

Exploring logical thinking through the use of logical connectors in Thai and international research articles

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Abstract

A lack of logical thinking has been said to be a problem for Thai researchers. The claim seems to be based on personal judgment, without clear evidence. This study aims to find out if such a claim is valid by looking at the uses of logical connectors in two corpora (20 Thai and 20 international research articles published in 2015). The analysis was conducted as follows: Firstly, 40 articles were inserted into the “AntConc” concordance program to identify the three logical connectors that were used most often, which were ‘because’, ‘thus’, and ‘therefore’. Secondly, the concordance lines where these three connectors appeared in each corpus were read carefully to see whether they were logically or illogically used. Finally, the number of logical and illogical cases of the two corpora were counted and compared. The findings revealed no difference in the use of logical connectors between the two groups, and most connectors were logically used. Based on these initial findings, we would argue that the claim that logical thinking is a problem for Thai researchers may be invalid.

1. Introduction

In academic writing, we need to create a well-organized text, which is a fundamental element of writing quality (Basturkmen & Randow, 2014; Hyland, 2009). Without a well-organized text, it is difficult for the reader to follow the author’s ideas and be persuaded (Stapleton & Wu, 2015). The ability to build a well-organized text is thus essential for authors, and such ability is related to logical thinking, which, as stated in Wallace and Wray (2011), refers to the ability to link a claim and its relevant, sufficient and reasonable support. One way to see if a text is logical is by looking at the use of logical connectors, as Celce-Murcia and Larsen-Freeman (1983) state that these connectors are used for logical relationships (see also Plakans & Gebril, 2016).

It has been claimed that Thai researchers have a problem with logical thinking (e.g. Jaroongkhongdach, Watson Todd, Keyurawong & Hall, 2012), but this claim seems to be based on personal interpretation and judgment without solid evidence. Therefore, this study aims to find out if such a claim is valid by exploring Thai researchers’ logical thinking, by comparing their use of logical connectors in their research papers with those published in international research journals.

2. Literature Review

2.1 Logical Thinking in Writing

Logical thinking can be defined as the cognitive ability to “think carefully” (Tittle, 2011, p.434). Generally, we can see this as an everyday activity when we need to make a rational decision. Logical thinking, when used in academic writing, is the process of making clear the connection within an argument between reasons and conclusions (Cottrell, 2005), or warranting and conclusion (Wallace & Wray, 2011). The connection between a claim and its support can be seen by looking at the use of logical connectors. The support can be seen in one or more sentences, which can be in the form of several elements such as facts, data, statistics, explanations, or previous literature, all used to justify a claim (Hughes & Lavery, 2008). If the

support is insufficient or irrelevant, or the claim cannot be clearly linked to the support, the text is illogical and “The reader may remain entirely unconvinced” (Stapleton & Wu, 2015, p.12).

2.2 Logical Connectors

Logical connectors are “types of cohesive devices” (Celce-Murcia & Larsen-Freeman, 1999, p.519) which are used to connect clauses, sentences, or paragraphs to indicate a logical relationship (Plakan & Gebril, 2016). The term ‘logical connectors’ can be used differently by different researchers, as they may be considered conjunctions (Halliday & Hasan, 1976), linking adverbials (Biber et al., 1999), discourse markers (Cowan, 2008), logical connectives (Crewe, 1990) and conjunctive ties (Gardezi & Nesi, 2009). In this study, we follow the idea of Celce-Murcia and Larsen-Freeman (1983), who explicitly use the term “logical connectors”, and suggest four types of logical connectors:

1. Additive (to signal addition, introduction, similarity, etc.)
e.g. additionally, moreover
2. Adversative (to signal conflict, contradiction, concession, etc.)
e.g. on the other hand, however
3. Causal (to signal logical consequences, etc.)
e.g. hence, therefore
4. Sequential (to signal a chronology or sequence)
e.g. firstly, secondly

(See Celce-Murcia & Larsen-Freeman, 1983, p.325-329)

While these four types are considered as ‘logical connectors’ by Celce-Murcia and Larsen-Freeman (1983), we see that not all of them are ‘logical connectors’. For example, ‘firstly’ or ‘secondly’ indicate time order rather than causal relationship. Or some connectors such as ‘however’ or ‘additionally’ can be used to create coherence in the text, but they do not reflect a causal relationship (Simon, 2008). Therefore, we focus only on the causal type (e.g. ‘because’, ‘since’, ‘thus’, ‘therefore’), which are used to indicate line of reasoning, and to link a claim and its supporting idea from the preceding clause (Biber et al., 1999; Charles, 2011).

This type of logical connector can indicate logical relationships in the text, and the logical thinking of the writer can be inferred from the text (see Cottrell, 2005; Wallace & Wray, 2011).

The relationship indicated by causal connectors will help the reader to see if the sentences or paragraphs are well-connected and hang together as the writer intends. The logical connectors can be seen in several positions as presented in Table 1.

Table 1. Position of logical connectors

Clause Initial	Before clause 1: [Connector] + Clause 1 + Clause 2 Before clause 2: Clause 1 + [Connector] + Clause 2
Clause Medial	Clause 1 + Part of Clause 2 + [Connector] + Rest of clause 2
Clause Final	Clause 1 + Clause 2 + [Connector]

(See Celce-Murcia & Larsen-Freeman, 1983, p.329)

These different positions may sometimes make it difficult for students and non-native English speakers to use logical connectors correctly. The difficulty may lead to problems of overuse, underuse, and misuse of logical connectors. For instance, Chen (2006) suggests that novice writers tend to clutter the text with too many logical connectors so as to achieve surface logicity, leading to the overuse of connectors. In contrast, writers may also underuse connectors, which can cause misunderstanding of the text (see Tseng & Liou, 2006). These

mistakes of overuse and underuse may be due to transfer from the first language (Tarone, 2006). In the Thai context, based on our experience as English teachers, we find in our class that many times students make mistakes in using logical connectors as they may not understand the meaning of the connectors or the surrounding content. The misuse may be due in part to insufficient knowledge regarding the use of connectors. This issue of using logical connectors may thus be of research interest.

2.3 Related Studies on Logical Connectors

There have been studies of logical connectors in several countries, including Australia (Yin, 2015), China (Lei, 2012; Liu, 2008), England (Heino, 2010), and Thailand (Baralee, 2011; Prommas & Sinwongsuwat, 2011). In Hong Kong, for example, Milton and Tsang (1993) studied the use of logical connectors in Hong Kong EFL students' corpus of 4 million words at tertiary and high-school levels by comparison with a native-English speaker corpus, and a computer science textbook corpus. 25 logical connectors (e.g. moreover, therefore, nevertheless) were investigated, and the findings revealed that the students faced difficulty with two types of connectors, 'additive' and 'causal'. Especially for the 'causal' type, the students tended to overgeneralize from the use of *therefore* as it seems they were unable to distinguish between facts and opinions from the preceding clause.

In China, Ting (2003) explored cohesive errors in the writing of Chinese EFL students. The data consisted of 80 essays written by Chinese EFL students, and the findings indicated that the Chinese learners were weak in using additive, adversative, causal, and temporal connectors. In the use of causal conjunctions, the students tended to show reversal of cause and effect in using 'because', probably due to the confusion of ideas, regarding which came first or second (Tittle, 2011).

In Libya, Hamed (2014) looked at the use of conjunctions in 32 argumentative essays written by Libyan EFL students. The top three conjunctions were identified manually in order to see if they were appropriately or inappropriately used. The researcher revealed that Libyan EFL students experienced difficulty in linking logical connections using 'because' and 'so', or used them unnecessarily.

In Thailand, Baralee (2011) studied the use of coherence expressions and problems in 30 English argumentative essays written by Thai fourth-year students in their final examination at Assumption University. The researcher applied five possible characteristics of coherence expressions and problems among his students, including (1) using more repetition; (2) making extensive use of lists; (3) not making conclusions; (4) impersonal style; and (5) lack of consideration or counterfactual. One point worth mentioning here is *'not making conclusion'*. The researcher revealed that "the students did not know appropriate conjunctions or linking words to be used for their conclusion" (p.85).

Another study related to Thai students, by Prommas and Sinwongsuwat (2011), compared the use of discourse connectors between Thai EFL and native-English speakers in argumentative essays. The data were two small corpora (24 essays from third-year Thai students majoring in English and 20 essays from native-English speaker students). The top-five discourse connectors used by the two groups were *'and'*, *'but'*, *'because'*, *'for example'*, and *'also'*. Among these, *'because'* was the most commonly used.

From reviewing these five previous studies, we can see two closely related issues: the misuse of logical connectors and the problem with thinking. The misuse of logical connectors is probably due to the writers' misunderstanding of logical connectors and selecting improper connectors, or putting them in the wrong position. This implies that that the usage of logical connectors deals with the surface forms of texts. This issue could be attributed to the improper types of mechanical exercises (Tseng & Liou, 2006). The other issue of logical thinking is more subtle, and cannot be directly observed. Most of the previous studies looking at logical

connectors focused on the surface use of such connectors, but based on our literature review, studies aimed at investigating logical thinking through the use of logical connectors were scarce, despite the fact that it is possible to infer logical thinking through the use of such connectors. Therefore, this study aims to explore logical thinking through the use of logical connectors. We focus on comparing the use of logical connectors between Thai and international research articles, to examine the claim that Thai researchers lack logical thinking. Note that we are aware that research articles written by Thais may have been edited by native English speakers, but it is not clear whether such editing focuses on the use of logical connectors or may be concerned with surface linguistic corrections.

3. Research Question

Is there any difference in the use of logical connectors between Thai and international research articles?

4. Data Collection and Analysis

The data comprised 40 research articles from journals or conference proceedings related to applied linguistics in the year 2015. These were separated into two corpora: 20 Thai and 20 international articles. Thai articles were written by Thai researchers (nine articles from ICLC (NIDA) 2015, six articles from the Journal of English Studies of Thammasat University, and five articles from the PASAA Journal. The Thai articles were written in English. The international articles were written by non-Thai researchers and taken from four internationally-recognized journals (five articles from Pragmatics, five articles from the Journal of English for Academic Purposes, five articles from English for Specific Purposes, and five from System. These articles were randomly selected.

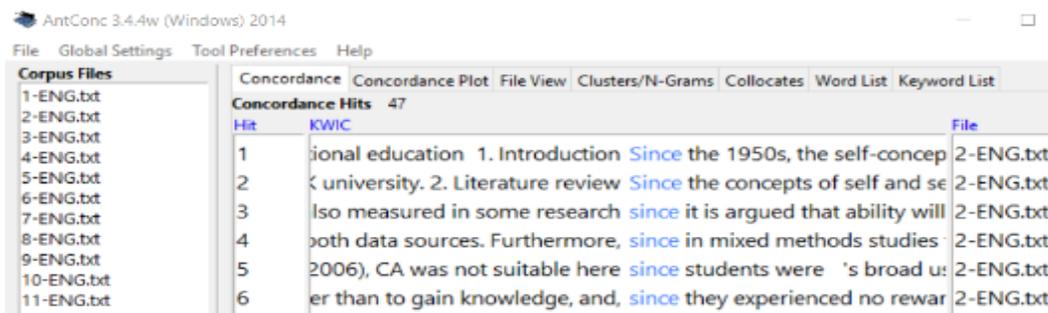
4.1 Methods

To analyse the data, there were four steps. Firstly, the articles were put into two corpora, one for the Thai articles and the other for the international articles. A code for each article was created. ‘1-TH...20-TH’ refers to each article in the Thai corpus, and ‘1-ENG...20-ENG’ refers to each article in the international corpus. All the articles were inserted into the “AntConc” concordance program which can be used to analyze corpora and obtain lists of the results (Kreiger, 2003). Secondly, we searched for 57 logical connectors which could possibly signal a line of reasoning, and linking claims and their support (see Celce-Murcia & Larsen-Freeman, 1983). From the frequency count, we found that some connectors were likely to appear as non-connectors. For example, “He implied that...”, “I stay at home for...”, “English as international...”, “The student so proud to.....” These linguistic features could be used as non-connectors, so they were discarded. We thus selected only the logical connectors that functioned as connectors only to reveal logical relationship. We found the top three (because, therefore, thus). Thirdly, 20 concordance lines of each connector were randomly selected (one line each 20th count), and read carefully. We found that some of the concordance lines were not appropriate for the purpose of the study (to see logical thinking in research articles) as the contents were derived from other sources. Moreover, we also eliminated ‘personal judgement’ due to the writers conveying their opinion in it (Milton & Tsang, 1993; Prommas & Sinwongsuwat, 2011). Thus, some of the concordance lines were excluded, which are presented in Table 2.

Table 2. Examples of the eliminated concordance lines

Extract	I liked xxxxxxxx because there was unlimited space. With this feature, I could learn more from the teacher feedback. I make the use of transitional words, such as first, second, however, but, because and so on to help understand the logical relations among the main points in the text I am aware of my ongoing reading tasks.
A whole citation / other source	(AAA, 20XX) reveals that "... <i>The nature of call center services was mainly communicating with customers over the telephone. Most of the CSRs in phone banking services in Thailand were non-native English speakers, and the CSRs always encountered a variety of English accents from people of different countries. Therefore, a top priority was listening skill in order to accurately understand a customer's request.</i> " (p. xxx)
Personal Judgement	The above discussion has shown that.....from classic detective fiction. His work is, therefore , better described by an array of terms than by a single label.

The eliminated lines were replaced by new concordance lines. Lastly, altogether 120 concordance lines were coded as 'logical' or 'illogical' and checked for reliability. An example of the concordance lines is shown below.



Given that identifying whether or not a text is logical can be subjective, we need to describe in more detail how we attempted to create reliability. There were several steps in the reliability check. Firstly, we looked at the position of logical connectors (see Table 1). Secondly, the concordance lines were converted into full-sentence format (see Figure 1).

“However, it appears most often in the Environmental Modeling & Software (EMS) subject area, with a frequency of 241 times, while its frequency is very low or non-existent in other subject areas. This is probably because the Environmental Modeling & Software (EMS) subject area includes a large amount of computer software-related research articles with code as a keyword, which potentially explains this frequency variance. Due to its low frequency in other subject areas, code should not be included in the EAWL”.

Figure 1. Example of full-sentence format in “AntConc”

Thirdly, we separated the full-sentence format into two sections: before and after the use of logical connectors (to distinguish a claim and its support). We then took 10 percent of the data to identify whether the sentences were logically or illogically used, based on the

relationship between claims and their support, and the function of connectors. An example of the analysis is shown in Table 3.

Table 3. Example of the analysis

Statement	Claim and Support	The validity of reason
<p><i>Cultural facts are convincing for tourists to visit cultural attractions which have interesting history, architectures, events, or traditional practice. According to Manca (2011), the relationship between language and culture has effects on word choices and cultural filters because language is used as a tool to disseminate cultures. Therefore, the use of language is inseparable from culture.</i></p>	<p>Claims</p> <p><i>The use of language is inseparable from culture.</i></p> <p>Support</p> <p><i>According to Manca (2011), the relationship between language and culture has effects on word choices and cultural filters because language is used as a tool to disseminate cultures.</i></p>	<p>Logical</p> <p>The use of ‘therefore’ The reader is expecting to see the consequences of the previous clause.</p> <p>We first see the claim that “<i>language is inseparable from culture</i>”. The reader may question why they could not be separated. Then, we see the support, where the writer mentioned “the relationship between language and culture”.</p> <p>Thus, the claim was presented logically.</p>
<p><i>People in English-speaking countries tend not to know another language (ABC, 20xx). Therefore, this indicates that they are poor language learners.</i></p>	<p>Claim</p> <p>This indicates that they are poor language learners.</p> <p>Support</p> <p>People in English-speaking countries tend not to know another language (ABC, 20xx).</p>	<p>Illogical</p> <p>The problem lies in the second clause, where the conclusion seems to be a hasty generalization. There is no reason or other support provided to show why they are poor language learners. Therefore, the claim is presented illogically.</p>

After several rounds of discussions on initial identification, we took another set of data (15 percent of the data), and coded it independently. The average score of the agreement was 80.95 percent, which was considered to be at an acceptable level.

5. Findings

This study aimed to explore logical thinking through the use of logical connectors of Thai researchers by comparing their use of logical connectors in research papers with those found in international research articles. The overall findings are presented in Table 4.

Table 4. Overview of the top-three logical connectors used in Thai and international research articles in 2015

Top Three (Thai) 133,364 Words	Total of Concordance Hits	Top Three (International) 179,047 Words	Total of Concordance Hits
1. Because	128	1. Thus	132
2. Therefore	89	2. Because	104
3. Thus	62	3. Therefore	79
Total	279	Total	315

From Table 4, we can see that the three logical connectors used by Thai and international researchers were not different, but the rankings were. The connectors were ‘*because*’, ‘*thus*’, and ‘*therefore*’. Thus, these three logical connectors can be taken as those most commonly used in research writing (Demiral, 2015), among other logical connectors, to indicate lines of reasoning, and linking claims and their support. However, this finding does not assess logical thinking, so we further analyzed whether these connectors were logically or illogically used, and the findings are revealed in Table 5.

Table 5. Total number of logical connectors that are logically or illogically used

Data	Logical	Illogical
Thai	58	2
International	58	2

In Table 5, we display the overall examination of the logic of all 120 concordance lines. The results indicate that Thai and international researchers are no different in their problems with logical thinking as shown in the use of logical connectors. Based on this, we may conclude that the claim that logical thinking is a particular problem for Thai researchers is invalid.

Table 6. Top three logical connectors and their logical or illogical use

Top Three (Thai)	Logical	Illogical	Top Three (International)	Logical	Illogical
1. Because	19	1	1. Thus	20	0
2. Therefore	20	0	2. Because	19	1
3. Thus	19	1	3. Therefore	19	1

In Table 6, however, there are only four concordance lines from two sets of data that were found to be illogically used. The illogical uses are ‘*because*’ and ‘*thus*’ in the Thai corpus, and ‘*because*’ and ‘*therefore*’ in the international corpus. We illustrate the illogical case below. To facilitate the explanation, see also Table 7.

Table 7. Example of the relationship between sentences

Logical Connectors	Claim and Support
1. Because	(Claim) + <i>because</i> + (Support)
2. Thus	(Support) + <i>thus</i> + (Claim)
3. Therefore	(Support) + <i>therefore</i> + (Claim)

Extract 1: “Thus” from Thai – Logically Used

(S1) A written comment is a form of communication between students and teachers, which aims to encourage the students to enhance their learning and improve their work (Hyland & Hyland, 2006). (S2) Learning can be varied, depending on the students’ level, and their work can include written assignments or research projects. (S3) **Thus**, written comments can be used with different levels of students; for example, at high school, undergraduate or graduate levels.

In Extract 1, we can see that “*Learning can be varied, depending on the students’ level, and their work can include written assignments or research projects*”, and “**Thus**, written comments can be used with different levels of students; for example, at high school, undergraduate or graduate levels”. There seems to be a connection of ideas, but it is not clear how the two sentences are logically related.

6. Discussion and Conclusions

This study explored logical thinking through the use of logical connectors in published research articles in the field of applied linguistics in the year 2015. The overall findings suggest that the top three logical connectors used by two groups were similarly ‘*because*’, ‘*thus*’, and ‘*therefore*’. Most of these connectors are logically used, and there is no difference between the research articles published by Thai and non-Thai researchers. However, this study still has some limitations. Firstly, the findings in this study are based on small corpora; thus, more data is suggested for further studies. Secondly, logical thinking can be expressed in several ways including the use of logical connectors, as can fallacies in arguments. Future research may try other ways of examining the logical thinking of Thai researchers.

Although we have found empirical evidence to reject the claim that Thai researchers lack logical thinking, we do not suggest that the issue of logical thinking is unimportant for students, especially in academic or research writing (Charles, 2011). It is beneficial for teachers to increase students’ awareness in using logical connectors. From doing this research, we have become more aware of the proper use of logical connectors.

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