Diachronic Changes of Frequencies in Discourse Connectives in the English Language: The Evidence from COHA

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Abstract: Recent studies have claimed that the amount of discourse connectives or discourse markers has risen in multiple languages. However, the thesis has seldom been evaluated using comprehensive empirical data evidence. This study investigates the historical changes of frequencies in discourse connectives in the English language over the last two hundred years. We find that the frequencies of the majority of discourse connectives showed a marked decrease. An opposing trend can be seen with respect to only a few types of discourse connectives. These research results show that the frequencies of discourse markers in English have not in fact increased over the last two centuries. We analyze the possible reasons for this decline. And this result suggests that English language users tend to use explicit discourse connectives less frequently, which finding may challenge recent claims concerning the rise of discourse connectives (markers).

Key words: frequency changes; decline trend; implicit discourse relation; historical development

1. Introduction

Discourse connectives are words or phrases connecting or relating discourse units. They are used to indicate discourse relations. A *discourse relation* is the semantic or logical meaning of the connections between discourse units. Discourse connectives play an important role in creating coherent discourse because they mark the semantic relation between discourse units and then help language users to attain an understanding of textual coherence. For example, “As he stood on the harbour thinking about his son (1), he wondered if the family would ever get to make the journey(2). However, soon after this disappointment (3) the father discovered how lucky the family had been (4).”. In this example, “as” provides the link between clause (1) and (2). This discourse connective allows readers/listeners to know that the two clauses have a temporary relation. Similarly, “soon after” allows readers know that clause (3) and clause (4) are linked by a temporary relation. Finally, “however” connects the two discourse units made up by (1)-(2) and (3)-(4) respectively and expresses the contrast between them.

Due to the importance of discourse structure, researchers have developed many different theories of discourse and these reflect the many and various perspectives on textual coherence. RST (Rhetorical Structure Theory, Mann & Thompson, 1988) is one influential approach in this field. It describes textual coherence using the rhetorical relations between EDUs and postulates a hierarchical tree structure. By contrast, the D-LTAG theory (a lexicalized Tree Adjoining Grammar for discourse) argues that discourse relations can be lexicalized (Webber, 2004). Based on the fact that discourse connectives signal discourse relations (e.g., “because, although, when”), this theory treats two discourse units as linked by a connective, which means that one discourse unit and the connective together constitute a dependency relation.

One influential discourse corpus, the Penn Discourse Treebank (PDTB, Prasad et al., 2008/2019), uses discourse connectives to annotate English discourse structures following the D-LTAG. But because the D-LTAG looks at each relation individually and disregards most of the surrounding structures, it does not take into account the global structure of the text. This approach is used in shallow discourse parsing. The PDTB uses discourse connectives as heads to form dependencies concerning local discourse structure. In this sense, discourse connectives play an essential role in this corpus. The PDTB distinguishes 43 relation labels with annotations (Webber et al., 2019). These labels are organized in a hierarchy consisting of three levels (i.e., sense, class, type).

Discourse connectives and their relevant concepts (e.g., discourse markers, discourse particles)

have been become quite popular (Lenk, 1998; Fraser, 1999) in studies of pragmatics and discourse. The main reason is that these studies have found that discourse connectives provide necessary discourse and pragmatic information in language. This has led to the thesis of “the Rise of Discourse Markers”, which has gradually become accepted (Heine et al. 2021). Although discourse connectives are one essential part of discourse markers, this nonetheless gives rise to the illusion that the use of discourse connectives has increased and thus that discourse connectives have risen in frequency. Although frequency effects have been extensively and intensively studied in language variations, language processing and language acquisition (ref. Bybee, 2007; Ellis, 2002; Grainger, 1990). However, the diachronic change of frequency has seldom been investigated to associate with usage of a language phenomenon. If we say that a language phenomenon is on the rise, it implies that language users have been using it more frequently. If its frequency is decreasing, it is difficult to say that it is on the rise. A frequency increase in one language phenomenon at least suggests that there is a motivation for this language phenomenon and that there is an increase in its usage (Sun & Baayen, 2021). In other words, if it is known that the frequencies of discourse connectives have in fact increased significantly, it is plausible to believe in “a rise of discourse connectives” In order to test this hypothesis and the surrounding issues, we need to examine the historical data on discourse connectives, and the historical data on discourse connectives can provide empirical evidence to test this hypothesis. Although previous studies have investigated the diachronic changes of frequencies in specific discourse markers, we do not think that such investigations are comprehensive enough to represent all discourse connectives (Lenker & Meurman-Solin. 2007; Claudia, 2013; Rysová, 2017). In order to see the bigger picture, we will examine the diachronic changes in all discourseconnectives derived from large-scale corpora and make a quantitative analysis. This study is possible thanks to the growing interest in discourse analysis and the availability of large-scale corpora.

This paper looks at the majority of discourse connectives comprehensively from the diachronic point of view. To our knowledge, this is the first time such an investigation has been made. We believe that by drawing upon the data on the historical development of this linguistic phenomenon, the current study can reveal much about general tendencies in the use of present-day discourse connectives. Our research questions are as follows:

- 1) Have the frequencies of discourse connectives in English increased or declined significantly over the last two centuries?
- 2) Do the diachronic changes of frequencies in discourse connectives provide empirical evidence to support the claim concerning a rise of discourse connective?

2. Materials and Methods

First, we need to obtain a comprehensive list of discourse connectives. The release of the PDTB (Webber et al., 2019) provides a high-quality and large-scale discourse resource for the English language. Corpora annotated with discourse relations for eight languages were developed following the release of the PDTB. The most recent release is PDTB3.0. This version contains a manual which provides a detailed list of discourse connectives (Webber et al., 2019). In this manual, an individual discourse connective is specified with its different semantic meanings as well as its frequencies. Such data are very important and valuable for historical studies and especially in the present context, given that we want to know the frequencies of different semantic meanings for this specific discourse connective. Figure 1 shows the hierarchy of semantic labels for discourse connectives. All clause relationships (i.e., semantic meanings) in PDTB3.0 can be classified into four main senses: *Temporal*, *Comparison*, *Contingency* and *Expansion*, and each main sense consists of smaller relations. The whole classification contains three levels: SENSE, CLASS and TYPE.

SENSE: There are four major semantic classes: TEMPORAL, CONTINGENCY, COMPARISON, and EXPANSION.

CLASS: A second level of types is further defined for each semantic class. For example, there are two classes: “Asynchronous” and “Synchronous” under the sense TEMPORAL.

TYPE: A third level of types is defined for some, but not all types. For instance, under the class “CONTINGENCY: Cause”, there are two types: “reason” (for cases like “because”) and “result” (for cases like “accordingly”).

Using the example from the Introduction, we know that the explicit connective (“however”) will be annotated with its three-level hierarchical relation type: it is of the “comparison” sense, the “contrast” class.

Figure 1: the classification of clause relationships in PDTB3.0

In PDTB3.0, a discourse connective can be either explicit or implicit. An *explicit* discourse connective is realized in the form of lexical items, but an *implicit* discourse must be inferred from the adjacent discourse units. Most explicit discourse connectives are subordinate and coordinate conjunctions as well as discourse adverbials. The discourse connectives are mostly explicit in English, yet approximately 40% of the discourse connectives are implicit (Prasad et al., 2014). In the present study, we will investigate the diachronic changes in frequencies of explicit discourse connectives. We can obtain 153 discourse connectives from PDTB3.0. The number of two-word phrase is 50, and that of three-word(or more) phrase is 20.

Second, we can obtain the data on the historical frequencies of these discourse connectives from a large-scale historical English corpus. The COHA (the corpus of historical American English) is a good candidate (Davies, 2010). This corpus consists of a number of balanced genres and represents real-world English language use over a long period of time. This corpus can provide the data on frequencies of an individual word by decade from 1820 to 2010. Parts of speech (PoS) of the majority of discourse connectives are conjunctives or prepositions. If a discourse connective has multiple PoSs, we will exclude those PoSs that cannot act as discourse connective. For example, when “like” works as verb, it cannot act as discourse connectives, so when we search the COHA, “verb” will be excluded.

However, we think it does not suffice to just obtain the historical frequencies of an individual discourse connective. As is well-known, a discourse connective can work in different discourse relations, that is, it can have different semantic meanings in the PDTB. It is difficult to obtain the data on the frequencies of these different meanings for a specific discourse connective. For example, the frequency of “although” was 158 (by one million words) in 1880s. However, the semantic meanings of “although” include contrast, concession, exception, and temporary. We want to know the frequency of those occasions where “although” is used with a contrast meaning or a concession meaning. In this case, the data from the PDTB3.0 manual can be used to calculate the weights of these different semantic meanings for a specific discourse connective. The following discusses how to calculate the frequency weights of different classes (semantic meanings) for the same discourse connective. All discussions about it be summarized into Table 1.

Table 1: Example of calculating frequency weights for different classes for the same word

discourse connective	sense	class	frequency
Although	Comparison	Concession.Concession.Arg1-as-denier	206
Although	Comparison	Concession.Arg2-as-denier	105
Although	Comparison	Contrast	14
Although	Expansion	Exception.Arg2-as-excpt	2
Although	Temporal.Synchronous Comparison.Contrast		1 (0.5+0.5)

(the original data from PDTB3.0)

discourse connective	sense.class	weight
although	Comparison.Concession	$(206+105)/311=0.9481707$
although	Comparison.Contrast	$(14+0.5)/311=0.04420732$
although	Expansion.Exception	$2/311=0.0060975$
although	Temporal.Synchronous	$0.5/311=0.001524$

(the data on weights for different PDTB classes of this discourse connective)

The total frequency for “although” is 311 (per one million words), as shown in Table 1. We merge the items shared with the same sense and class regardless of types. For example, the first and second “although” are merged to be treated as “Comparison.Concession”. The last “although” is annotated as “Temporal.Synchronous|Comparison.Contrast”. In this case, the two types of “sense.class” will be split with equal frequency. Here, we split it into “Temporal.Synchronous” and “Comparison.Contrast” with the frequency of 0.5 respectively. Generally, “although” can be classified into four types according to its “sense.class”. Each item has their own different frequencies. We are interested in the weight of each item. However, we have obtained the frequency for “Comparison. Contrast”, so the frequency on this item (i.e. 0.5) is put into the one above. The weight of an individual “Sense.Class” is calculated by its frequency divided by the total frequency. For example, the weight of “Comparison.Concession” can be computed by its frequency (206+105), divided by the total frequency (311), that is, its weight is 0.9482. The data on the weights of the four different meanings (Sense. Class) is shown in the bottom panel of Table 1.

The total frequency of “although” for each decade can be obtained in COHA. However, we are more interested in knowing the frequency of each type of “sense.class” for this word. It can be easily calculated using the equation of “the total frequency * the weight”. For example, the total frequency (per million words) of “however” in 1900 is 378.76. In this case, its frequency of “Comparison.Concession” is $378.76*0.9481707=359.13$, the one of “Comparison.Concession” is $378.76*0.04420732=16.74$, the one of “Expansion. Exception” is $378.76*0.0060975=2.31$, the frequency of “Temporal.Synchronous” is $378.76*0.001524=0.58$.

Using COHA, we can gain data on the frequencies (standard frequency, by one million words) of all discourse connectives derived from PDTB3.0 from 1810 to 2010. An individual discourse connective can be classified into several types according to the PDTB3.0 annotation manual, as shown in Table 1. We can calculate their frequencies in each decade using the corresponding frequency weights of the different classes for the same discourse connective (1820-2010). Note that the weights of the different classes of this discourse connective are based on the PDTB3.0, which used WSJ texts published in 1990s. That means these weights only reflect usage in the 1990s. However, the weights must have been somewhat different in each decade of the last two centuries. Nonetheless, the semantic changes in these discourse connectives are much smaller than nouns, verbs, and adjectives. The reason for this is that the majority of discourse connectives are conjunctions and prepositions. It is well-known that function words undergo a lesser degree of historical semantic changes than content words (Kutuzov et al., 2018). Bloomfield (1933) defines function words as “innovations which change the lexical meaning rather than the grammatical function of a form.” . In view of the fact that these small semantic diachronic changes in these discourse connectives have been basically ignored, we maintain that the weights based on the PDTB can be used to calculate the frequencies over all decades. This can be done if we use the same weights for each decade between 1810 and 2010.¹

3. Results

First, we represented the historical changes in frequencies for all discourse connectives as classified into the four senses in Figure 1. The results are shown in Figure 2. Figure 2 shows that the four types of senses underwent a significant decline in frequencies. The regressive statistical analysis in each case shows that the slope is negative and the p value (<0.001) is significant, as can be seen in each panel. This indicates that English users have significantly reduced their use of explicit discourse connectives over the last two hundred years.

After obtaining the data on these overall tendencies, we can examine the different cases grouped under the same sense. The following considers the different classes of each sense. Each sense is composed of a number of types in the PDTB3.0 as seen in Figure 1. Figure 3 represents the six classes under the category of “expansion”.

1 All data on the weights of the different classes, the frequencies in the decade from 1820 to 2010, as well as the frequencies of explicit discourse connectives from the PDTB3.0, are available in <https://osf.io/h38x4/>.

Figure 2.

Figure 2: The frequencies of the four senses declined dramatically from 1820 to 2010.

Figure 3: In the sense of “expansion”, the class “instantiation” exhibits a growing trend. By contrast, the other classes have dramatically fallen.

The four classes under “expansion” show a significant decline in their frequencies. The linear regressive analysis (negative slopes and significant p -value <0.001) also confirm this observation. By contrast, the increase in the frequency of “instantiation” may suggest that English users have preferred to use more examples. This preference leads to an increase in the use of discourse connectives involved in exemplification. The exception is “exception”. The regression analysis shows that there is no significant change in this case. It indicates that the frequency of “exception” remains relatively stable.

What is very interesting is that the three classes under the category “comparison” show different trends. As is well-known, the proportion of explicit discourse connectives regarding “comparison” is relatively high. In other words, language users usually have to employ discourse connectives to express comparative meanings.

Figure 4: In the sense of “comparison”, the class “similarity” trend has shown an increase. By contrast, the other classes have decreased.

Figure 5: In the sense of “contingency”, the class “cause” has undergone no significant change. By contrast, the other classes show a declining trend in their frequencies.

As shown in Figure 4, the frequency of the three classes shows a clearly declining trend. Due to the need for discourse connectives, the declining frequency of “concession” could indicate that language users tend to employ less concession-relationship clauses over the course of time. The regression analysis shows that the p -value is greater than 0.05, which suggests there is no dramatic changes in frequencies of contrast.

In the following, we examine the frequency changes from an orthographic perspective. As is well-known, some discourse connectives are just one word, but the others may consist of two or three (or more) words. “N-gram” here means one word, a two-word combination or a three-(or more)-words combination. Figure 6 represents the diachronic changes in different types of discourse connective from the perspective of n-gram.

Figure 6: Bigram shows a clearly increasing trend. By contrast, the other types dropped significantly.

Here “Bigram” represents two-word phrase such as “due to”, “in fact”. Trigram refers to three (or more than three) word phrases, such as “in any case”, “on the other hand”. “Lemma” refers to one-word discourse connectives. Only Bigram shows an increasing trend in frequency. This could mean that English users tend to use two-word discourse connectives more frequently although the overall trend is a less frequent use of discourse connectives.

4. Discussion and Concluding Remarks

According to Aser & Demberg (2012), implicitness represents the proportion of implicit frequency to the total frequency

$$\text{implicitness} = \frac{\text{implicitfrequency}}{\text{implicitfrequency} + \text{explicitfrequency}}$$

Table 2 provides frequencies of explicit and implicit discourse connectives in PDTB3.0. Based on the data on the frequencies, we can calculate implicitness for each discourse relation, as shown in Table 2. Note that the annotations in the PDTB3.0 are different from the PDTB2.0 (Sun & Zhang, 2018). Our study is based on the PDTB3.0. As shown in Table 2, most of the discourse relations declined in frequencies. The frequency of “similarity” is very small in comparison with the other discourse connectives. In view of this fact, we believe that it is highly likely that when a given discourse relation increases its frequency, its implicitness is higher. In other words, those discourse relations preferring implicit discourse connectives have a great chance of increasing the frequency of the use of explicit connectives over the course of time.

Table 2: the distribution of frequencies for different types of relations in the PDTB3.0 (Ranked according to implicitness)

Type	Explicit	Implicit	Total	Implicitness	Diachronic trend
Level-of-detail	263	3361	3624	92.74%	decline
Equivalence	27	336	363	92.56%	decline
Instantiation	325	1533	1858	82.52%	increase
Purpose	324	1373	1697	80.91%	decline
Cause	2116	6009	8125	73.96%	stable
Manner	410	739	1149	64.32%	decline
Contrast	1234	983	2217	44.34%	decline
Asynchronous	2025	1289	3314	38.9%	decline
Conjunction	8788	4386	13174	33.29%	decline
Synchronous	1629	539	2168	24.86%	decline
Concession	4831	1504	6335	23.74%	decline
Similarity	102	31	133	23.31%	decline
Exception	35	5	40	12.5%	stable
Condition	1499	201	1700	11.82%	decline
Disjunction	305	30	335	8.96%	decline

Table 2 shows that 74% of causal relations are implicit. On the other hand, through experiments, Kuperberg et al. (2011) report that causal relations are not marked unless an explicit cue such as adversative connectives (e.g., “but”) provides the marking for another type of relation. The data on PDTB also support the study of Kuperberg et al. (2011) because 65% of *contrast* relations and 76%

of concession relations are explicit, as show in Table 2. We believe that the higher proportion of implicitness in *causal* relations provides evidence for the causality-by-default hypothesis proposed by Sanders (2005:111). Humans speaking different languages may well generally use *conjunction* and *causation* as their paradigmatic thinking (semantic) patterns instead of *alternative* or *exception*.

It would be easy to accept that the frequencies in explicit discourse connectives concerning *contingency* declined over the course of time because the causality-by-default hypothesis supports the view that people do not need extra cues in understanding causality. Furthermore, many other language devices are capable of replacing such discourse connectives. For example, *causality verbs* can indicate the causal relation between two sentences. However, our historical finding on adversative connectives (contrast, concession) seems to contradict our intuition. People seem to need more cues to help them understand adversative relations between clauses and sentences. Despite this, English language users seem to be historically less reliant on the use of adversative connectives. People tend to prefer similarity connectives, a fact worth further exploring.

However, Jin and Marneffe (2015) proposed that *expansion* should be treated as being the default option as it is explicitly marked far more often than *causation* in English. It is clear that *causation* is not the least marked relation. We can also see that contingency and comparison are often implicit. These data further support the explanation that implicitness is used to a proportionally greater extent. Our finding suggests that English language users are historically less reliant on the use of expansion connectives. The frequencies of “expansion” and “causation” are the highest among those of discourse relations. Due to the high frequency, language users habitually treat the two relations as the relation-by-default. For example, when language users find half of discourse relations are either *expansion* or *causation*, this high probability drives them to assume that two discourse units are likely to be linked by either of the two relations. In this situation, language users would rely less on using explicit discourse connectives regarding expansion or causation. Our historical data supports the claim that English language users have used two types of connectives less frequently. But there are two exceptions. The first exception is “instatiation” under the category of *expansion* and the other exception is *comparison*. It is not clear why the frequency of “instatiation” increased over the course of time. The two classes of comparison declined in frequency. In the following, we propose a preliminary analysis.

We can apply these two factors to the analysis of the decline of comparison connectives. For example, the first possibility is that English users reduced their dependency on the use of explicit relations. In other words, English users tended to use explicit relationships less frequently. The other possibility is that English users tend to use explicit connectives less frequently but the overall amount of discourse relations in language remained stable. Moreover, English users tended to use

two-word discourse connectives more frequently probably these bigram discourse connectives are robust in productivity and usage.

It is possible that some discourse connectives came into being after grammaticalization (Traugott, 1995). With regard to some specific words, it is also possible that their function as discourse connectives has become historically prominent due to semantic shifts (Degand & Evers-Vermeul, 2015). For example, “like” serving as discourse connective has become prominent. However, this does not indicate that English language users have used them in language more frequently than previously. For these words or phrases, they might have become significant for the function (discourse connectives). However, when these words or phrases have changed to work as discourse connectives, their frequencies have been declined in the last two centuries. Once their frequencies have been declined, it could be a little difficult to conclude that the use of these discourse connectives has risen in discourse and language because this claim lacks the historical empirical data to support it. However, this does not necessarily indicate that English language users have used them more frequently than previously. For example, it could be as they took on an increasingly prominent role as discourse connectives, the frequency of their use more generally declined over the last two centuries. Clearly, in the present study, our diachronic data on frequency in discourse connectives does not really verify the hypothesis of rising of discourse connectives mentioned in Introduction. Additionally, it is not clear that what exactly caused the decrease of frequencies in the use of discourse connectives, a topic which merits further investigation.

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