密。(You 20)

Pinyin of TT 2: Gēnjù chuánshuō, zhè gè xiōngdìhuì zhìzuòle yī gè shítou dìtú——fǎwén chēngwéi clef de voûte, yīngwén shì keystone, yìjí gǒngxīnshí——zhè kuài diāokèguo de shíbǎn, shàngmian yǒu gāi xiōngdìhuì zuì dà mìmì de zuìhòu qīshēn zhī dì……zhè gè xùnxī de lìliàng zhī dà, yǐzhìyú gāi xiūhuì cúnzài de mùdì, jiù shì wèile yào bǎohù zhè gè mìmì.

Using various English dictionaries, I can say that the term "keystone" in English has at least two meanings: (a) the central stone at the top of an arch that keeps all the other stones in position, and (b) the most important part of a plan or argument that the other parts depend on. The Chinese term, "塞缝石" (*sāifèngshí*), literally means: "fill-gap-stone"/"wedge-shaped stone." As for "英文是keystone，亦即拱心石" (*yīngwén shì keystone, yìjí gǒngxīnshí*) in TT2, there are at least four possible readings in Chinese: (a) TT readers who are totally ignorant of the English language will have no idea whatsoever about the meaning of "英 文 是keystone," nor will they readily understand what kind of stone an "arch-heart stone" (拱心石) is because the Chinese term is a new coinage and is not in common usage; (b) TT readers who are totally ignorant of the English language will have no idea of what "英文是keystone" means, although they do know what "拱心石" means; (c) TT readers who know the English word in "英文是keystone" do not readily understand what "arch-heart stone" (拱心石) means; and (d) TT readers who know what "英文是keystone" means believe that "arch-heart stone" (拱心石) refers to "a round or heart-shaped stone." Table 1 illustrates the different forms of the readers' understanding of the fuzzy items related to "keystone."

Table 1. Different Possibilities of the Readers' Understanding of "Keystone"

| Items | Discription |
|---|---|
| A | The central stone at the top of an arch that keeps all the other stones in position |
| B | A wedge-shaped stone |
| C | The most important part of a plan or argument that the other parts depend on |
| D | TT readers who are totally ignorant of the English language will have no idea whatsoever about what "英文是keystone" means, nor will they readily understand what kind of stone an "arch-heart stone" (拱心石) is because the Chinese term is a new coinage and is not yet in common usage |
| E | TT readers who are totally ignorant of the English language will have no idea what "英文是keystone" means, although they do know what "拱心石" means |
| F | TT readers who know the English word in "英 文 是keystone" do not readily understand what "arch-heart stone" (拱心石) means |
| G | TT readers who know what "英文是keystone" means believe that "arch-heart stone" (拱心石) refers to "a round or heart-shaped stone" |

Table 2 shows the probability of the group of readers' understanding of the ST, TT1, and TT2 through their responses to the question. The different understandings of ST readers and TT readers are put together. In Table 2, "0.6" indicates that the probability for "keystone" to be understood as "A" is 0.6. The right-most row is the total entropy of a fuzzy expression. "0" means that the corresponding item is not fuzzy and there is no ambiguity about its meaning. With regard to "keystone," hypothetically, readers who do not know Chinese will not understand the meanings expressed in D through G. The same type of measurement can also be applied to "塞缝石" (fill-gap-stone) in TT1 and "英文是keystone，亦即拱心石" (i.e. the English [expression] is "keystone," meaning "arch-heart stone"). The principles are the same as those for analyzing the other possible understandings, marked B through G, respectively, in Table 2.

Table 2. Categories of Forms of Understanding

| Items | A | B | C | D | E | F | G | Entropy |
|---|---|---|---|---|---|---|---|---|
| keystone | 0.6 | 0.2 | 0.2 | 0 | 0 | 0 | 0 | 1.3710 |
| 塞缝石 (fill-gap-stone) | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 英文是keystone，亦即拱心石 (i.e. the English [expression] is "keystone," meaning "arch-heart stone") | 0 | 0 | 0 | 0.2 | 0.3 | 0.25 | 0.25 | 1.9855 |

According to the results, the probability of different forms of understanding by the 20 subjects can be described as "keystone" = {⟨*A*,0.6⟩, ⟨*B*,0.2⟩, ⟨*C*,0.2⟩, ⟨*B*,0.2⟩, ⟨*Others*,0⟩}. Applying Shannon's formula and its reinterpretation for fuzziness in translation (see Section 3), the entropy or fuzziness of the item "keystone" is calculated in the following way:

$$H_R(\text{“keystone”}) = -\sum_{j=1}^{m_i} \mu_{i,j} \log \mu_{i,j} = -(0.6\times\log 0.6 + 0.2\times\log 0.2 + 0.2\times\log 0.2) = 1.3710$$

When I apply this formula to the two Chinese translations of keystone, I find that the entropy for "塞缝石" is 0 and the entropy for "英文是keystone，亦即拱心石" is 1.9855. I can represent a comparison of entropy across the three items—the ST, TT1, and TT2 in the following way:

$H_R$("英文是keystone，亦即拱心石") > $H_R$("keystone") > $H_R$("塞缝石")

A calculation of this yields the following:

| $H_R$("keystone")−$H_R$("塞缝石") = 1.3710

| $H_R$("keystone")−$H_R$("英文是keystone，亦即拱心石") = 0.6145

The results of the calculations show that the TT2 "英文是keystone，亦即拱心石" is fuzzier or vaguer than the ST "keystone" and the TT1 "塞缝石," and that TT2's expression is closer to the ST (keystone) in terms of fuzziness.

#### 4.3 Analyzing *Vittoria* (Item II), *Have You Mounted Her?* (Item III), and *Diminutive Insecure Leaders* (Item IV)

The next items I discuss are in close proximity to each other in the text and so I discuss these together. The following excerpt shows each of the items in context and highlighted using bold font.

> ST: […] Seeing it, Langdon thought of Vittoria, recalling their playful promise a year ago that every six months they would meet again at a different romantic spot on the globe. The Eiffel Tower, Langdon suspected, would have made their list. Sadly, he last kissed Vittoria in a noisy airport in Rome more than a year ago.
>
> "Did you mount her?" the agent asked, looking over.
>
> Langdon glanced up, certain he had misunderstood. "I beg your pardon?"
>
> "She is lovely, no?" The agent motioned through the windshield toward the Eiffel Tower. "Have you mounted her?"
>
> Langdon rolled his eyes. "No, I haven't climbed the tower."
>
> "She is the symbol of France. I think she is perfect."
>
> Langdon nodded absently. Symbologists often remarked that France—a country renowned for machismo, womanizing and diminutive insecure leaders like Napoleon and Pepin the Short—could not have chosen a more apt national emblem than a thousand-foot phallus. (Brown 32–33)

TT1: […] 看到铁塔，兰登想起了**维多利亚**，想起了他一年前玩笑般的承诺。他说他们每六个月都要在全球范围内换一个浪漫的地方约会。兰登想，当时艾菲尔铁塔一定是上了他们的名单的。遗憾的是，他一年多前在罗马一个喧闹的机场和维多利亚吻别。

“你上过她吗？”侦探看着远方问。

兰登抬头看了他一眼，确信自己错解了意思。“对不起，你说什么？”

“她很美，不是吗？”侦探透过挡风玻璃指向艾菲尔铁塔。“**你上过她吗？**”

兰登的眼珠转了转。“没有，我还没爬过那座铁塔。”

“她是法国的象征。我认为她完美无瑕。”

兰登心不在焉地点了点头。符号学家常说，法国是一个以男子气概、爱好女色，以及拥有像拿破仑和矮子丕平这样**矮个子又缺乏安全感的领袖**而闻名的国度。它选择一个一千英尺高的男性生殖器作为国家的象征再合适不过了。(Zhu et al. 13)

Pinyin of TT 1: Kàndào tiětǎ, Lándēng xiǎngqǐle Wéiduōlìyà, xiǎngqǐle tā yī nián qián wánxiào bān de chéngnuò. Tā shuō tāmen měi liù gè yuè dōu yào zài quánqiú fànwéi nèi huàn yī gè làngmàn de dìfāng yuēhuì. Lándēng xiǎng, dāngshí Àifēi’ěr Tiětǎ yīdìng shì shàngle tāmen de míngdān de. Yíhàn de shì, tā yī nián duō qián zài Luómǎ yī gè xuānnào de jīchǎng hé Wéiduōlìyà wěnbié.

“Nǐ shàngguo tā ma?” Zhēntàn kànzhe yuǎnfāng wèn.

Lándēng táitóu kànle tā yī yǎn, quèxìn zìjǐ cuòjiěle yìsi. “Duìbùqǐ, nǐ shuō shénme?”

“Tā hěn měi, bù shì ma?” Zhēntàn tòuguò dǎngfēng bōlí zhǐxiàng Àifēi’ěr Tiětǎ. “Nǐ shàngguo tā ma?”

Lándēng de yǎnzhū zhuànle zhuan. “Méiyǒu, wǒ hái méi páguo nà zuò tiětǎ.”

“Tā shì fǎguó de xiàngzhēng. Wǒ rènwéi tā wánměi-wúxiá.”

Lándēng xīnbùzàiyān de diǎnle dian tóu. Fúhàoxuéjiā cháng shuō, Fǎguó shì yī gè yǐ nánzǐ qìgài, àihǎo nǚsè, yǐjí yōngyǒu xiàng Nápòlún hé Ǎizi Pīpíng zhèyàng ǎi gèzi yòu quēfá ānquángǎn de lǐngxiù ér wénmíng de guódù. Tā xuǎnzé yī gè yīqiān yīngchǐ gāo de nánxìng shēngzhíqì zuòwéi guójiā de xiàngzhēng zài héshì bùguò le.

TT2: […] 看着艾菲尔铁塔，兰登想起了**薇多利雅**，忆起一年前他们曾玩笑地承诺，说每隔六个月就要在全世界各个不同的浪漫地点重逢一次。而兰登猜想，艾菲尔铁塔也将成为他们名单上的地点之一。令人哀伤的是，他最后一次吻薇多利雅，是在嘈杂的罗马机场，那是一年多前了。

“你上过她吗？”那个探员问着，望向远方。

兰登抬头，确定自己听错了。“你说什么？”

“她好美，不是吗？”那个探员指指挡风玻璃外头的艾菲尔铁塔。“**你爬上去过吗？**”

兰登翻了个白眼。“没有，我没上去过那个塔。”

“她是法国的象征。我觉得她真是完美。”

兰登心不在焉地点点头。符号学家们常评论说，法国——这个素以其男性气概、沉溺女色、以及拿破仑和“矮子”贝班这类**矮小无安全感的领袖**而著称的国家——再也找不出比一千尺阳物更适合的国家象征了。(You 24)

Pinyin of TT2: Kànzhe Àifēi’ěr Tiětǎ, Lándēng xiǎngqǐle Wēiduōlìyǎ, yìqǐ yī nián qián tāmen céng wánxiào de chéngnuò, shuō měi gé liù gè yuè jiù yào zài quánshìjiè gè gè bùtóng de làngmàn dìdiǎn chóngféng yī cì. Ér Lándēng cāixiǎng, Àifēi’ěr Tiětǎ yě jiāng chéngwéi tāmen

míngdān shàng de dìdiǎn zhī yī. Lìng rén āishāng de shì, tā zuìhòu yī cì wěn Wēiduōlìyǎ, shì zài cáozá de Luómǎ jīchǎng, nà shì yī nián duō qián le.

"Nǐ shàngguo tā ma?" Nà gè tànyuán wènzhe, wàng xiàng yuǎnfāng.

Lándēng táitóu, quèdìng zìjǐ tīngcuò le. "Nǐ shuō shénme?"

"Tā hǎo měi, bù shì ma?" Nà gè tànyuán zhǐzhi dǎngfēng bōlí wàitou de Àifēi'ěr Tiětǎ. "Nǐ pá shàngqù guo ma?"

Lándēng fānle gè báiyǎn. "Méiyǒu, wǒ méi shàngqù guo nà gè tǎ."

"Tā shì Fǎguó de xiàngzhēng. Wǒ juéde tā zhēn shì wánměi."

Lándēng xīnbùzàiyān de diǎndian tóu. Fúhàoxuéjiāmen cháng pínglùn shuō, Fǎguó——zhè gè sù yǐ qí nánxìng qìgài, chénnì nǚsè, yǐjí Nápòlún hé "ǎizi" Bèibān zhè lèi ǎixiǎo wú ānquángǎn de lǐngxiù ér zhùchēng de guójiā——zàiyě zhǎobùchū bǐ yīqiān chǐ yángwù gèng shìhé de guójiā xiàngzhēng le.

The highlighted fuzzy items II, III, and IV found in the ST and its TTs are shown in Table 3.

Table 3. Fuzzy Items II, III, and IV and Their Translations in Example 2

| Fuzzy Items | ST | TT1 | TT2 |
|---|---|---|---|
| II | Vittoria | 维多利亚 (Wéiduōlìyà, *Vittoria*) | 薇多利雅 (Wēiduōlìyǎ) |
| Ⅲ | Have you mounted her? | 你上过她吗?(ni shangguo ta ma?; *Have you been on her?*) | 你爬上去过吗? (ni pa shangqu guo ma?; *Have you climbed on her?*) |
| Ⅳ | diminutive insecure leaders | 矮个子又缺乏安全感的领袖(ai gezi you quefa anquangan de lingxiu; *short leaders lacking a sense of security*) | 矮小无安全感的领袖(aixiao wu anquangan de lingxiu; *short leaders with no sense of security*) |

The different forms of understanding for the readers of the fuzzy items listed in Table 3 are presented in Tables 4, 5, and 6:

Table 4. Different Forms of Understanding Item II *Vittoria* (ST, TT1, and TT2)

| Items | Discription |
|---|---|
| A | heroine who figures prominently in Dan Brown's 2000 novel *Angels and Demons* as Robert Langdon's accomplice, and in the end of the book has intimate relations with Robert (valid in ST, TT1, and TT2). |
| B | Robert's ex-girlfriend, whom the author Dan Brown doesn't account for in *The Da Vinci Code* (valid in ST, TT1, and TT2). |
| C | Some woman in Robert's mind whom Robert is often thinking of (valid in ST, TT1, and TT2). |

Table 5. Different Forms of Understanding Item III *Have You Mounted Her?* (ST, TT1, and TT2)

| Items | Discription |
|---|---|
| D | Have you mounted the Eiffel Tower? (valid in ST and TT2). |
| E | Have you mounted a mountain/a hill/a building? (valid in ST and TT2). |
| F | Have you had sex with a woman in the agent's mind? (valid in ST and TT1). |
| G | Have you had sex with Vittoria? (valid in ST and TT1). |

Table 6. Different Forms of Understanding Item Ⅳ *Diminutive Insecure Leaders* (ST, TT1, and TT2)

| Items | Discription |
|---|---|
| H | Very small leaders lacking self-confidence (valid in TT1 and TT2). |
| I | Very small leaders who make their people insecure (valid in ST, TT1, and TT2). |
| J | Short and fat leaders lacking self-confidence (valid in TT1). |
| K | Short and fat leaders who make their people insecure (valid in ST and TT1). |
| L | Short and lean/skinny leaders lacking self-confidence (valid in TT1 and TT2). |
| M | Short and lean/skinny leaders who make their people insecure (valid in ST, TT1 and TT2). |

Through the evaluation of the group of readers' views of these fuzzy items, the probability of forms of different understandings among readers is calculated. Tables 7 through 9 show the results of the responses to the different forms of understanding and the calculation of the information entropy for each item.

Table 7. Categories of Forms of Understanding for *Vittoria* (Table 4)

| Item Ⅱ | A | B | C | Entropy |
|---|---|---|---|---|
| Vittoria (ST) | 0.4 | 0.2 | 0.4 | 1.5219 |
| 维多利亚 (wéiduōlìyà) (TT1) | 0.35 | 0.35 | 0.3 | 1.5813 |
| 薇多利雅 (wēiduōlìyǎ) (TT2) | 0.1 | 0.5 | 0.4 | 1.3610 |

Table 8. Categories of Forms of Understanding for *Have You Mounted Her?* (Table 5)

| Item Ⅲ | D | E | F | G | Entropy |
|---|---|---|---|---|---|
| Have you mounted her? | 0.35 | 0.1 | 0.1 | 0.45 | 1.7129 |
| 你上过她吗？(ni shangguo ta ma?; Have you been on her?) | 0 | 0 | 0.3 | 0.7 | 0.8813 |
| 你爬上去过吗？(ni pa shangqu guo ma?; Have you climbed on her?) | 0.9 | 0.1 | 0 | 0 | 0.4690 |

Table 9. Categories of Forms of Understanding for *Diminutive Insecure Leaders* (Table 6)

| Item Ⅳ | H | I | J | K | L | M | Entropy |
|---|---|---|---|---|---|---|---|
| diminutive insecure leaders | 0 | 0.5 | 0 | 0.3 | 0 | 0.2 | 1.4855 |
| 矮个子又缺乏安全感的领袖 (ai gezi you quefa anquangan de lingxiu; *short leaders lacking a sense of security*) | 0.1 | 0.3 | 0.1 | 0.2 | 0.1 | 0.2 | 2.4464 |
| 矮小无安全感的领袖 (aixiao wu anquangan de lingxiu; *short leaders with no sense of security*) | 0.15 | 0.45 | 0 | 0 | 0.2 | 0.2 | 1.8577 |

## 5. Analysis and Visualization of the Readers' Responses

In this section I analyze the different understandings of readers by means of probability distribution, and information entropy. The corresponding results are presented in the form of histograms.

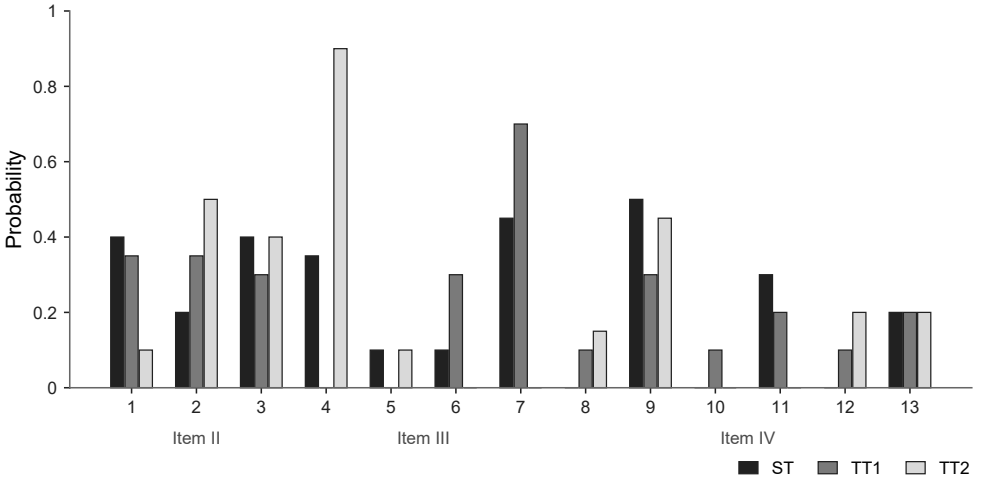


Figure 2. Probability Distribution of Different Forms of Understanding

Figure 2 shows the probability distribution of the different forms of understanding of fuzzy items II, III, and IV. There are three forms of understanding for fuzzy item II, four for fuzzy item III, and six for fuzzy item IV. In all, there are 13 forms of understanding shown along the X-axis. The Y-axis manifests the probability of a form of understanding by readers. The higher the probability, the more likely readers will understand that particular form. "0" on the Y-axis means there is no probability of a form of understanding, while "1" on the Y-axis means that there is a 100% probability of a certain form of understanding. The X-axis lists all forms of understanding in fuzzy items II, III, and IV. The black columns, the gray columns, and the white columns, respectively, represent the probability distribution of ST, TT1, and TT2. For example, the X-axis 6 shows "Have you had sex with a woman in the agent's mind?" where the probability of TT2 is "0," which means that its readers do not have this kind of understanding. Similarly, X-axis 4 shows "Have you mounted the Eiffel Tower?" where the probability of TT2 is "0.9," which means that there is a 90% probability of this form being understood by the readers.

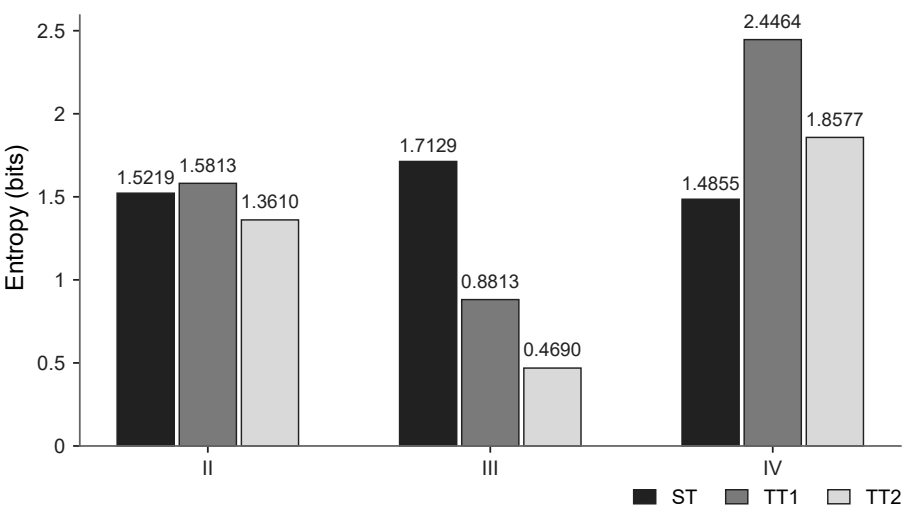


Figure 3. Entropy of Items in Terms of Fuzziness

Figure 3 shows the entropy of fuzzy items II, III, and IV. The X-axis is an entropy axis, according to which the larger the entropy, the fuzzier an item. For instance, the entropy of the ST in X-axis for III is larger than that of TT1 or that of TT2. That is, "Have you mounted her?" is fuzzier than "你上过她吗?" (Have you been on her?) or "你爬上去过吗?" (Have you climbed on her?).

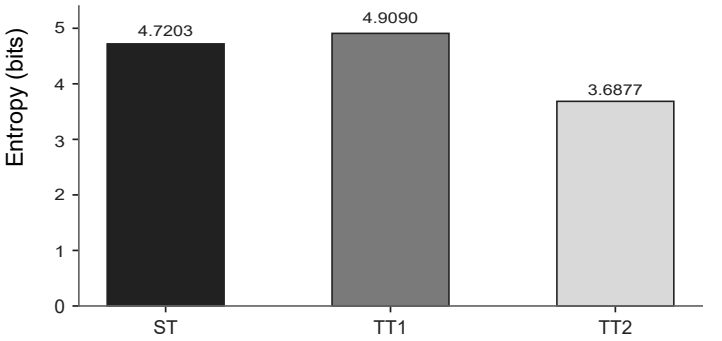


Figure 4. Entropy of ST, TT1, and TT2 for Items II, III, and IV

Figure 4 is the sum of the degree of fuzziness of ST, TT1, and TT2. The black, gray, and white column each represent the total degree of fuzziness of the three sets of items in Example 2, representing the ST, TT1, and TT2, respectively. It can be seen clearly from Figure 4 that TT1 is the fuzziest, ST less fuzzy, and TT2 the least fuzzy.

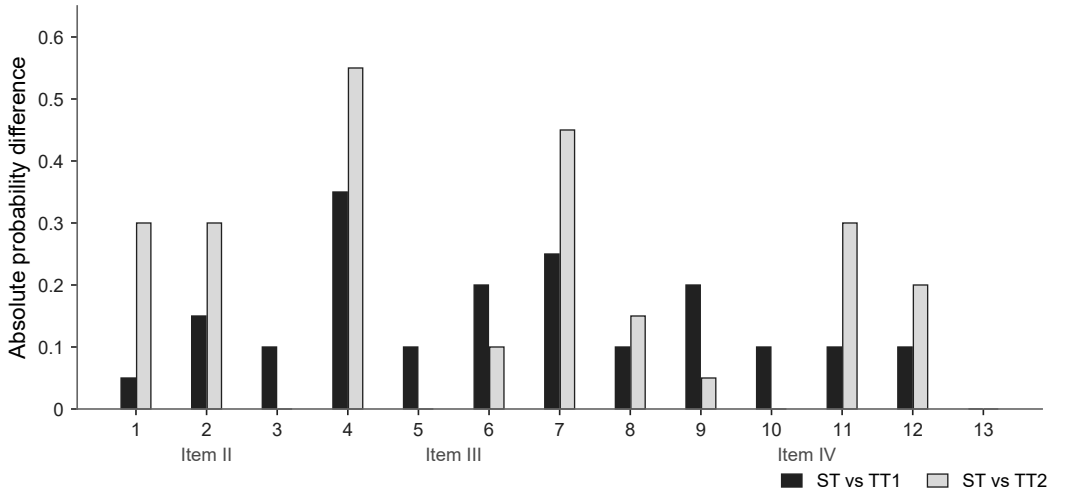


Figure 5. Difference in Probability in Forms of Understanding

Figure 5 contrasts the probability distribution of the forms of understanding in the difference between the fuzzy items in the ST and TT1 (represented by the black columns) with the parallel difference between the fuzzy items in the ST and TT2 (represented by the white columns). The smaller the sum of the differences put together between a TT and the ST, the closer this TT is to the ST in terms of the understanding by readers of the TT and ST respectively. For example, X-axis 13, "short and lean/skinny leaders who make their people insecure," shows that the probability of the forms of understanding in the ST, TT1, and TT2 are the same.

Figure 6 shows the sum of the differences in the probability distribution of the understanding between the fuzzy items in the ST and those in TT1 (black column) and the sum of the differences between the fuzzy items in the ST and those in TT2 (white column). It can be seen from Figure 6 that the sum of the differences of probability between the ST and TT1 is smaller than that between the ST and TT2. That is, TT1 is closer to the ST in terms of the probability distribution of the forms of understanding.

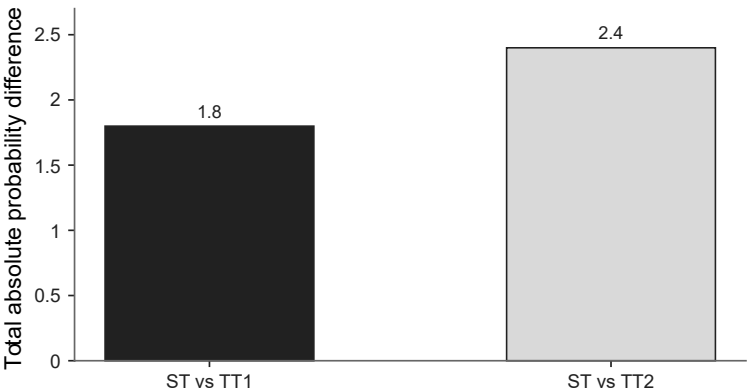


Figure 6. Sum of Differences in the Probability Distribution across All Items

Figure 7 exemplifies the fuzzy degrees of ST, TT1, and TT2 in items II, III, and IV. The black columns show the differences between the fuzzy degrees—the entropy of fuzzy items in the ST and those in TT1. The white columns represent the differences between the fuzzy degrees of items in the ST and those in TT2. The X-axis for II is "ST (Vittoria), TT1 (维多利亚/wéiduōlìyà), and TT2 (薇多利雅/wēiduōlìyǎ)"; the X-axis for III is "ST (Have you mounted her?), TT1 (你上过她吗?/Have you been on her?), and TT2 (你爬上去过吗?/Have you climbed on her?)"; and the X-axis for IV is "ST (diminutive insecure leaders), TT1 (矮个子又缺乏安全感的领袖/short, lacking-sense-of-security leaders), and TT2 (矮小无安全感的领袖/short, small, with-no-sense-of-security leaders)." With regard to fuzzy items II and III, the fuzzy degree of TT1 is closer to that of the ST. However, in fuzzy item IV, the fuzzy degree of TT2 is closer to the ST.

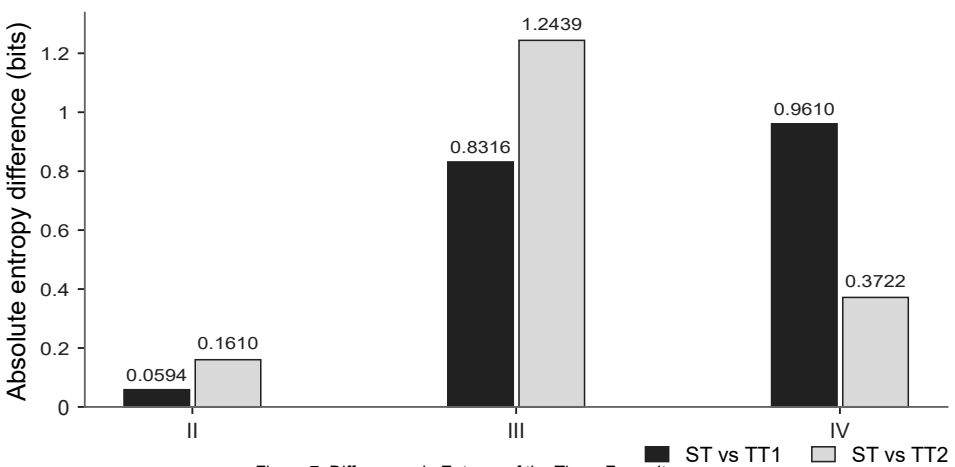


Figure 7. Differences in Entropy of the Three Fuzzy Items

Figure 8 shows the sum of the differences in the degree of fuzziness for ST, TT1, and TT2. The smaller the sum, the closer a TT is to its ST. From the results we can see that TT1 is more faithful than TT2 to the ST in terms of the fuzziness of language from the perspective of the readers. By comparing Figure 6 and Figure 8, we can see that the two measures capture different aspects of fuzziness equivalence. In terms of the probability distribution of readers' interpretations, TT1 is closer to the ST. In terms of aggregate entropy difference, however, TT2 is slightly closer to the ST. This suggests that fuzziness equivalence should be assessed through both distributional similarity and entropy-based uncertainty, rather than through a single numerical ranking.

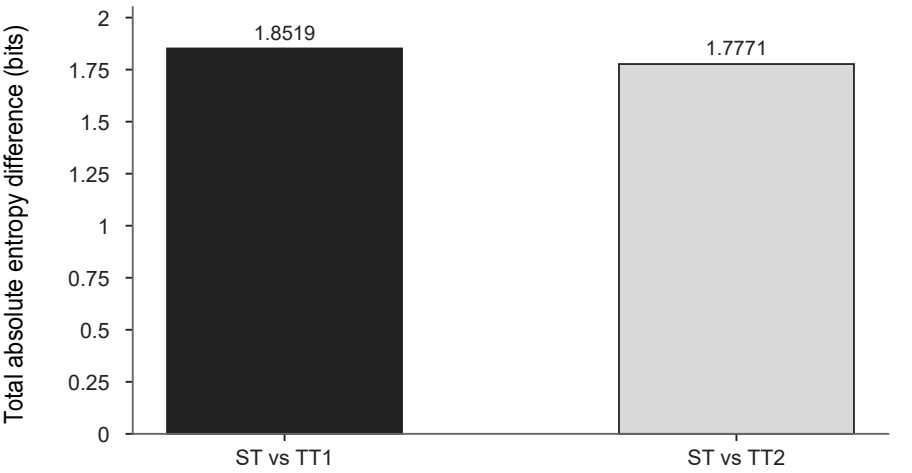

Figure 8. Contrast of Total Entropy for ST, TT1 and TT2

## 6. Conclusion

Analyzing fuzziness using information entropy entails assessing and counting the readers' understanding of fuzzy items in a text. As an alternative method to a quantitative study on textual fuzziness, the application of information entropy makes it possible to measure the degrees of fuzziness of the ST and its TT(s) and thus to open up an approach to analyzing and measuring reader understanding.

With regard to the process of translation, I. A. Richards once famously observed that it "may very probably be the most complex type of event yet produced in the evolution of the cosmos" (250). Indeed, translation is a complex activity, and it is clear that it is not possible to achieve 100% equivalence in the TT with regard to its ST. What one can do is to try to make the TT as similar as possible to its original. But how can one decide that a TT is similar to its ST? Is this "closeness" a verifiable concept, or is it very much something to be judged by the subjective mind? This study has tried to address these questions by using Shannon's measure of information entropy. The paper demonstrates that this approach is useful and effective when employed in the calculation of the fuzziness of an ST and its TT(s). By contrasting the fuzziness of a TT with that of an ST, information entropy theory provides the translator and translation critic with a more objective and scientific criterion for translation evaluation. As such, the use of information entropy in translation studies may represent a step towards a new direction in which other translational

aspects can be measured or assessed in a more objective way, including the stylistic features of translations and the idiosyncrasies of translators.

## Notes

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2. Yan Fu was a renowned Chinese thinker and translator. In the preface to his translation of Huxley's *Evolution and Ethics*, Yan presents his three translation principles, which came to be highly influential in Chinese translation during the 20th century (cf. Munday 46).

3. Hou's PMEP is a tentative attempt at describing and interpreting translation by combining Pragmatics and Nida's translation theory. It seems subjective due to the following reasons. 1) Not all words or items can be easily assigned the label of "[U]" or "M"; 2) Unmarkedness or Markedness is usually assessed in terms of one or two but never all of the six major criteria; 3) sometimes none works well enough; 4) sometimes some criteria contradict each other; 5) Unmarkedness or Markedness is a matter of subjectivity and degree; 6) that which seems or claims to be inequivalent translation may sometimes be Fair TT, not to say Ideal TT; 7) perfect translation does not entail a great knowledge of Markedness Theory or FEP and vice versa; 8) Even with PMEP, semantic loss still occurs so PMEP does not guarantee ideal translation; 9) NEV calculation lends itself to some measures of subjectivity; 10) NEV calculation is not as scientific as science, nor as artistic as art; 11) NEV calculation is not so valid with ST–TT comparison where there are few salient M-Value parameters thereby to compare, or where the M-Value of one or two parameters is vague or intangible; and 12) PMEP is a heavy borrower of theories, depending more on FEP of Nida and Markedness Theory than on other ideas and hypotheses.

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