

Effects of Lexical Richness on Text Readability of Medical Journal Articles

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Abstract

To discover the effects of lexical richness and text readability in medical journal articles, we have found that lexical density has the strongest impacts on text readability, followed by lexical sophistication and lexical diversity. Therefore, we encourage scholars to adjust their usage of nouns and sophisticated words so as to adjust text readability. For teachers, it is of great significance to receive professional training targeted on vocabulary and expressions. This study intends to contribute to complete the study of lexical richness on text readability in medical academic articles.

Keywords

Lexical richness; Text readability; Medical journal articles.

1. Introduction

Vocabulary is proven to be crucial in foreign language writing since it correlates strongly with writing quality (Engber 1995). As a matter of fact, studies on vocabulary have always been the center of second language acquisition field since words, the smallest meaningful unit, are foundations of language learning. And one's ability of vocabulary can be reflected through lexical richness. It is a vital tool used for measuring vocabulary in writing (Daller et al. 2003; Read 2000).

Text readability, on the other hand, refers to the difficulty level given rise to the ways of diction and syntax in writing (Fry 2002). As one of the influencing factors of text readability, to what extent can lexical richness determine text readability has not yet been explored.

Medical journal articles are objective presentations of medical results and achievement. However, as we observe, these papers are usually very difficult to understand for normal citizens. One of the reasons why might be attributed to massive usage of sophisticated words and normalization phenomenon. While the employment of complicated words and nouns can be referred to lexical sophistication and lexical density, which are two components of lexical richness. Unfortunately, how exactly does lexis factors affect text readability has so far not been explored.

Therefore, this paper develops from the following three sections, strong effects of lexical density on text readability, medium effects of lexical sophistication on text readability and low effects of lexical diversity on text readability.

2. Literature Review

Text readability studies can be divided into three aspects. To begin with, the studies on its affecting factors remains to be the center of readability studies, ranging from lexis, textual factors, reader factors to settings. Betts (1949), for example, believes lexis is the definitive factor, which includes the average number of words per sentence, number of simple sentences, number of prepositional phrases, percentage of different words, number of uncommon words,

number of words beginning with certain letters, the number of polysyllabic words, adjectives and adverbs, personal pronouns and the number of other personal referential words. Apparently, lexis is insufficient to explain readability. Scholars, such as Deehant & Smith (1961/1977), believed word length, the number of syllables, sentence types, number of illustrations, writing purpose, the organization of materials and the relationship between typography and content all matters when it comes to text readability. Gradually, researchers have come to realize the significance of readers. Bruee & Rubin (1988) pointed out that readers' interest, motivation, beliefs, background information as well as reading environment is crucial to text readability but has been neglected for a long period. In addition, scholars have shed some lights on its measurement. Traditionally, text readability was measured through Question-and-Answer Technique and Sentence Completion Technique. However, it was been replaced quickly after the emergence of formulas. So far, formulas remain to be the main measurement of text readability. Typical formulas include FRE (Flesch Reading Ease), Fry, SMOG (Simple Measure of Gobbledygook). These formulas have largely increased accurateness and objectiveness of readability measurement. Despite this, they still fail to cover setting factors, which are crucial for readability. Furthermore, the measurement of readability using formulas are under attack since readability is in nature subjective. As we aware, being easy or difficult to read describes the feeling when we read, which varies from individuals to individuals. Besides, scholars abroad have recently shed lights on its applications, the relationship between text readability and citation rate as well as writing quality, for instance. Stremmersch et al. (2007) uncovered that text readability and citation rate are in inverse proportion. On this very note, compositions with higher index are more comprehensible, hence higher citation rate. However, the opponents, such as Metoyer-Duran (1993) stands for the opposite side, favoring direct proportion between citation index and text readability.

As we can summarize from previous studies on text readability, it has been limited to its affecting factors, measurement and its applications. However, other fields, such as the relation to lexical richness has not been investigated so far.

The framework of lexical richness varies from scholars to scholars. For Linnarud (1986), lexical richness can be classified into lexical individuality, lexical variation and lexical density. As far as Laufer & Nation (1995) are concerned, four categories, namely, lexical variation, lexical density, lexical sophistication and lexical originality constitute the framework of lexical richness. Laufer & Nation's classification received some criticisms. For example, Read argue that lexical originality fails to measure learners' lexical ability. On this very note, Read come up with a new classification. According to his classification, lexical richness is categorized into lexical density, lexical diversity and lexical sophistication as well as lexical error. Although this classification seems fixed, it was adjusted to meet scholars' needs. For instance, lexical error was excluded when learners are of high language proficiency together with repeated revisions. From the above-mentioned classification, it can be detected that in Read's classification, lexical diversity, in some cases known as lexical variation, lexical density as well as lexical sophistication remain to be defining factors in most cases. And Read's classification has been proven to be valid in various research. Therefore, the framework of lexical richness for this study includes lexical density, lexical sophistication, as well as lexical diversity.

Lexical density refers to the ratio of lexical words in the text. (Ure 1971). It reflects how much information the text conveys. Generally speaking, lexical words is proportional to lexical density, meaning the higher the percentage of lexical words is, the higher lexical density will be. This has reached common sense. Regarding the definition of lexical words, however, it is rather controversial. Although some scholars equal lexical words to content words and use relevant software to calculate lexical density index by counting the number of content words. Among the majority of scholars such as Lu (2012) classified lexical words into nouns, verbs (excluding modal verbs, auxiliary verbs, "be", and "have"), adjectives and adverbs as well. Lexical

sophistication means appropriate usage of low-frequency instead of high-frequency words tailored to the subject and literary form (Read 2000). Based on this, Laufer & Nation pointed out that “sophistication” is not an absolute term which can be adjusted according to learners’ language proficiency. Besides, Lexical diversity, or lexical variation, refers to a wide variety of words and expressions used in a text. It has been used as quite a few assessment tools such as a measure of proficiency in a second language (Engber, 1995; Cumming et al., 2005), vocabulary knowledge (Zareva et al., 2005; Yu, 2010) and et cetera.

3. Effects of Lexical Richness on Text Readability

In order to find out the effects of lexical richness on text readability, three sections are employed, including strong effects of lexical density on text readability, medium effects of lexical sophistication on text readability together with low effects of lexical diversity on text readability.

3.1. Strong Effects of Lexical Density on Text Readability

Lexical density has strong predictive power to text readability. The reasons lie in three aspects. First and foremost, the level of lexical density in some way determines formality, which is a strong indicator of text readability. As we aware, generally speaking, the lexical density of text in written forms is higher than in spoken forms. That is to say, the former the language is, the higher lexical density will be. As we can observe from examples below. One of the examples is chosen from introduction part of article in Chinese Medical Journal in 2011 and the other is a revised version with spoken language features. In other words, less content words and simple sentence structures.

Eg.1 More than 800, 000 Europeans and North Americans have an out-of-hospital cardiac arrest every year, with overall survival averaging 5%. (Sample 1 from introduction sub-corpora in NSC 2011)

Every year, over 800, 000 Europeans and North Americans have heart problems outside the hospital. Only about 5 % of them will survive. (Revised version)

From the above example, we can see clearly that the second sentence is much easier to understand. To do that, phrase “out-of-hospital” is changes into “outside the hospital”, “cardiac” into “heart problems”, and “overall survival averaging 5%” into “about 5 percent of them will survive”. According to Martin Joos (1962), the degrees of formality can be divided into frozen, formal, consultative, casual and intimate. The unbridged version is of typical medical article features with technical terms and formal sentence structures. While the revised one is expressed in common languages with lower formality which is frequently seen in spoken language.

Eg.2 Our results show that treatment with active compression decompression CPR with enhancement of negative intrathoracic pressure during the decompression phase significantly increases survival to hospital discharge with favorable neurological function compared with standard CPR after an out-of-hospital cardiac arrest of presumed cardiac cause (panel). (Sample 601 from discussion sub-corpora in NSC 2011:1)

Moreover, amid content words employed in the above example, nouns are the most frequently used. Normalization is one of the carefully studied and prominent features in academic context. The most outstanding feature of academic text is high formality which is achieved by accelerating semantic density, using normalization expressions and non-personal structure in Hyland’s (2006) words. This is particularly eminent in example 2. Lexical density is ascending by the usage of nouns like treatment, compression, decompression, enhancement, phase, survival, arrest. And it is a comparatively long sentence, with four lines and 44 words in total. It can be rewrite in the following version with lower lexical density index. It goes like “From the

results, we can see that when we are clear of the causes of heart problems in cases happened outside the hospital and when the patient is experiencing decompression phase, compression decompression CPR is better than standard CPR. By enhancing the negative intrathoracic pressure, this new CPR discharge patients with better brain function." This version uses less content words and naturally less nouns to express same meaning.

By definition, lexical density refers to the ratio of lexical words in the text. (Ure 1971). It reflects how much information the text conveys. Generally speaking, lexical words is proportional to lexical density, meaning the higher the percentage of lexical words is, the higher lexical density will be. This has reached common sense. Regarding the definition of lexical words, however, it is rather controversial. Although some scholars equal lexical words to content words and use relevant software to calculate lexical density index by counting the number of content words. Among the majority of scholars such as Lu (2012) classified lexical words into nouns, verbs (excluding modal verbs, auxiliary verbs, "be", and "have"), adjectives and adverbs as well.

It has been applied to measure readability. For example, ERMS(English Readability Measurement System), a software proposed by research groups in Chongqing University added lexical density as one of the index to measure text readability. In this software, four levels of words are divided, including level 1 (precollege vocabulary), level 2(CET-4 vocabulary), level 3 (CET-6 vocabulary) and level 4 (TEM 8 vocabulary and GRE vocabulary). It is capable of counting tokens, types, sentences, syllables. Based on this figures, lexical density, and FRE can be calculated. Besides, words were put into 4 categories automatically. These functions enable ERMS to become the most influential software to calculate readability.

In addition, content words also increase recognition time. As we aware, content words contains more information which demands readers' longer attention and adds to memory burden. And lexical density has the same effects on Chinese and International Journal Articles. For example, Example 3 and 4 were chosen from methods section of an article published in Chinese Medical Journal and The Lancet in 2011. Words underlined contains large information to be processed by our brains.

Eg.3 We undertook our randomized, multicenter trial in seven geographical sites in the USA. These sites had 46 emergency medical service agencies in urban, suburban, and rural areas, and served 2.3 million people. (Sample 201 from methods sub-corpora in NSC 2011)

Eg.4 The study was conducted in Suixi county of Anhui Province, China, where HIV spread among former commercial blood donors. The method of stratified cluster sampling was carried out. (Sample 301 from methods sub-corpora in CSC 2011)

To sum up, from two perspectives, namely formality and cognitive processing, we have explained the reasons why lexical density is capable of posing strong effects on text readability. In order to achieve that, we have borrowed the concept of five degrees of formality and memory processing mechanism.

3.2. Medium Effects of Lexical Sophistication on Text Readability

As we aware, lexical sophistication is measured by Lexical Frequency Profile, the most frequently used method put forward by Laufer & Nation in 1995. This measurement highlights the distribution of words varying from frequency levels. Concerning the details, it includes three wordlists: first 1000 most frequent words, second 1000 most frequent words and the 570 most frequent academic words. Quite a few studies have testified the its reliability. For instance, Chen (2011) applied Lexical Frequency Profile in research on different genre writing. He came to conclusion that on the one hand, compared to narrative writing, learners employ more academic words in expository writing. On the other hand, a variety of word types and comparatively complex words were used. Furthermore, Higgibotham & Reid (2019) revealed that thesis with high grades tend to use more low-frequency academic words while their

counterparts rely on high-frequency ones. All in all, this research measures lexical sophistication in accordance with the aforementioned three wordlists.

On the one hand, the reason why lexical sophistication has certain effects on readability is because lexical sophistication is one of factors affecting text readability. According to Betts (1949), lexis, including number of uncommon words or frequency of the words, is one of the influencing factors of readability. That is to say, words that occur with low-frequency is comparatively harder for readers to understand if other factors remain the same. It is also reasonable to explain it from the perspective of cognition. That is to say, high-frequency words entail readers' familiarity, which is crucial for memory burden relief.

Eg.5 Evidence is missing to help decision makers objectively and dispassionately balance the reduction in risk to unaffected countries by restricting international travel from areas affected by Ebola virus, against the possible humanitarian and public health consequences to countries currently in the midst of the epidemic. (Sample 51 from introduction sub-corpora in NSC 2015)

Eg.6 Renal biopsy is unsurprisingly the golden standard to determine the degree of renal fibrosis in patients; however, it is an invasive method and inconformity for repeatedly monitoring the progression of fibrosis in clinical follow-up, and it remains challenging to establish a noninvasive biomarker to monitor the progression or regression of renal fibrosis in substitute of biopsy. (Sample 128 from introduction sub-corpora in CSC 2013)

From example 5 and 6, we can see that employment of sophisticated words, including evidence, objectively, unaffected, restricting, areas, affected, consequences, method, monitoring, challenging, establish, substitute. These words certainly take more time for ordinary readers to identify and process, which adds pressure to their information retrieving. Consequently, it affects text readability.

On the other hand, referring to five levels of formality, using sophisticated words intend to increase formality, especially in written language. Considering authors' influence on lexical sophistication, as we are aware of the fact that mastering of AWL contributed largely to high ratio of lexical sophistication. Relevant studies have showed that high-achievers employ more academic words indicating academic depth to some extent. This also applies to native speakers and foreign language writers. For instance, wan (2010) is in favor of this insights by saying that "the higher the language proficiency, the higher the lexical sophistication in written production". Furthermore, Zhu's (2013) research summarized that lexical sophistication climbs up along with learners' language proficiency. To take one last and one of the most recent studies as an example, Gao's (2020) research results are also consistent with this research. He conducted a comparative study of lexical richness on English majors and native speaker. In his research, he stated succinctly that native speakers with high proficiency intend to master and use more advanced and sophisticated words in compositions. These supportive findings may be due to the similarity of research subjects, all with high language proficiency. On the other hand, the huge gap serves as a reminder for Chinese scholars to keep pace with native scholars in terms of academic words. This also indicates plateau phenomenon which has been described in great details in former section. Being advanced second language learners, with a considerable large vocabulary, it is easy to fall into the phase of fossilization. In academic papers, it embodies in the form of lacking academic depth.

In a word, we have elucidated underlying reasons of medium effects of lexical sophistication from formality and cognition by citing concrete examples from Chinese and International medical journal articles.

3.3. Low Effects of Lexical Diversity on Text Readability

Comparing to lexical density and lexical sophistication, lexical diversity has limited effects on text readability. As one of the parameters of lexical richness measurement, lexical diversity is an index reflecting a variety of words used in writing. Lexical diversity can be measured in

various ways. Historically, Read (2000) applied TTR (Type-token Ratio), which consists of its types and tokens. Higher ratio indicates larger vocabulary of the learner and thus higher lexical richness. However, it is highly sensitive to length of the data sample. That is to say shorter texts usually have disproportionately higher TTR compared to longer texts, thus the value of the indices is less reliable. With the aim to overcome its deficiency, STTR (Standard Type Token Ratio) is proposed by Scott in 2008. Compared to TTR, STTR is consistent irrespective of text length. When it comes to rather large text samples, STTR is apparently more suitable for the present study. Indeed, there are other measuring tools for lexical diversity, such as moving average type-token ratio (MATTR; Conbington and McFall, 2010), measure of textual lexical diversity (MTLD; McCarthy, 2005; McCarthy& Jarvis, 2010), the Hypergeometric Distribution (McCarthy& Jarvis, 2010) which bears no major difference from STTR. Therefore, STTR, the commonly used tool, is employed in this research.

Generally speaking, seeking for synonyms or equivalent expressions represents one of the distinctive features of English writing. The followings are how lexical variants are applied in specific examples chosen from introduction part of articles published in Chinese Medical Journal and The Lancet in 2014 and 2013.

Eg.7 Adolescence has long been regarded as a time of heightened emotional reactions. More than a century ago, Stanley Hall delineated adolescence as a distinct life phase, in which emotional turbulence (or “sturm und drang”) was typical. Early psychoanalysts also viewed emotional turmoil as a universal feature of adolescence but without major implications for later mental health. (Sample 44 from introduction sub-corpora in NSC 2014)

Eg.8 Although the global incidence of gastric cancer has decreased in recent years, in China, the mortality rate is the highest of all tumors, representing 25% of gastric cancer fatalities worldwide. The overall 5-year survival rate in China is low and remains at 40%. Most gastric cancers are diagnosed at Stage III or IV, and the rate of lymph node metastases is relatively high (50%-75%). (Sample 128 from introduction sub-corpora in CSC 2013)

In example 7 and 8, various words are used interchangeably, such as “emotional turbulence, emotional turmoil” for intense emotional changes “regarded as” and “viewed ” for considering something. With the highest lexical diversity, introduction section in NSC apparently employs more varieties of words. For instance, “incidence, mortality rate, fatalities” all refers to death rate. And for the rate, author also applies different words with inflections, such as “representing, remains, relatively high”. As we can observe, lexical diversity merely involves using various words to express the same meanings. Therefore, from the perspective of cognition, it seldomly adds any pressure to readers’ recognition and memory. Though we cannot ignore that the familiarity of similar expressions is likely to contribute to quick recognition of words, thus higher text readability. On the other hand, formality in this case seems to have very little connection to lexical diversity. Therefore, we say lexical diversity has only low effects on text readability.

In a nutshell, we have demonstrated in this section that lexical diversity’s low effects on readability from the definition and measurement of lexical diversity, five levels of formality as well as cognition. It has been proven by citing concrete examples randomly chosen from sample articles published in Chinese and International medical journals in the last decade.

4. Conclusion

So far, we have illustrated that what effects do three dimensions of lexical richness, namely, lexical density, lexical sophistication, and lexical diversity bring to text readability. The results demonstrated that (1) Lexical density has strong effects on readability; (2) Lexical sophistication has medium influences on readability; (3) Lexical diversity affects readability the least comparing to lexical density and lexical sophistication. This study aims to explore

lexical richness's effects on text readability of Chinese and International medical journal articles so as to fill in this blank. Based on this findings, we encourage learners to pay more attention to lexical sophistication and lexical density so as to adjust text readability.

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