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Translation as a mathematical problem: An analysis of Chinese-English and English-Chinese word equivalents

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Abstract
This paper is based on the hypothesis that translation involves certain complex mathematical problems, some of which are yet to be solved. When translating a word from one language to another language, it is like adding or subtracting some meaning components of the word to come up with an equivalent in the target language. In this paper we use simple mathematical equations and formulae to demonstrate how translators consciously or subconsciously employ mathematical skills to come up with equivalents of words between two or more languages. We made use of the Youdao online dictionary to check meanings of basic Chinese level 3 proficiency words. A reverse translation of the equivalents of these words shows that about 90 percent of Chinese basic words do not totally equal their so-called English equivalents. Thus, for the majority of words there is no situation where X is totally equal to Y; that is 【X≠Y】, where X represents a given word in a source language and Y represents a supposedly equivalent word in the target language. We concluded that in most cases inter-language word equivalence takes the formula X is equal to Y plus or minus Z:【X=Y+ or – Z】, where Z stands for extra meaning of a given word which can or cannot be accommodated in X. Even though we came up with this mathematical formula, we strongly believe that the human mind is able to solve even more complex mathematical problems during translation, some of these mathematical formulas still await discovery.

Keywords: Translation; mathematical; equivalence; Chinese and English.

1. Introduction

This paper, which is based on Nida's equivalence translation theory, discusses the process involved in translation as a mathematical problem. Translation, as defined by Nida and Taber (1974), refers to "reproducing in the receptor language the closest natural equivalent of the source-language message, first in terms of meaning and secondly in terms of style" (p. 12). Catford (1969) also describes translation as a process whereby textual material in one language is replaced by equivalent textual material in another language. In most definitions of the term translation, the word 'equivalent' is used to describe those words, concepts or meanings which are deemed by the translator as equal (=) to the components of the source language.

Nida (2006) notes that "skilled translators must have a special capacity for sensing the closest natural equivalent of a text" (p. 11). From Nida's observation, there is evidence that there is rarely total equivalence in word

meaning, so the question is: what makes a word have a closer meaning? We can also ask; how does a translator consciously or sub-consciously sense the equivalence of a given translated word? Based on the definition of the word 'translation', we therefore make an assumption that translation is mathematical because translators work out mathematical problems where one can ask such a question as; "what is the equivalent of the Chinese word 好？" This translates into a mathematical equation '好= what?', as is the case in a mathematical equation like 'X= what?' We can even further formulate substitution equations as in mathematics, for instance: if '你怎么样?' = 'How are you?' then what does 你 equal? It is within this hypothetical framework of equivalence that we will use some examples from basic Chinese (Chinese Proficiency (HSK) 3) vocabulary with their English equivalents to show some mathematical problems that are consciously or subconsciously solved by translators.

2. Background of the Research and Literature Review

This research was inspired mainly by the observation that there is rarely total equivalence in meaning of words in two different languages. Nida (2006) mentions that translators should aim for "the closest natural equivalent", which suggests that although words might not be considered totally equivalent, they still have a form of equivalence which can be defined as either far or close equivalence. Despite the differences in meaning between these equivalents, translators still take these words as equivalents (either partial equivalent, close equivalent or total equivalent). This entails that behind the translation of a given word there must be some hidden concepts that make a given equivalent word appropriate in a given context. The author felt that there should be a scientific explanation that makes non-equivalent words to be considered equivalent. Nida believes that translation in itself is not a science; however he acknowledges that there is a need to understand "the ways in which the brain manipulates information and transfers concepts from one language to another" (Nida, 2006, p.11). Nida further notes that the reason why it is difficult to formulate an adequate theory of translation is the fact that we still do not know the subconscious processes involved in translation. In other words, researchers have not yet explored what takes place in the brain of a translator during translation. As described by Nida (2006), the current theories of translation describe principles in matching the semantic contents of verbal utterances but do not give us a picture of the mental processes involved.

We believe that a mathematical explanation will help us understand some of the mental processes that are involved during translation. This will also help explain the relationship between equivalent words in two different languages. This relationship between equivalent words in two different languages will in turn help both translators and second language learners to have a deeper understanding of the complex relationship that exists between words of their native language and those of the target language. Fries (1945) noted that "the most effective materials are those that are based upon a scientific description of the language to be learned, carefully compared with a parallel description of the native language of the learner" (p. 9). This research therefore seeks to conscientise translators and language learners to the need to acquaint themselves with the various extra meanings of a given word in the languages concerned.

Due to the complex relationship between words in source language and target language, translation seems to be one of the toughest tasks, such that some scholars believe that translators are naturally talented people

(Venuti, 1995; Zarandona, 2013). However, Vazquez-Ayora (1977) believes that a translator is not born a translator; rather, he or she must be trained. Although in this paper we are not trying to teach about how to translate, we do aim to reflect on how understanding of the possible mental processes that are at work during translation can help translators to develop their skills.

In this paper, we believe that there is a close relationship between solving mathematical problems and solving word equivalence problems between two languages. While it is rare to find articles that discuss the interwoven relationship of mathematics and language, we should remember a famous statement by the 17th-century scientist Galileo Galilei, who once said that:

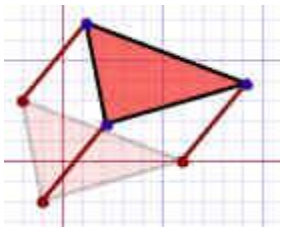
> The universe cannot be read until we have learned the language and become familiar with the characters in which it is written. It is written in mathematical language and the letters are triangles, circles and other geometrical figures, without which means it is humanly impossible to comprehend a single word (quoted in Opere II Saggiatore, 1938, p. 171).

Galileo's statement reminds us that in order to understand words and phrases in a given language, we put together some small components to make bigger components. For instance, the phrase 'I love you' which is 'I + love + you' can only be understood when all the components of this phrase are there, thus 'I + love' does not accumulate to the meaning we understand by 'I love you' unless 'you' is added. In this study we believe that not only phrases can be defined as mathematical but also words. In terms of sound, a given word requires combining sounds to make a whole sound with meaning. This also applies to the semantic structure of vocabulary; we argue that each word has a set of accumulative meaning which rarely equals that of its counterpart in another language.

Although there seems to be a close relationship between mathematics and language, there is more research that examines the use of language in mathematics than research on the uses of mathematics in language. For instance, Mercer and Sams (2006) wrote about the role and use of language as a tool for reasoning in solving mathematical problems. Similar studies were also carried out by Tout (1991), Ellerton and Clements (1991), Kabasakalian (2007), and Pierce and Fontaine (2009).

It is interesting to note that some of the key terms used in translation are similar to those used in mathematics; for instance the word translation itself is a specialized term in the field of mathematics. Translation in mathematics is a sub-branch of transformation, which refers to the moving of a shape, without rotating or flipping it, as in the following diagram.

Figure 1: Translation in mathematics[1]



[1] Definition and Figure for translation adapted from http://www.mathsisfun.com/definitions/translation.html

In the above figure, the lower triangle is moved to another position without any other modifications. This implies that translation of words is also a way of moving meaning of words from one language to another, which might be the reason why 'equivalence' is stressed by many translation researchers (e.g. Baker, 1992; Kashgary, 2011; Nida & Taber, 1974; Robinson 1997; Vázquez Burgos & Bello Jaimes, 2007). This might be also the reason why Robinson (1997) defines translation as "the ability to mediate between cultures, to explain one to another; mixed loyalties; the pushes and pulls of the source and target cultures" (p. 222). Translation is thus seen as a skill of moving meaning from one language to another in a way that will not distort the original meaning, as is the case in moving of shapes.

In translation, the word 'equivalent' is commonly used to show equality in meaning that exists between words in different languages. In language translation it is normally seen as the relation that holds between a Source Language (SL) text and a Target Language (TL) text (Bolaños Cuéllar, 2002). This suggests that equivalence in translation, as in mathematics, refers to the state of having the same value, function, meaning, and so on (Merriam-Webster Dictionary)[2]. Some scholars believe that in translation, equivalent forms and non-equivalent forms are used as methods of transferring meaning from one language to another. For instance, Kashgary (2011) compared equivalent and non-equivalent forms in translation of Arabic texts into English. Qiu Shude (1989) also once grouped Chinese words translated into English into three classes, which are:

i) Totally equivalent words, such as number "5" and the Chinese number "五";
ii) Partially equivalent words, such as the English word "you" and the Chinese word "你"; and
iii) Non-equivalent words (also known as non-correspondent words), such as the English word "pizza" and the Chinese word "饼".

These researchers attempt to show some of the challenges faced in translation, where the degree of equivalence varies and there is not a complete match with the original words or texts.

There is a vast amount of literature on these issues pertaining to the problems and complexity of translation of words from one language to another (Sechrest, Fay & Zaidi, 1972; Weeks, Swerissen & Belfrage, 2007). Apart from the problems of equivalence, there are also other external translation problems. Some of these problems are summarized by Zarandona (2013) as follows: lack of training and expertise of the translator, insufficient understanding of the source and target language, pressure from short deadlines as well as lack of knowledge of the subject being translated. Venuti (1995) in the book, *The Translator's Invisibility: A History of Translation*, traces the history of translation from the seventeenth century to the present day. This work unveils some of the challenges of translation where some foreign texts translated earlier failed to depict the cultural aspects depicted in the original texts.

The majority of researchers in the field of translation seem to be more interested in the level of equivalence of words and/or texts between languages. As a result, there are also a number of theories developed to present ideal methods of translation. Nida's ideas in *Toward a Science of Translating*, originally published in 1964 and

[2]Definition of the word *equivalence* from Merriam-Webster Dictionary http://www.merriam-webster.com/dictionary/equivalence

later republished in 2003, is an example of a comprehensive research in the field of translation that describes the main elements of translation and problems of equivalence. Nida's work sets translation into the context of historical transformation; it also attempts to give a comprehensive description of the procedures involved in the translation of the Bible.

Nida's theory of equivalence is opposed to skopos theory proposed by Hans Vemeer in the 1970s. In skopos theory, the source language text (phrases or words) does not necessarily have to be equivalent to that in the target language, what matters is the function of the text. Paul Kussmaul (1995) argues that in skopos theory the function of the source text is modified depending on the knowledge, expectation, values and norms of the target audience. Nord (2001) also notes that skopos translation theory is based on the notion that translation is required for a variety of communicative functions, thus translators do not aim to produce total equivalence in their final translated text.

Despite the fact that previous research seems to have vastly explored the issue of equivalence and non-equivalence, problems in translation as well the theories of translation, there seems to be little research that attempts to explain the mental processes involved during translation. In this paper we are not trying to propound any new theory of translation; however, we will attempt to trigger discussions related to the justification of so called "equivalence of words" in translation. As pointed out above, we propose that there is a close relationship between mathematics and language. We will therefore try to demonstrate some mathematical aspects involved in translation of words from one language into another. We will focus on the Chinese and English vocabulary equivalent problems as a case study, with an aim to give a mathematical formula involved in translation.

3. Theoretical framework and hypothesis

This paper explores the concept of equivalence in translation within Nida's translation theoretical framework. We chose Nida's theory as the main theoretical framework for this study mainly because although his theory received several criticisms – such as those by Nichols (1981), and Eco (2001) – his contribution to the history of theory of translation is still considered by many authors as "an outstanding one and a landmark in the history of translation" (Dollerup, 2009; Zhang & Wang, 2010). Nida is well known for developing the theory of dynamic equivalence, which he differentiates from formal equivalence or the traditional translation method. The 'dynamic equivalence' or 'functional equivalence' theory stresses the importance of transferring meaning from source language to the target language, rather than transferring the grammatical form. Nida argues that formal equivalent translation theory focuses much on the message in form, while functional equivalence seeks to find the closest natural equivalence in the target language. Eco (2001) critiques Nida's theory of equivalence, arguing that:

> Equivalence in meaning cannot be taken as a satisfactory criterion for a correct translation, […] We cannot even accept the naïve idea that equivalence in meaning is provided by synonym, since it is commonly accepted that there are no complete synonyms in language. 'Father' is not a synonym for 'daddy', 'daddy' is not a synonym for 'papa', and 'père' is not a synonym for 'padre'. (p.9)

While we agree that there is rarely equivalence in meaning between words in two languages, we however maintain that the concept of equivalence is still largely at work at any given time during translation. The hypothesis in this paper is that; though a word in a source language is rarely totally equivalent to words in the target language, however during translation the human mind either add or subtract those extra meanings which makes the word being translated non-equivalent. This addition and subtraction thus results in what Nida calls "closest natural equivalence". These subconscious mathematical calculations can be illustrated in the following example. The Chinese word 你(ni) is generally translated as 'you' but this does not mean that 你=you. If we use reverse translation we can prove that these words do not have total equivalence. The word 'you' can refer to a single person as in the phrase "Tom, **you** are the only one who did not come to school yesterday". In this case 'you' is referring to '你' (singular form). However, 'you' can also refer to 'many people', as in the phrase "**you** girls are not willing to be submissive" – in this case, 'you' is referring to the plural 你们 (*nimen*). This therefore means that '你' is not totally equivalent to 'you'; however, when we use this '你' as the closest equivalent of 'you' our subconscious mind subtracts the extra meaning (plurality) which is contained in the word 'you'.

In this paper we will, therefore, attempt to answer the following question: Given the situation that words in the source language are rarely equal to their so-called equivalents in the target language, what then is the relationship of a given word in a source language and its equivalents in the target language? In order to answer this question, we will examine various Chinese words and their equivalents in English and try to come up with a mathematical formula that can sum up the relationship between source language words and their target language equivalent words. This in turn is an attempt to reflect the subconscious processes at work during translation.

4. Research Methods

In this research we used mainly qualitative research to show the complex relationship between Chinese and English word equivalence. We used a total of 682 HSK level 3 vocabulary list which was compiled by Lingomi (2014) (also available on the Hanban HSK website), with word equivalents provided by the Comprehensive Online Chinese-English Dictionary (CC-CEDICT). We also used the Youdao online dictionary for reverse translation of the given equivalents. Then we counted the number of Chinese words with a single completely equivalent meaning in English, and those with more than one equivalent. For illustrations of mathematical relationships between equivalences we selected basic vocabulary commonly used in daily conversation, such as in greetings and simple introductions with more than one equivalent. The selection was based on the presumption that if basic words exhibit complex relationships, then we can extrapolate that the vocabulary for higher proficiency levels will be even more complicated.

5. Research findings and Discussions

Out of the 682 element Chinese proficiency Test vocabulary listed on the Hanban website, only 10 percent of the words are totally equivalent to their English correspondences as shown below:

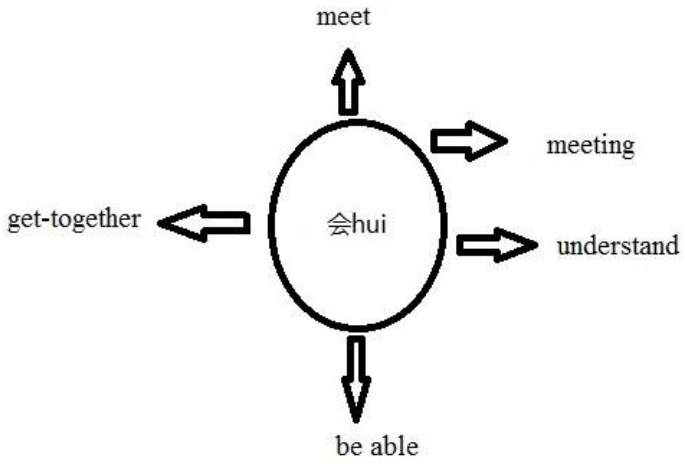
Table 1: Equivalence of English and Chinese basic vocabulary

Number of equivalent words	Number of words	Percentage
Single equivalent word	68 words	10%
2 or more equivalent words	614 words	90%

We observed that the majority of Chinese basic words are not completely equivalent to their English counterparts. The majority of those words which seem to have total equivalence include loanwords from English such as '*chocolate'* and *'sofa',* as well as numbers. However, not all of these loanwords and numbers have total equivalence in terms of meaning and use, because some of the loanwords from English have either extended or reduced meaning in Chinese. For instance, the Chinese borrowed word '巴士' (bashi) borrowed from the word '*bus*', refers to long distance buses only while another term (公共汽车) is used for short distance buses. For numbers, some numbers in Chinese do have some other extra meanings, for instance: the Chinese number one (一) has partial equivalence with other English words such as 'once and single' which are not necessarily substitutes of 'one' in English; apart from that, the number 10 (十) is also equivalent to the word 'topmost' while number three (三) is also equivalent to 'many or several'. This makes equivalence of Chinese words and English words more complex; thus there is need for a clear explanation of this relationship that exists between English and Chinese equivalences.

Equivalence between Chinese and English words is complex due to the fact that a single word in Chinese might have 3 to 5 other equivalent words in English, while in some cases a single English word might also have other several equivalences in Chinese. For example, the Chinese word 会 (*hui*) has 5 English equivalents which are; '*meet, meeting, understand, be able,* and *get-together*'. We can illustrate this in as follows:

Figure2: English words partially equivalent to the Chinese word 会(hui)

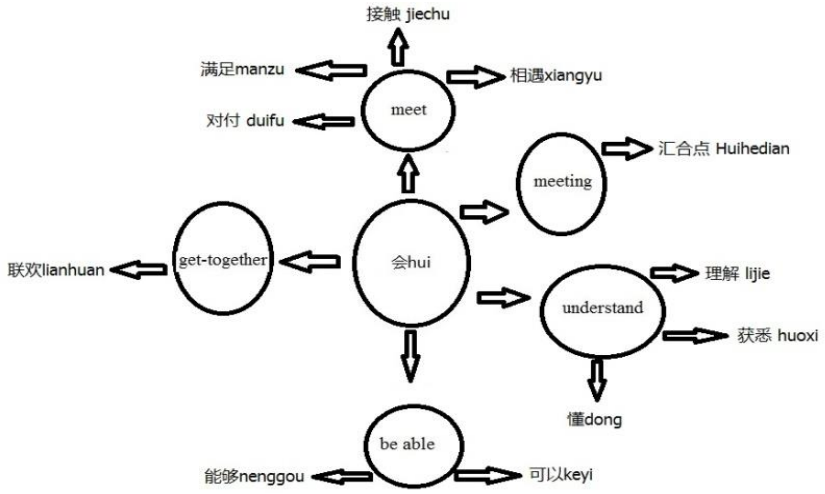


However, if we do a reverse translation of these 5 English equivalents each of these English words has other Chinese equivalents apart from 会 (*hui*). We can use another diagram below to further expand this relationship.

The extended meanings of the 5 English equivalent words for the word 会 are not related to this original word 会 (*hui*). If we were to further check meanings of those Chinese extended equivalent words for the 5

English words we could find another chain of other meanings not related to the original 5 English words. This is a general picture of the complex relationship between equivalent words in Chinese and English.

Figure 3: Complex relationship between 会 and its English equivalent words



This observation is not anything new, because other researchers seem to agree with this fact that the majority of Chinese words are not totally equivalent to their English counterparts. For instance, Lay (1975) noted that word-by-word literal translation of some Chinese vocabulary into English is quite difficult and complex. However, these researchers do not go on to explain the kind of relationship that exists between those Chinese-English words which have partial equivalence. Based on the above observation, it can be noted that to a larger extent, there is non-correspondence between words in Chinese and English. Here, the question is: when translators opt for these non-equivalent words to take the place of totally equivalent words, what factors do they consider or how do they deduce the equivalence? Below we will use some few Chinese words and their English equivalents to explain the relationship between words in a source language and their partial equivalents in the target language.

According to the Youdao Online Dictionary, '好' has 4 English equivalents, while a reverse translation of the word 'good' has 9 Chinese equivalents as shown in the example below:

Figure 4: Equivalents for the word Chinese word "好"and English word "good"

The above word equivalent diagram implies that, the Chinese word 好 [*hào, hǎo*] = 'all right + well + good + fine + ok'. However, a reverse translation of the word 'good' shows that: 'good' =好的 + 优良的 +愉快

的 +虔诚的 + 好处+善行+慷慨的行为+古德+好。Therefore, according to this example, can we say '好=good', or 'good =好' ? If neither 好 is equal to 'good' nor 'good' is equal to 好, then how do the translators come up with equivalents in different environments? This makes translation more like mathematics, where we can say: 'good' is equal to 好, provided we have taken away the other meanings such as 好处、善行、古德、愉快 etcetera. In our survey of the 682 basic Chinese words there are few situations where a Chinese word is completely equal to an English word or an English word is completely equal to a Chinese word. There are always certain variations where a word in the source language might have more other meanings than those that can be conveyed by the equivalent word in the target language or vice versa. This is what we will call 'plus or minus' meaning, as in the following example.

The example above is fairly complex because the words involved have more than 2 equivalents. Below we will use a simple example with minimum variations to explain the mathematical relationship between meaning of words in source language and target language. Using simple example 'you', we can argue that the English word 'you = 你 (*ni*) or 你们 (*nimen*)'. This can be further developed into the following mathematical sequence, if 'you' can be equivalent to either 你 or 你们, then it means that 你 = 'you' minus 们 that is to say:【你 = you-们】. In other words, for the Chinese word 你 to be equivalent to 'you', translators subconsciously subtract the plurality form (们 in Chinese) which is also incorporated in the word 'you'.

From these examples we can therefore mathematically generalize the relationship between vocabulary of source language and target language as either; **X** = **Y+Z** or **X=Y-Z**; where **X** is a word in a source language, **Y** is a supposedly an equivalent word in the target language and with **Z** representing some extra meaning of the given word in the target language which can or cannot be accommodated into the source language word (**X**). This can be further simplified as: 【X=Y+/-Z】.

This equation also applies in second-language learning and teaching. In second-language learning, students always seek to solve a simple equation X=Y, so what they always seek is that word in the target language which they deem to be a direct equivalent of a given word in their mother tongue. Lado (1957) observes that for second language learners, "those elements which are similar to [the learner's] native language will be simple for him, and those elements that are different will be difficult" (p. 2). If we apply Lado's argument to the lexical relationship of learner's native language and target language, what Lado describes as 'similar to' can be mathematically described as 'equal to'. Thus, Lado's point is that if X=Y, then this will be easy for the learner to grasp.

One might ask a question as to why the Chinese word 好 – despite having such a complex relationship with the English word 'good' – still proves to be easy for learners to grasp? We believe that in such contexts an equivalent is memorised over time, which means that the translator or learner do not need too much time to calculate. However, learners might find it difficult to grasp this word in other phrases. For instance, if the same word appears in a context where the meaning is not equivalent to 'good', as in phrase 好了，别来吧(*hao le, bie lai ba*) which is translated as 'ok, do not come' rather than 'Good, do not come'.

This is not to deny that there are certain words which are easily grasped by learners, and yet are partially equivalent to the vocabulary of the learners' native language. From a mathematical point of view we can argue that a word which is easy to grasp is one where the variation (Z) will

be smaller. In mathematics 2-1 (two minus one) does not need complex calculations, but if we say 23-4-6-2-3, (*twenty three minus four minus six minus two minus three*) one will need a moment to think before he or she can give the answer. In mathematics, one hundred minus one (which is 99) can be easier to calculate compared to one hundred minus twenty seven. The same applies to words in a given language: the more the extra meanings of a given word in the target language, the more difficult it might be to grasp. Based on these mathematical equations, we can conclude that there are simple mathematical problems and complex mathematical problems in translation. This also entails that the more related meanings exist for a given word which do not correspond with the equivalent word in the target language, the more complex it will be for an unskilled translator to find the closest equivalent word. We can therefore argue that when some translators use inappropriate words during translation, it is due to subconscious miscalculation of the best equivalent word.

From this discussion we can therefore conclude that translation is a form of mathematical activity, whereby translators subconsciously add or subtract other related meanings of a given equivalent word. We can accordingly summarise this hypothesis of translation as being a mathematical model which functions at a subconscious level, and the correctness of the equivalence is therefore dependent on how much time the translator practices his or her mathematical problems. We therefore suggest that, for a translator or second language learner to be able to sense what Nida describes as the "closest natural equivalent", there is need for the same nature of rigorous practice as one would perform to master the multiplication tables in mathematics.

6. Conclusion

This research shows how a high percentage of Chinese basic words are not completely equivalent to their so-called English equivalent words. Although from a broader perspective the majority of Chinese words are not totally equivalent to their English counterparts, we still use them in given phrases or certain contexts as close equivalent words. Therefore, we can conclude that when translators offer 'equivalent words' this does not mean that these words are totally equal to those of the target language, but rather that there are certain conditions that justify such equivalence. Given a large degree of non-correspondence between Chinese and English words, we then attempted to give an explanation of why translators determine the choice of the various close equivalent words in different circumstances.

We argue that in the mind of a translator there are hidden assumptions that lead to the selection of given words in the target language as equivalents to those of the source language. In this paper we have shown that during the act of translation, it is presumed that: word X in Chinese (source language) is equivalent to word Y in English (target language) provided that certain aspects (Z) of the word X or Y are not included. This implies that when a translator gives a word as an equivalent, he or she would have subconsciously removed the other meanings which do not correspond with that of the source language. We therefore conclude that in most cases, inter-language word equivalence takes the following formula: X is equal to Y plus or minus Z:【X=Y+ or – Z】. Although we have arrived at this single mathematical formula, we strongly believe that the human mind is able to solve even more complex mathematical problems during translation, and that there are even further such mathematical formulas still awaiting discovery.

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