

Translating Science into Chinese: An Interactive Perspective

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ABSTRACT

In the studies of science translation into Chinese, the focus lies primarily on the role of translation in knowledge transmission. In terms of the linguistic impact of science translation, the discussions tend to focus on the creation of terminology, and the attention of translators is drawn to different methods of translating new terms. The studies conducted in the past have been based mostly on specialised science, but nowadays, more and more science translations are targeting a lay audience. We feel that the translation of popular science is an area that remains under-researched. This paper presents an interactive perspective in the area of science translation, focusing on the genre of popular science. Literature reviews on pragmatic studies of science communication are explored and these insights are related to the changing perceptions of science translation. A quantitative analysis based on the English magazine *Scientific American* and its Chinese edition published in Taiwan sheds some light on the patterns of the selected interactive features in the translations. Two case studies are used to demonstrate how translators' interactive strategies are designed according to the purpose of translation and considerations regarding the target readers.

KEYWORDS

Science translation, popular science, pragmatics, interaction, deixis, personal reference, conjunction, hedging.

1. A historical view of science translation into Chinese

The history of science translation into Chinese dates back to 200 BC, and studies on science translation have traditionally been focused on two aspects: cultural and linguistic (Fan 2007: 67). The cultural aspect concerns knowledge transmission resulting from science translation. The studies on modern science translation are particularly interested in the large-scale translation activities at the end of the 19th century and early 20th century (e.g. Wright 2000, Xu 2005, Zhao 2007), when translation played an important role in the modernisation of China. "Saving China by science" (Fan 2007: 43) was the historical background of that period, and the translations were done mostly for the purpose of education.

When one considers the linguistic study of science translation, the area that has been explored most is methods of translating new terms and the standardisation of scientific terminology. Fan (2007) offers a historical account of how chemical terms were standardised by using different translation methods and borrowing words from Japanese in the early twentieth century. The problems of terminology continue as English is the *lingua franca* of science (see, for example, Montgomery 2009), and new words are being created all the time. Our survey on reviews in the first important popular scientific magazine published in Taiwan, *Science Monthly*, finds that scientists and readers repeatedly called for a

consistent use of translated terms since its first issue in 1970. The reviews on science translations also concentrate on inaccurate translations into Chinese or inappropriate coinage of new terminology.

In terms of the studies on the methods employed in science translation in Chinese, science translation is often seen as the opposite of literary translation (following the dichotomy literary/non-literary), and characterised by objectivity, standardisation, and its scientific and reality-based nature (Xu 2005: 1020). "Be accurate and faithful" is often the golden rule given to science translators (Lü and Hou 2001: 175), and translators are not expected to interfere with the text in any way. The excerpt below can be regarded as a prevailing view of science translation among Chinese scholars.

Perfect translation means to reappear the content and form of the original, but the former is more important in science translation. Therefore, faithfulness is the most important aspect of science translation, including faithful to the meaning, mood and logic of the original, since the goal of science translation is to introduce new ideas, new techniques and skills, and new methods. So science translation means to express the information of the original (Xu 2005: 1020).

The view generally taken is that science translation should be concerned more with the information itself rather than with the communication of information. Therefore, the translators' attention is always drawn to faithfulness to the meaning of the source text, whereas other concerns, if any, are secondary. It is believed that the aim of science translation is to provide new information, so accuracy of content is what matters.

In recent decades, more and more of the science articles that are translated are categorised as "popular science," i.e. science for the public, such as translations of popular science magazines and science news, and other reports or information written for the public. In academic contexts such as international journals, many scientists use English to communicate rather than relying on translations for updated information. On the contrary, the lay audience of science with no knowledge of foreign languages would have to rely on translations or second-hand information provided by local scientists. We feel that translation of popular science into Chinese is one area which is currently under-researched. The genre of popular science is different from specialised science in its salient features of interaction between writers and readers. The writing is less impersonalised, and the main purpose is to communicate accurate information to the readers, not just to present it to them. The main goal of science communication may not be to introduce new ideas (as described in the quotation above), but to arouse the interest of readers and involve more lay people in the world of science. To be able to work with popular science texts, the translators need to have a more comprehensive understanding of popular science writing, which brings the interactive dimension into consideration. The next section will introduce recent literature from the field of pragmatic studies in the genre of

popular science with regard to writer-reader interaction, which may shed some light on the Chinese translation of popular science.

2. Interactive dimension of the popular science genre

The most significant difference between the genres of popular science and specialised science is their target audience. Popular science is written for lay people, and this difference tends to lead to the simple conclusion that popular science writing is a process of simplification from academic language to ordinary language, by, for example, avoiding technicalities and using everyday terms.

However, the study of linguistic features in popular science in recent years has altered the traditional view that it is a process of simplification based on academic science. Rather, popular science is regarded as a sub-genre in science writing, with its own unique features of interaction. Hyland (2005: 37) comments on this genre:

What interests analysts about this is that academic papers written for specialists and popularised accounts of this research differ in their *purposes* and *audiences*, and so in their *use of language* (my emphasis).

Popular science is a sub-genre within science genres; it has its own rhetorical purposes and therefore employs different linguistic strategies. The aim of popular science is not simply to relay accurate scientific information, thus the writings are not always objective and detached. When considering the uses of language in science for lay people, Calsmiglia (2003: 142) reminds analysts to be aware of the ill-founded notions of “conceiving the linguistic representation of science as rhetoric-free, maximally informative and transparent.”

Pragmatic studies on the genre of popular science have shown that the scientific content is important, but the way it is communicated through the use of linguistic features is no less important. To be more specific, the linguistic resources that carry out the function of interaction in texts can be categorised into two rhetorical purposes (Hyland 2005: 49):

- *To guide the reader through the text:* the linguistic resources available are cohesive devices, such as conjunctions and deixis.
- *To involve the writer and the reader in the text:* the linguistic resources available are attitudinal markers, such as hedges and boosters, and first and second personal references.

By using these features in ways that differ from other scientific writings, the genre of popular science is able to achieve its different communicative purposes which do not coincide with other science writing. These micro-level features in the genre of popular science have been studied in relation to the communicative features of popular science. For example, Myers

(1989) compares linguistic strategies such as hedging, pronouns, jokes, etc. and relates them to the different politeness strategies used between expert-expert communication and expert-lay audience communication. He finds that when communicating to the lay audience, more personal attribution can be seen. Parkinson and Adendorff (2004) also examine the different writer-reader relationship in academic science writings, popular science writings, and textbook writings. Their finding is that the writer of popular science is cautious about not treating the readers as outsiders, and uses linguistic strategies to construct solidarity with lay readers.

From the point of view of knowledge assumption, Myers (1991) finds that given that lay readers have less scientific knowledge, cohesion in texts is largely achieved through explicit cohesive markers such as conjunctions and demonstrative pronouns, whereas in academic science implicit cohesive devices such as lexical cohesion is more often used. For example, a specialised reader will have no difficulty seeing the connection between *infection of human cells by adenovirus 2(Ad2)* and *Ad2 DNA*, but a lay reader may need an explicit cohesive marker to understand that the two phrases refer to the same process (*ibid*: 11).

Hyland (1998) and Varttala (1999) focus on how scientists use hedges to make their claims most effectively while considering the relations with their peers and the readers. For example, when a writer wants to put forward a claim, impersonal structures or nominalisations help move the readers' focus onto the claim itself rather than onto the writer's responsibility in making the claim.

These studies on the interactive dimension of popular science have all pointed out that the linguistic features that are used in texts for writer-reader interaction are worthy of more in-depth analysis. We would like to stress the importance of the inclusion of these views when dealing with translation of popular science, both in theory and in practice, and mitigate the gap between the current trend of science translations for the public and the translation studies that are still based on the framework of specialised science writings.

3. Some statistical indicators

We first carry out a statistical investigation on four quantifiable interactive features, including deixis, personal reference, conjunctions, and hedges, in a parallel corpus of popular science. The texts in the corpus include 66 English texts from the English magazine *Scientific American* and their Chinese translations published in Taiwan. Both English and Chinese publishers have their websites on which selected articles in each issue were published. We collected all the texts published between 2002 and 2005 that have both source texts and target texts available on the websites. The total word counts are 103,004 English words and 109,985 Chinese words. A 566,717-word science sub-corpus taken from the five-

million-word *Academia Sinica Balanced Corpus of Modern Chinese* is also included in this study in order to compare and contrast the translation corpus.

In the category of deixis, demonstrative pronouns and place and time adverbs are included. The category of personal references includes first person and second person references. In junctions, the most frequently used conjunctives in six semantic categories (additive, alternative, adversative, causal, hypothetical, and temporal) are calculated. In hedges, the most frequent hedges are calculated¹. As there is no straightforward equivalence of conjunctions and hedges between English and Chinese, we compare the statistics of these two categories only in the two Chinese corpora.

The table and the chart below show the frequency of the four interactive features in English, in the Chinese translation, and in the Chinese reference corpora.

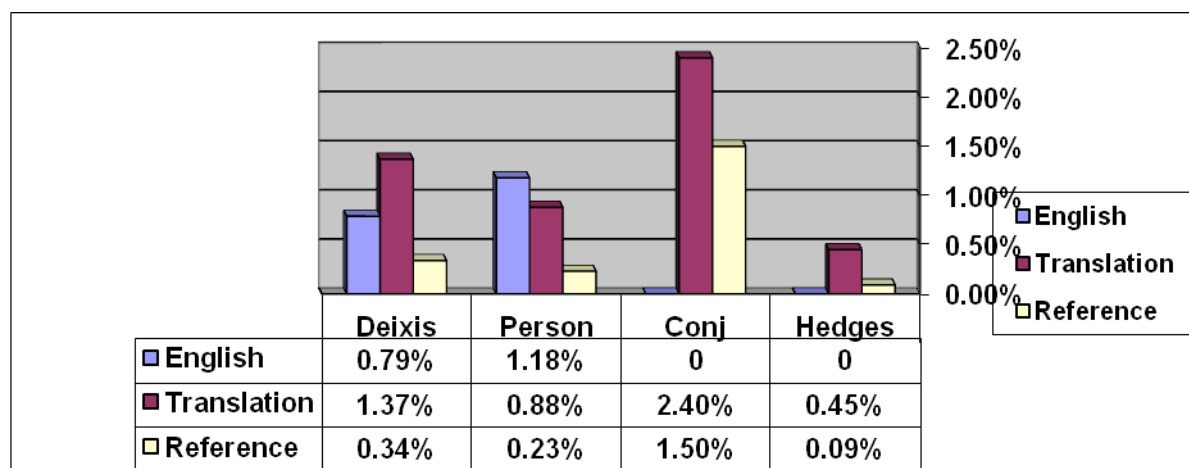


Fig 1 Frequency of Selected Interactive Features in the Corpora

The table shows that, compared with the Chinese reference corpus, the translation corpus has higher frequencies in the four categories of selected interactive features. The low frequency of interactive features in the reference corpus suggests that a high frequency of interactive features in the translation is not an accommodation to the Chinese norm, but a feature emerging from the process of translation. One explanation could be the influence of the source text, as the English corpus has higher frequencies of interactive features than the Chinese reference corpus. However, we can see that in the category of deixis, the Chinese translations have even higher frequencies than the source text. Therefore, it seems that the use of interactive features in the translation is not restricted by the Chinese norm, and cannot only be explained by the influence of source text. We suggest that the translator's decision based on other factors is involved in the process of translation. These findings confirm that interactive features in science translations are worthy of further investigation. In the following two case studies, we would like to

show what factors in texts motivate the translator's choices of interactive features, and how individual interactive features interact with other features in texts to achieve the overall aim of communication with the target readers.

4. Interactive strategies in translation: two case studies

As pointed out in the previous section, deixis, personal references, conjunction, and hedges are important indicators of the degree of interaction in texts. However, this does not suggest that every translation should contain as many of these features as possible. Rather, individual translations should use interactive strategies differently according to the specific interactive purpose they want to achieve, regarding the purpose of the source text and the target readers' background.

In this paper, we take two parallel texts from our corpus for closer analysis. When the Chinese edition of *Scientific American* was published in Taiwan, it received many credits in reviews and in sales. The influence and evaluation of this magazine can be seen from the fact that it has received national awards for best science magazine (Golden Tripod Awards for Publication Excellence, organised by the Taiwanese Government) every year since its publication in 2002, until the latest one in 2008.

The translation of this magazine shows a unique feature that is different from many other science translations in the past: its concern for readability. In a question and answer column on the Chinese publisher's website, (Kexueren 2009), the editor states that easy readability is their primary concern, and therefore they have decided to minimise the occasions where English originals are supplied after technical terms—a practice which used to be followed by most science translations in order to maintain accuracy and to avoid ambiguity. The publisher gives their reasons on the website. First, they suggest that other translated scientific articles tend to include the English specialised terms because of lack of confidence in the accuracy of their translations, while this magazine is translated by a group of scientific experts and they spare no effort in making their translation accurate and consistent, so the inclusion of the English source is not necessary. Second, inserting English words too often makes the Chinese translations look disorderly, and also makes readers process texts less smoothly. This statement suggests that the long historical debate of terminology may have come to an end. The translators are less occupied with terminology, and they start focusing on other aspects. Also, the publisher's decision has also shown that accuracy is not their only priority: how the readers approach the texts is also a top priority. Against this background, we would like to study how interactive features used in the translation of this magazine may have an effect on writer-reader interaction and contribute to readability.

Of the following two case studies, the first is a scientist's challenge to the validity of statistical evidence, and the second is a first-hand report written by a scientist. The purpose of these two case studies is to show that, under the general trend of a high frequency of interactive features as shown in our quantitative analysis, the translators adjust their strategies to interact with the target readers.

4.1 Case Study 1: Terror Bull (反恐吹牛王)

Terror Bull is an article from a famous column in *Scientific American* called “anti-gravity”. This series of columns challenges concepts that are too often taken for granted and are rarely examined by the public. This article questions the credibility of statistics that are usually cited as scientific evidence. A story is used as an introduction to the arguments, and then several scenarios are provided to give further support to how statistics can be manipulated in order to achieve a particular purpose.

Interaction in the source text is characterised by its frequent use of reference to the writer (*I*) and to the readers (*you*, except for those appearing in free indirect speech), and also the rather informal tenor, which makes the written texts read as if in spoken mode. The use of colloquial expressions, such as *well*, *you know*, *now*, *I'm sure*, also adds to the conversational style of the articles. The unconventional organisation of the articles—such as the presentation of several scenarios/results/conclusions and the free indirect speech—suggests that the article is designed to be informal and different from conventional science writings.

In the following examples, we will look at the translation shifts taking place in deixis, personal reference, conjunction, hedges, as well as other related interactive features, and investigate how the source text writer's interactive strategy is relayed in the target text.

In deictic shifts, the dominant trend in this article is the shifts towards proximity rather than distance. However, there are also several shifts towards distance, as shown in example 1.

Example 1

(ST) Actually, there were two days of rioting over gas shortages in Basra in August 2003, and officials did say it was a sign of an improving economy.

(TT) 事實上 2003 年 8 月巴斯拉真的因石油短缺而發生兩天暴動，當時官方的確聲稱那是經濟改善的跡象。

[In fact in August 2003 Basra really had two days of rioting due to gas shortages, at that time officials indeed said that it is a sign of an improving economy.]

In this example, the translation adds one distal temporal adverb and one distal demonstrative. One reason for the temporal adverb being added may be related to the fact that Chinese grammar does not encode the tense system in grammatical inflections. If it is necessary to make tense explicit (rather than understood from the context or co-text), a temporal adverb is usually used. The use of the distal demonstrative as an anaphoric reference may also be related to temporal distance, but a proximal demonstrative can also be used here, since proximal demonstratives are the preferred choice of anaphoric reference in Chinese (Zhu *et al.* 2001: 32). The use of a distal demonstrative here can also be motivated by the psychological distance (Yule 1996: 13)—to express emotional detachedness, since this is a view with which the writer does not agree. In fact, the distinction between the established-but-incorrect views and the alternative ones is an important feature in this text.

Example 2 illustrates this point further.

Example 2

(ST) The decrease in injuries, as well as in deaths and in terrorist incidents, prompted Deputy Secretary of State Richard Armitage to say, “You’ll find in these pages clear evidence that we are prevailing in the fight”.

(TT) 而且，不僅受傷人數減低，連死亡人數與恐怖攻擊事件也變少了。對此，美國副國務卿阿米塔吉（Richard Armitage）表示：「本報告清楚證明，我們所向披靡。」
[Besides, not only the number of injuries decreases, deaths and terrorist incidents also decrease. Responding to this (*ci*, formal register), Deputy Secretary of State Richard Armitage said, “This (*ben*, formal register) report clearly proves that we are prevailing.”]

In this extract, the first proximal is used as a discourse deictic referring back to the situation described in the previous sentence. It is often the case that, because of syntactic differences, the Chinese translator needs to segment sentences and add anaphoric deictics to maintain coherence. In this case, the choice of proximal deictics is a preferred choice for anaphoric reference in Chinese grammar. However, there is another interesting use of deictics that can be found in this translation: the translator uses formal and standard deictics alternately in the translation. In modern Chinese, 這 (proximal) and 那 (distal) are the standard forms of demonstratives, but there are other obsolete forms that may be used in particular collocations or more formal registers, such as official reports. In this translation, the translator uses formal forms of demonstratives (此 *ci*, 本 *ben*, 該 *gai*) when the words come from the authorities who manipulate the statistics, such as the two instances of proximals in this example. In the first instance, the choice of the formal form (*ci*) rather than the standard form (*zhe*) in *responding to this* may not be entirely for reasons

of formality, because *Duici*, 'responding to this,' is usually used as a fixed expression. Therefore, the translator may simply want to use an idiomatic expression. However, in the second case, the use of *ben* (the formal form of *this*) in *This report* in the quotation highlights the formality of the saying of the Deputy Secretary of State.

Other examples, such as the formal demonstrative *gai*, an anaphoric reference often used in written texts, are also used in the text to indicate formality. By switching between the formal and standard deictic systems, the translator presents the readers with two points of view in this text. When referring to the authorities who claim the credibility of statistics, formal deictics are used, which makes the reader feel distant. On the other hand, when the writer's views are given, standard deixis is used, which makes the writer talk to the readers as if he were their friend, in contrast to the authorities.

Another shift that can be found in example 2 is the omission of the second person reference in the Deputy Secretary of State's speech. The use of personal reference is a feature that characterises writer-reader interaction in the source texts, and few shifts are found in the translation. It has been pointed out in many contrastive linguistic studies that Chinese tends to use less personal reference than English (e.g. Li and Thompson 1982: 657; Huang 1994: 248), so the omission of personal references in the translation may be regarded as a grammatically preferred shift. Nevertheless, the omission of *you* in this case may also be related to the translator's tendency to highlight formality in the authorities' speech and to distance the readers in such instances. From the consistent pattern of interaction with the readers managed by the translator in this text, we suggest that the omission of references is more likely to be motivated by interaction with the readers, rather than conformation to the target norm. In fact, the addition of a second personal reference is also found in the translation.

Example 3

(ST) Then, in June, the State Department updated the original document's incorrect statistics and revealed that terror-related injuries in 2003 in fact totalled 3,646. This number, according to mathematicians, is higher than 2,013.

(TT) 但 6 月時，國務院更正原始報告的錯誤數據，顯示 2003 年因恐怖相關事件受傷的人數，其實共有 3646 人。數學家會告訴你，這個數字大於 2013。

[But in June, the State Department updated the original document's incorrect statistics, showing that terror-related injuries in 2003, in fact totalled 3,646 people. Mathematicians will tell you this number is higher than 2013.]

In this example, instead of presenting the source of evidence as the *mathematicians*, the translator makes mathematicians address to the readers directly by using the second person reference. The target readers are directly addressed and more involved in this argument. In this case study, there is only one instance of addition and one instance of omission of second personal reference, so we are not able to make a generalisation of the shifts of second person reference. However, the shift of second person reference in this example has a coincidence with the deictic shifts in other examples in that the readers are more distant when the views in the texts are presented as being challenged, and they are more involved when the alternative views from the writer are given.

Also adding to the contrast between the two views in the target text is the explicitation of adversative conjunctives in the translation, as shown at the beginning of example 3. In the source text, cohesion is provided by a temporal conjunctive *then*, indicating the sequence of the situation described in the previous paragraph. However, the translator chooses an adversative conjunction, and thus signals to the readers to expect the other side of the story. Nevertheless, overall, the trend of conjunction explicitation is not obvious in this translation. There are only two instances of addition of adversative conjunctions and one instance of causal conjunctions. The two instances of adversative conjunctions are both used as a cross-sentence link that signals the contrast between the taken-for-granted and the challenged views, which is the theme of this article.

Interaction in this article is highlighted by the salient involvement of the text producer in the writing. Unlike specialised science writing in which the writers are usually hidden behind the science community, this source text is characterised by the strong personal-opinion voices from the writers against the traditional science or social community. In example 4, we will see how the translator makes shifts to add to the prominent presence of the writer in the article, through the addition of first person singular references and attitudinal markers.

A marked shift in the personal category is a shift from inclusive first person plural to first person singular reference.

Example 4

(ST) Just don't tell us that chocolate ice cream is vanilla, especially when it's not even chocolate ice cream but only something a frat boy rolled in.

(TT) 我只希望不要有人把巧克力冰淇淋硬說成是香草口味的，甚至那可能根本不是巧克力冰淇淋，而只是某位兄弟會少年曾在上面打滾過的東西。

[I just hope people don't say that chocolate ice cream is vanilla, when that's not even chocolate ice cream, but only something a frat boy rolled in.]

The inclusive *us* in the source text, including the writer and readers, is translated as *wo*, 'I', functioning as a subject. With this shift, the translator excludes the readers and stresses the voice of the writer himself. In fact, this is the only instance of the use of first person plural reference in this source text—with the exception of those instances in free indirect speech—and the translator omits this one, so there is no first person plural reference at all in the translation. The effect is a reinforcement of the narrator's personal-opinion voice in the target text.

The text producer's personal attitude is stressed further in the translation by the use of a few attitudinal markers to express excitement, such as the sentence-final particles 啦, colloquial expressions used by young people 棒呆了, 'stupidly superb', and four exclamation marks. These features are all characteristic of colloquial Chinese speech. The addition of these attitudinal markers in the translation makes the text producer appear more expressive and lively, and the use of colloquial language also reduces the distance from the readers—so they do not feel that they are being addressed by a scientific authority figure.

To conclude, in the source text, the interaction between writers and readers is characterised by an intimate conversation style—the frequent use of personal reference *I* and *you* and other informal expressions, and the purpose of this article is to present an argumentation that challenges the interpretation of statistics by the authorities. In the translation, we found that different strategies are used to highlight further the presentation of argumentation, and to manipulate the relationship between writers and readers. The translators use distant strategies (such as a formal tenor) when presenting views to be argued against, and friendly devices (such as second person reference and attitudinal markers) when presenting the alternative views given by the source text writer. In this way, the translator helps to relay more clearly the themes that the source text writer tries to argue in this text.

In the next case study, we will examine a text that interacts with the readers in a different way by using different strategies.

4.2 Case study 2: Controlling Hurricanes (掌控颶風)

The second case study is a feature story written by a scientist who conducts the research himself, and the story presents his motivation, processes, and the results of his research. The interaction with the readers in this text is characterised by the attempts to explain scientific knowledge to lay readers—including giving definitions of scientific terms, using metaphors, and comparing the scientific phenomenon to common experiences in the readers' daily lives.

Example 5 is a paragraph which illustrates well how deictics, conjunctions, personal reference and lexical choices function in a network in the translation to assist the target readers to process a science explanation.

Example 5

(ST) To see why hurricanes and other severe tropical storms may be susceptible to human intervention, one must understand their nature and origins. Hurricanes grow as clusters of thunderstorms over the tropical oceans. Low-latitude seas continuously provide heat and moisture to the atmosphere, producing warm, humid air above the sea surface. When this air rises, the water vapor in it condenses to form clouds and precipitation. Condensation releases heat—the solar heat it took to evaporate the water at the ocean surface. This so-called latent heat of condensation makes the air more buoyant, causing it to ascend still higher in a self-reinforcing feedback process. Eventually, the tropical depression begins to organise and strengthen, forming the familiar eye—the calm central hub around which a hurricane spins. On reaching land, the hurricane's sustaining source of warm water is cut off, which leads to the storm's rapid weakening.

(TT) 如要理解颶風與颱風等強烈熱帶風暴為何易受人為干預的影響，就必須從了解它們的本質與起源著手。颶風（颱風亦同）是誕生在熱帶海洋上的雷雨雲團。低緯度海洋不斷提供熱與水氣給大氣，海面上方因而產生溫暖潮濕空氣。當這些空氣上升，水氣會凝結形成雲或降水。凝結會釋放熱，這些熱就是當初在海洋表面的水，蒸發時所吸收的太陽能量。這所謂的「凝結潛熱」釋放，使得空氣浮力增加，透過此自我增強回饋的過程而繼續上升。最後熱帶低壓會開始組織與強化，形成我們所熟知的「風眼」（無風的中心地帶，颶風會繞其旋轉）。當颶風接觸到陸地時，暖水的補充來源被切斷，其強度因而迅速減弱。

[In order to understand why severe tropical storms such as hurricanes and typhoons are susceptible to human intervention, [one] needs to start from understanding their nature and origins. Hurricanes (like typhoons) are clusters of thunderstorms growing over the tropical oceans. Low-altitude seas continuously provide heat and moisture to the atmosphere, warm and humid air is therefore formed above the sea surface. When this air arises, the water vapor will condense [and] form clouds and precipitation. Condensation will release heat; this heat is the solar energy that the water at the ocean surface absorbs when [it] evaporates. This so-called “latent heat of condensation” increases buoyancy, through this self-reinforcing feedback process to ascend still higher. Eventually, the tropical depression will begin to organise and strengthen, forming the “wind eye” that we are familiar with (the windless central hub, around which a hurricane spins). When the hurricane reaches land, the sustaining source of warm water is cut off, its force thus rapidly being weakened.]

The most noticeable shift in this extract is the lexical choice: two instances of *hurricanes* are translated as *hurricanes and typhoons* and *hurricanes (like typhoons)*. The word *typhoon* also appears in the subtitle in the

Chinese article, although the title remains unchanged. We argue that typhoon is specified in the translation, because target readers are more familiar with typhoons than with hurricanes. The word typhoon helps readers to recall their experiences related to typhoons, which they can then relate to the research on hurricanes.

Another device that constructs solidarity with the readers is the addition of *we* in *the "wind eye" that we are familiar with*. The "wind eye" is the Chinese expression of the eye of a typhoon, and in this case the translator makes the assumption that the target readers should be familiar with this term. This is also a gesture to appeal to the knowledge shared between the writer and the readers, so the readers are not treated as complete outsiders in the texts. However, the use here of quotation marks, as well as in many other instances (such as "*latent heat of condensation*" in this extract), signals that these terms have scientific specialty in Chinese. These terms may also be technical in English, but in the source text their specialism is not emphasised by the quotation marks. In this sense, the translation presents the text producer as an expert in science who, though trying to be close to the readers, still uses specialist terminology.

The authoritative presence of the text producer can also be observed from the frequent addition of devices of explanation in the texts—the causal conjunction (*therefore*), and the proximal deictic that makes the explanation explicit (*this heat is...*). The shifts towards the explicitation of causal conjunctions are frequent in the translation, occurring mostly when the formation of a scientific phenomenon is explained, as in this example. Segal *et al.* (1991:50) pointed out that causal and adversative conjunctions often involve the character's subjective perspective. In this text, the translator not only uses conjunctions to specify a relationship between propositions: she also sometimes adds her own explanatory words in the translation, and very often the link between explanatory phrases is supplied by a proximal demonstrative reference to the previous sentence. An example is "*this heat is the solar heat that...*" in the translation. This phrase is given as an explanation of the word "heat" in the previous clause. In the source text, the explanation is implicitly introduced by a hyphen, which is a convention in the English language, so that the English readers would understand that the hyphen serves an explanatory function (like a colon on other occasions). By contrast, the translator adds a proximal deictic, and also makes the explanation more explicit by turning the transitivity into a relational process (see transitivity in systemic functional grammar, Halliday 2004), a structure often used for definition.

In other places in the text, appositive conjunctives such as *yiji* 'i.e.' are also found, as in example 6, below.

Example 6

(ST) In an analogous fashion, our challenge is to find just the right stimuli—changes to the hurricane—that will yield a robust response that leads to the desired results.

(TT) 相似地，我們的挑戰便是找出能產生穩定反應的正確刺激（亦即對颶風的改變），從而達到我們的需求。

[Similarly, our challenge is to find the right stimuli that will yield a robust response (i.e. changes to the hurricane), leading to our desire.]

The addition of an appositive conjunctive in this example is also related to an explanation added by the translator. The link between the main clause and the inserted clause is made more explicit by the appositive conjunctive in the translation. The appositive conjunctives and other explanatory indicators discussed in the previous examples—analogy (typhoon), causal conjunctives, deictics—form the network of explicit explanation provided by the translator for the target readers.

In this translation, the translator anticipates that the readers may have problems with the cause-effect relationship in the explanation of science, and therefore adds causal, appositive conjunctives, and even provides more explanations. Although these are regarded as reader-friendly signals, the translators also restrict the target readers' freedom of interpretation, and this may enhance authoritative attitudes in the text.

5. Discussion

When comparing the two case studies, it is found that the translators do not make the same translation shifts in each text. Although a general trend of shifts has been found in our quantitative analysis, the strategies in each text differ according to the rhetorical purposes of the translations, and the interactive relationship that the translators want to establish with the target readers. In the first case study, interaction in the source text is characterised by the writer's presence in the text and intimate conversational style with the readers; the shifts taking place in the translation—explicit personal reference, deictics, hedges and informal tenor—are found to be mostly related to the explicit attitude of the writer in the argument. The high frequency of addition of conjunctives or first personal plural reference, however, is not seen in this translation, and this is likely to be related to the fact that they contribute little to the desired rhetorical purposes in the translation. On the other hand, the second case study has salient translation shifts in the addition of discourse deictics, causal and appositive conjunctives, and explanatory phrases. These devices are related to the fact that the interactive dimension in the text is mostly reader-oriented, i.e. how the writer anticipates the readers' difficulty in comprehension and tries to make explicit signals in the texts to facilitate the process of reading.

Of course, a text involves different interactive purposes—never simply a reader—or writer-oriented purpose. However, the case studies here endeavour to demonstrate that the main interactive purposes differ from one text to another, and the interactive strategies adopted by the translators also seem to accord with the rhetorical purposes of each text.

6. Conclusion

In this paper, we have suggested a different perspective of the study of science translation, i.e. the interactive dimension in science writing for the public. The function of knowledge transmission of science translation and the principle of accuracy and faithfulness (especially in terms of terminology) in translation have been discussed throughout the history of science translation into Chinese, as in many other languages. However, since the communicative function of science writings has become more important, and pragmatic studies in English have started addressing these trends, it seems that translation scholars and translators have not yet fully addressed these issues, and still approach popular science texts with the methods and principles adhered to in the translation of specialised science texts. This study draws from the pragmatic studies on the topic of interaction, and has demonstrated in two case studies how interaction is achieved through writers' and translators' deployment of linguistic features. This paper stresses that the interactive dimension is essential to the studies and practice of science translation for the public, and an understanding of the interactive functions of linguistic features in texts can benefit the researchers and translators in science translation.

Note

1. The conjunctions included in the quantitative analysis are: additive (與,和,而,及,並,以及,而且), alternative (或,或是,或者), adversative (但,不過,但是,雖然,然而,可是), causal (因為,因此,所以,由於,因), hypothetical (如果,的話,若) and temporal (當,的時候). The hedges investigated are 可能,約,也許,幾乎,或許,似乎,大約,看來,大概.

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Biography

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