Semantic Denotations of Non-Restrictive Relative Clauses in English Clinical Anatomy Textbooks

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บทคัดย่อ

การศึกษานี้ศึกษาเกี่ยวกับความหมายของอนุประโยคแบบไม่ระบุเจาะจงในหนังสือกายวิภาคศาสตร์การแพทย์ซึ่งเขียนเป็นภาษาอังกฤษ การศึกษาก่อนหน้านี้ให้ความสำคัญกับตัวบทที่แตกต่าง เช่น วรรณกรรม คลังข้อมูลภาษานานาชาติ ดังนั้นการศึกษานี้จึงสำรวจอนุประโยคแบบไม่ระบุเจาะจงในตัวบทที่แตกต่างไปได้แก่ หนังสือกายวิภาคศาสตร์การแพทย์ซึ่งเขียนเป็นภาษาอังกฤษ คลังข้อมูลการศึกษาวิจัยเก็บรวบรวมมาจาก *Netter's Clinical Anatomy* (2019) and *Gray's Anatomy for Students* (2020) ไม่เพียงแต่หนังสือกายวิภาคศาสตร์ที่เลือกมาศึกษานี้เป็นหนังสือที่ขายดี (amazon.com) ผู้แต่งหนังสือยังเป็นที่ยอมรับในเนื่องจากวุฒิทางการศึกษาและประสบการณ์การทำงานทางคลีนิค คลังข้อมูลจำนวนทั้งสิ้น 268,600 คำซึ่งประกอบด้วย 184 ตัวอย่าง การวิเคราะห์ข้อมูลอนุประโยคแบบไม่ระบุเจาะจงวิเคราะห์จากคำปรากฏของ *who*, *whom*, *whose* and *which* พร้อมกับเครื่องหมายจุลภาค ผลการศึกษาแสดงให้เห็นว่าอนุประโยคแบบไม่ระบุเจาะจงแบบ *which* พบได้บ่อยสุดเป็นจำนวนทั้งสิ้น 98.91 เปอร์เซ็น ความหมายเชิงอรรถศาสตร์ของอนุประโยคแบบไม่ระบุเจาะจงในหนังสือกายวิภาคศาสตร์การแพทย์ประมาณ 60 เปอร์เซนต์บ่งชี้ว่าเป็นความหมายเกี่ยวกับส่วนประกอบต่างๆ การสร้างตัวขึ้นของอวัยวะ และการเคลื่อนไหวของของเหลวในร่างกาย การศึกษานี้จะเป็นประโยชน์ต่อผู้เรียนภาษาอังกฤษทางด้านการแพทย์ และผู้เรียนภาษาอังกฤษเป็นภาษาต่างประเทศ

คำสำคัญ: ความหมายเชิงอรรถศาสตร์ อนุประโยคแบบไม่ระบุเจาะจง หนังสือกายวิภาคศาสตร์การแพทย์

Abstract

This study investigated the semantic denotations of non-restrictive relative clauses (NRRCs) in English clinical anatomy textbooks. While previous studies focused on NRRCs in different texts (i.e., novels, international corpus), this study fills the gap by contributing something new to the field by studying NRRCs in English clinical anatomy textbooks. The materials were collected from *Netter's Clinical Anatomy* (2019) and *Gray's Anatomy for Students* (2020). Not only are they best-selling textbooks (amazon.com), but the writers of these textbooks are also professionally qualified concerning their educational qualifications and clinical work experience. Approximately 268,600 words, containing 184 tokens of NRRCs, were extracted from these textbooks. NRRCs were analyzed via the keywords of *wh*-relativizer *who*, *whom*, *whose* and *which* used with comma(s).

The results showed that 98.91 percent of NRRCs in the English clinical anatomy textbooks mostly occurred with the relativizer *which*. The semantic denotations of NRRCs in English clinical anatomy are components, formation and liquid movement at nearly 60 percent. It is hoped that the results of this study will be beneficial to the field of medical English and learners of English as a Foreign Language.

Keywords: Semantic denotations, Non-restrictive relative clauses (NRRCs), English clinical anatomy textbooks.

Introduction

English is a language that uses a lot of relative clauses (Gordon & Lowder, 2012). There are two types of relative clauses in English as in *restrictive relative clauses* (RRCs) and *non-restrictive relative clauses* (NRRCs) (Gordon & Lowder, 2012). Semantically, the former is compulsory; otherwise, the use of RRCs could result in a violation of the principle of quantity, referring to inadequate information for the sake of understanding (Abdolmanafi & Rahmani, 2012). However, NRRCs are different in that they are optional since omitting this information does not affect the core meaning. They provide either extra or supplementary information (Allen, 2009). Accordingly, omitting them does not affect one's understanding. In other words, NRRCs are unnecessary information (Abdolmanafi & Rahmani, 2012; Mereroff, Birchfield, Ballard, Watson & Charters, 2021), such as (1).

(1)

(a) Mr. Hoskin**, who lives next door,** is our good neighbor.

(b) Leonardo**, who lives in this mansion,** is a famous person.

In (1a), *who lives next door* is analyzed as an NRRC as omitting this information does not impact understanding of the main idea that *Mr. Hoskin is our good neighbor*. Example (1b) shows that the NRRC *who lives in this mansion* is not necessary information as omitting this piece of information does not violate the principle of quantity nor its grammaticality.

This leads to the significance of this study in that form and meaning of language use are encouraged to be learned simultaneously as they are considered inseparable (Yilmaz, 2018). This study will allow us to understand the connection between form and meaning of NRRCs in the context of English clinical anatomy textbooks.

While NRRCs are used to add supplementary information, most previous studies that examined NRRCs in English have taken advantage of certain selected text varieties, such as novels, and international corpora. This study of NRRCs in English clinical anatomy textbooks fills the gap by investigating the semantic denotations of NRRCs in English clinical anatomy textbooks, since a

previous study indicated that medical textbooks frequently use complex sentences and formal language (Krulj, Prodanovic & Trbojevic, 2011). Moreover, 85.7 percent of non-native English medical students confessed that they have problems understanding English medical textbooks (Nghia & Yen, 2018). NRRCs are particularly useful for medical texts as they provide extra details, explain experimental processes and simplify information if complicated (Tetzner, 2017). To fulfil this gap and support medical students' needs, the objective of this study is to investigate the frequencies and semantic denotations of NRRCs in English clinical anatomy textbooks. It is hoped that the outcomes of this study will be useful for non-native English medical students and learners of English for Medical Purpose (EMP).

Literature review

This section provides information about the structures of NRRCs in English. Also, this section reviews the previous studies, relating to NRRCs in different text varieties.

Non-restrictive relative clauses

The characteristics of NRRCs in English are given in this section, as in (2).

(2)

(a) John**, who studies in London,** is my brother.

(b) This is Mr. Rogers**, who's joining the company next week**.

(c) In 1980, Ford developed his model T car**, which sold for $500.**

(Swan, 2016, p. 234)

The non-restrictive pronouns *who, which, whom* and *whose* are used as the complementizer heads to introduce supplementary information regarding persons and things (Swan, 2016). For example, while the relative pronoun *which* in (2c) introduces things, the relative pronoun *who* in (2a)-(2b) introduces people. NRRCs must only be introduced by *wh*-relative pronouns, such as *which* and *who*. Using NRRCs with the relative pronoun *that* and zero results in ungrammaticality (Hofherr, 2014; Swan, 2016).

NRRCs can modify different types of nouns. NRRCs modify *proper nouns*, which is the noun beginning with the capital letter, such as *Peter* in (3a) (Gobbo, 2007). *Definite description* is a noun phrase or a singular common noun, such as *the new professor* as in (3b) (Gobbo, 2007). *Specific noun* refers to a person in a specific place, such as *a new student from Oxford University* (Gobbo, 2007), as in (3c).

(3)

(a) **Peter**, who studies in my class, was absent today. (Proper name)

(b) **The new professor**, who has just joined our department, is an expert in the field of anatomy. (Definite description)

(c) Professor John invited **a new student from Oxford University**, who came late, to his office. (Specific nominal)

(Gobbo, 2007, p. 174)

These are examples that can be used with NRRCs. However, there are certain limitations about NRRCs, such as the restrictions of using quantifiers and double restrictive relative clauses (Hofherr, 2014), as in (4).

(4)

(a) *Any tiger**, which eats small reindeers,*** is cowardly.

(b) *The tiger**, which was just born, which was fed four time a day,*** can drink only milk.

When the head noun contains *any* as the quantifier, using NRRCs results in ungrammaticality as in (4a) and it cannot occur twice with the same head as in (4b) (Hofherr, 2014).

Apart from that, NRRCs can be grammatically tested with the coordinating conjunction *and* as illustrated in (5) (Hofherr, 2014).

(5)

(a) Tom eats chocolate cake**, which tastes good.**

(b) Tom eats chocolate cake **and it tastes good.**

The construction of NRRCs as in (5a) is similar to the coordinating conjunction *and* where the pronoun *it* refers to *chocolate cake.* However, the use of RRCs cannot be tested by the coordinated conjunction *and*, as in (6).

(6)

(a) Peter talked to his ex-colleague **who had not met him for a long time.**

(b) Peter talked to his ex-colleague **and he had not met him for a long time.**

As shown in (6), using the coordinator *and* in (6b) allows us to interpret the pronoun *he* as *Peter*, which could lead to ambiguity. Beyond the syntactic and semantic characteristics of NRRCs, the uses of NRRCs are given in the following section.

Semantic Denotations in NRRCs

Semantic denotation refers to the literal meaning (Barker, 2002). This study aims to investigate different patterns of the semantic denotation of NRRCS that occur in English clinical anatomy textbooks.

Semantically, the truth condition between RRCs and NRRCs are different (Song, 2014) in (7).

(7)

(a) Rosy has two sisters **that study English.**

(b) Rosy has two sisters**, who study English.**

In general, RRCs cannot be omitted as it will lead to insufficient information to understand. However, it is possible for NRRCs to be omitted without effecting understanding (Abdolmanafi & Rahmani, 2012). Based upon this description, the semantic denotations between (7a) and (7b) is different in that (7b) denotes only two sisters, whereas it is possible for *Rosy* in (7a) to have more than two sisters.

In terms of semantic denotations, NRRCs could be used to have different semantic denotation, such as movement, formation, component, subjectivity, result, providing explanation of new information, definition of terms, position, and historical data.

Loock (2007) showed the semantic denotations of NRRCs as movement referring to the flow of one event into others, as in (8).

(8) Robinson College asks candidates to complete a questionnaire on their education background, **which is then used to help decide whether they are offered a place**.

(Locck, 2007, p. 341)

Orwell (1946) provides the use of NRRCs as formation, referring the creation of something, as in (9).

(9) These three had elaborated old Major's teaching into a complete system of thought, **to which they gave the name Animalism.**

(Orwell, 1946, p. 26)

In addition to formation, Loock (2007) also showed the pattern of components in NRRCs as in (10).

(10) The princess, **who after nine months of pregnancy has swollen ankles, post-natal depression, and a figure completely shot to hell and had turned into another tired old queen,** gave birth to her baby daughter.

(Locck, 2007, p. 341)

In the NRRC in (10), there are several components in the situation as in *swollen ankles, post natal depression and a figure.*

According to Loock (2007), NRRCs are used to add personal opinions or comments as in (11).

(11) The home, **which were extremely expensive**, have not been sold.

In (11), subjectivity is explained by the use of the comment *too expensive*.

As indicated by Arnold (2005), one of the semantic denotations of NRRCs is the result of the main clause as in (12).

(12) John gets on the best with those firms, **who therefore employ him frequently.**

(Arnold, 2005, p. 8)

NRRCs are also used to explain new information known as the principle of pragmatic-discourse function, referring to given and new information, as in (13) (Master, 2002; Loock, 2007).

(13) The piece she's playing is called "Gavotte" Ettovag. It is a good word; she will think of a use for it later. The Piano reeks of lemon oil. **Ethel, who came in to clean,** has been told not to polish the keys with it.

(Loock, 2007, p. 348)

In (13), *Ethel* is the name of a person who is introduced for the first time as a new piece of information, so the NRRC functions as elaboration of that new information. While *Ethel* is new information as in (13), *who came in to clean* is given information as it is linked with *the piano reeking of lemon oil*. So, the NRRC plays a role in introducing who *Ethel* is. In addition, NRRCs are used for the reason of giving background information about the head noun (Hwang, 1994). In (14), there are no pieces of old information with which to connect.

(14) Once upon a time there was **a little girl**, **who lived alone with her father**.

(Hwang, 1994, p. 680)

The NRRC *who lived alone with her father* provides background information regarding the *little girl*. The next section provides a discussion of medical textbooks and NRRCs in previous linguistic studies.

Master (2002) showed the semantic denotations on NRRCs to indicate the definition of technical terms, as in (15).

(15) There is also, in the larva, a tissue known as *mucocartilage*, **which is an elastic material serving more as an antagonist to the muscles than for their attachment.**

(Master, 2002, p. 205)

In (15), the writer uses NRRCs to explain the meaning of the term *mucocartilage.*

Adika and Klu (2014) shows the semantic denotations of position as used in NRRCs in (16).

(16)

(a) Doctor Acheampong, **who is also the Director of Research at the Polytechnic**, made the declaration at a press briefing at Koforidua [...].

(Adika & Klu, 2014, p. 2,946)

(b) His mother**, who is the chairman of the school board,** refused to vote.

As mentioned by Arimura (2010), NRRCs can be given to denote historical data, as in (17).

(17)

(a) Tom has a violin**, which once belonged to Heifets [...]**

(Arimura, 2010, p. 114)

(b) Oliver**, who died in 1989 at the age of 82,** co-founded the National Theatre [...]

(Loock, 2012, p. 2)

The NRRC in (17a) shows that the violin had been previously owned by Heifets. The NRRC in (17b) provides bibliographical information about Oliver. These semantic denotations will be used to interpret the use of NRRCs in English clinical anatomy textbooks. The next section provides a discussion of medical textbooks and NRRCs in previous linguistic studies.

Medical Textbooks and NRRCs in Previous Studies

A variety of ways to interpret NRRCs has been given above. This section reviews previous research in medical textbooks. Discussion will also be provided regarding previous studies which focused on a variety of data collection sources to examine the use of NRRCs, such as different texts: novels and newspapers, World Englishes and international corpora.

Previous Studies in Medical Textbooks

A number of previous studies examined linguistic research in medical textbooks and medical research articles. Most previous studies in medical research in the field of structural study focused on passive constructions. The doctors do not need to mention themselves as the agent in using passive constructions so as to avoid being sued by patients. In terms of modal verbs, Vold (2006) focused on the choices of epistemic modality markers, referring to modal verbs to express the certainty of speakers' opinions in medical research papers. The result shows that the epistemic modality *may* appears more frequently at 73 percent. The researcher in this study discussed that they tend to be cautious when commenting on other people's studies. Since medical texts show a lot of carefulness and cautiousness in writing, along the same lines, NRRCs are especially beneficial for medical texts as they give extra details and experimental process to help patients understand the process of treatment and reduce anxiety, so the doctor can explain information to the patient clearly (Tetzner, 2017). While previous studies in the field focused on the use of passive constructions and modal verbs, this study sheds light on the NRRCs in medical textbooks. The reason why this study focused on medical textbooks is because these textbooks are seen to use a special language that is not used for everyday life (Krulj, Prodanovic & Trbojevic, 2011). The medical field in the present day is dominated by the English language (Schmid, 2008). Not only do medical students use English as a medium of instruction, they are also required to read and understand medical texts in English (Lu & Corbett, 2012). People who study medicine in English need to be trained to understand (Krulj, Prodanovic & Trbojevic, 2011).

NRRCs in Different Texts

This section focuses on NRRCs in different texts. It is assumed that different texts are likely to have their specific preferences of NRRCs. As mentioned by Krulj, Prodanovic & Trbojevic (2011),

English medical textbooks use formal language and prefer the use of complex sentences. With this assumption, it is assumed that the use of NRRCs in English medical textbooks are likely to be different from those found in other text varieties. Moreover, authors of medical textbooks are likely to be careful in expressing the degree of subjectivity, referring to the expression of the writer's opinions.

When comparing medical texts to others, one of the clearest examples to contrast is novels. Koça and Pojani (2016) studied the relativizers in an English novel called *Animal Farm.* The relativizer *who* is commonly used with an animal so as to convey a higher degree of empathy than using *which*, as in (18).

(18) At the last moment, Mollies, the foolish, pretty white mare**, who drew Mr. John's trap**, came mincing daintily in, chewing at a limp of sugar.

(Koça & Pojani, 2016, p. 388)

Unlike newspapers and fiction, the relativizer *which* is rather preferred in scientific texts (Hundt, Denison & Schneider, 2012). Since the purpose of narrative writing, such as novel, is written to entertain people, animals and things can be personified to human beings for the sake of entertainment and enjoyment. So, it might not be such a serious issue to follow the grammatical rule of usage. However, the medical text is a quite serious genre of writing which is relevent to life and death of human beings. It is thought that the use of grammatical patterns in medical texts may more strictly follow medical rules than other kinds of semi or informal texts.

To provide more information as to why medical texts are different from other text varieties, the use of passive constructions in medical texts is very productive, as in (19). The agent as the subject who prescribed medication to the patient is omitted (Minton, 2015).

(19) **Mr. Hopkin** is prescribed to take Esidep 0.5 milligrams before bedtime.

The focus in (19) is the patient. The reason for using the passive construction in (19) is to conceal in order for self-protection from being sued if something goes wrong (Minton, 2015). Therefore, the agent, referring to the one who instigates an action in passive constructions is assumable as the doctor. These claims show that medical texts are written differently from other text varieties due to formality and carefulness.

NRRCs in World Englishes

It is important to make a note here that the medical texts in this study are written in the English variety of American English. Previous studies which focus on the NRRCs in different varieties of English language, such as Philippine English, Indian English and Singaporean English may have found different results of NRRCs. In addition to different occurrences of *wh*-relative pronouns in different text varieties, the study of relative clauses is also worldwide in different varieties of English. Collins, Yao and Borlongan (2014) studied NRRCs in Philippine English. One of the

distinctive patterns of relative clauses in Philippine English is the use of the relativizer *which* to indicate supplementary information, as in (20).

(20) The Internet**, which is turning the world into a true global village,** is the nightmare of authoritarian regimes.

(Collins, Yao & Borlongan, 2014, p. 130)

In addition to the use of relative clauses in Philippine English, another study by Suarez-Gomez (2015) studied relative clauses in Indian and Singaporean English. The results show that Indian English prefers to use *in which* in spoken language, whereas Singaporean English prefers to use the null relative pronoun, as in (21).

(21)

(a) Then you have to think about uh **the way in which sentences develop from deep structure**. (Indian English)

(b) Uh **the way they make the parables** is very interesting. (Singaporean English)

(Suarez-Gomez, 2015, p. 631)

The reason to explain this is that Indian English may prefer to use a more formal form in spoken language than Singaporean English. When it comes to the current study, it is focused on clinical anatomy textbooks that were written by American speakers.

NRRCs in International Corpora

One of the prevalent studies of NRRCs is to take advantage of international corpora, such as British National Corpus (BNC). Gilquin and Jacob (2006) studied the acceptability of the relative pronoun *who* with non-animate animals in BNC. Although many grammar references do not accept the use of the non-restrictive relative pronoun *who* used with animals, Gilquin and Jacob (2006) discovered that it is acceptable for certain animals, such as horses, cats and dogs, as in (22).

(22)

(a) He had several pets; a grey cat Maria, **Shep the sheepdog who went everywhere with him over the field**.

(b) The latest member of the Clinton family to hit the headlines is **Socks the family cat, who will be seen in America next month on the front of Cats Magazine.**

(Gilquin & Jacob, 2006, p. 94)

According to Gilquin and Jacob (2006), the reason of acceptability of the non-restrictive relative pronoun *who* is that these animals are given their specific names. As mentioned in the characteristics of non-restrictive relative pronouns in the above section, it is acceptable for proper nouns to be used with NRRCs (Gobbo, 2007). Since this study focuses on English clinical anatomy textbooks, it is curious as to whether the writers will treat human organs and cells as living things

via using the relative pronoun *who* or not. The current study focuses on NRRCs in English as English is a language that uses a lot of relative clauses (Gordon & Lowder, 2012). This study uses English clinical anatomy textbooks to investigate the use of NRRCs where the research questions are given as follows:

(1) What are the frequencies of NRRCs used with the relative pronouns *which, who, whom* and *whose* in English clinical anatomy textbooks?

(2) What are the semantic denotations of NRRCs used with the relative pronouns *which, who, whom* and *whose* in English clinical anatomy textbooks?

Method

Materials

In regard to materials, this study employs two clinical medical textbooks that have received popularity in regard to being best-sellers (amazon.com). One of them is *Netter's Clinical Anatomy* (2019) as written by Professor Emeritus John T Hansen, Ph.D. He currently works in the School of Medicine, University of Rochester, USA, as a Professor of Neurobiology and Anatomy. He has published many anatomy textbooks, such as Atlas of Human Anatomy, Netter's Anatomy Coloring Book, and TNM Staging Atlas with Oncoanatomy. The one that is used in this study is Netter's Clinical Anatomy (2019), which is his latest edition.

The other clinical anatomy textbook is *Gray's Anatomy for Students* (2020). It was written by a team of experts who are professionally qualified concerning their educational qualifications and clinical work experience. Richard L. Drake, Ph.D. is a Professor of Surgery at the Cleveland Clinic Lerner College of Medicine of Case Western Reserve University, USA. A. Wayne Vogl is a Professor of Cellular & Physiological Sciences from the University of British Columbia, Canada. Adam W. M. Mitchell is a Director of Radiology, Fortius Clinic, London, United Kingdom. From these textbooks, containing approximately 268,600 words, 184 tokens of NRRCs were extracted.

Framework

The framework of this study follows Loock (2007) who classified NRRCs into three main types based upon their semantic denotations. The first type, Loock (2007) called *Continuative Appositive Relative Clauses*. This type of NRRC allows movement or the flow of one event into others as in (23a)-(23b). In other words, the writer wants to make their writing become a smooth report via using NRRCs.

(23)

(a) Robinson College asks candidates to complete a questionnaire on their education background, **which is then used to help decide whether they are offered a place**.

(b) She got to see Peter, **who died two hours later.**

(Locck, 2007, p. 341)

Based upon Loock's (2007) framework, in (23) the temporality words *then* and *later* as appear in the NRRCs show the movement of sequential events that continue the flow of the story.

The second classification of NRRCs is called *Relevance Appositive Relative Clauses*. The writer tries to show that the given information in NRRCs is relevant and useful enough for the readers to know (Loock, 2007). The use of Relevance Appositive Relative Clauses helps reduce the effort that the readers need to expend to understand historical information, new concepts, definitions, terminology and difficult terms that the readers have never known before.

(24)

(a) The Governor is Bob Taft, fourth generation of a Republican dynasty founded by his great grandfather, William Howard Taft, **who was elected president in 1908.**

(b) Tony Sewell, **who has just finished an inquiry into soaring levels of exclusions among black pupils from a London school,** claimed that too much concern with money and consumer goods was almost as damaging to black pupils' chances as racism.

(Locck, 2007, p. 341)

In (24a) and (24b), relevant information about *William Howard Taft* and *Tony Sewell* are given in order to describe them.

The third classification of the semantic denotation of NRRCs is called *Subjectivity* referring to judgement or comments as in (25).

(25)

(a) Great Britain can be found down in thirty-fourth place**, which doesn't seem too clever,** but who cares when the US of A flounder a further three places back.

(b) The men's 4 x 100 m team**, who might not have qualified anyway,** went out in the heats when they bungled a change-over, straying out of the prescribed area

(Locck, 2007, p. 356)

Which doesn't seem too clever in (25a) and *who might not have qualified anyway* in (25b) indicate the speakers' comment or opinion. The framework leads to the analysis as follows.

Data Analysis

The data analysis of NRRCs is extracted via the keywords of *wh*-relative pronouns *who*, *which*, *whose* and *whom* used with comma(s) as illustrated in Table 1.

Table 1: Use of non-restrictive relative pronouns in English clinical anatomy textbooks

(26)

***Wh*-relative pronouns**	**Examples**
who	(a) In the 1980s, multislice (multidetector) CT scanners were developed that capture many slices as the tube rotates in a helical pattern around the patients**, who is moving through the scanner on a table.**
which	(b) The most common type is an infiltrating ductal carcinoma**, which may involve the suspensory ligaments,** causing retraction of the ligaments and dimpling of the overlying skin.
whose	Not found in this study
whom	Not found in this study

Table 2: Data validation of NRRCs in English clinical anatomy textbooks

(27)

Interpretations	**Examples**	**Agree**	**Disagree**
Position	(a) The female pelvic reproductive viscera include the midline uteras and vagina and the adnexa, **which are positioned between the urinary bladder anteriorly and the rectum posteriorly.**	✓	
Subjectivity	(b) This results in a postnatal shunt of blood from the aorta into the pulmonary trunk**, which may lead to congestive heart failure.**	✓	

In regard to data validation, three experts in the field of English were asked to validate the data as exemplified in Table 2. The experts in the field of English were asked about the semantic denotation as interpreted by the researchers. If two or three experts said “agree” with the data analysis, the interpretation gains accuracy and reliability. However, if only one or none of them said “agree”, the analysis of its semantic denotation was considered again. With this data collection, data analysis and data validation, the results of NRRCs in English clinical anatomy textbooks will be presented in the following section.

Results and Discussion

Based upon the method as written above, from a total of 268,600 words, 184 tokens of NRRCs were extracted from English clinical anatomy textbooks. This section will answer the first research question; What are the frequencies of NRRCs used with the relative pronouns *which, who, whom* and *whose* in English clinical anatomy textbooks? The results of non-restrictive relative pronouns are presented below.

Table 3 Use of non-restrictive relative pronouns in English clinical anatomy textbooks

Non-restrictive relative pronouns	Frequency	Percentage
which	182	98.91%
who	2	1.09%
whose	0	0%
whom	0	0%
Total	**184**	**100%**

Table 3 reports the use of NRRCs with the different restrictive relative pronouns *which*, *who*, *whose* and *whom* in English clinical anatomy textbooks. The results show that the use of the non-restrictive relative pronoun *which* occurs the most at 98.91 percent. The use of the non-restrictive relative pronoun *who* occurs at only 1.09 percent. The use of the non-restrictive relative pronouns *whose* and *whom* were not found in this study.

The highest frequency of relative pronoun *which* at 98.91 percent complies with what has been mentioned in the literature review in that the use of *who* will be the head complementizer of people, while the use of the relative pronoun *which* is used to introduce things or objects (Hofherr, 2014; Song, 2014; Swan, 2016). The empirical evidence of NRRCs in English clinical anatomy textbooks to introduce things is shown in (28).

(28)

(a) The spinal cord is anchored inferiorly by the terminal filum**, which is attached to the coccyx.**

(b) These nodal collections often are referred to as the preaortic and paraaortic nodes and ultimately drain to the cisterna chyli, **which is located adjacent to the celiac trunk.**

(c) The female pelvic reproductive viscera include the midline uteras and vagina and the adnexa, **which are positioned between the urinary bladder anteriorly and the rectum posteriorly.**

(d) For example, the latissimus dorsi muscle is innervated by the thoracodorsal nerve**, which is composed of nerves from the anterior rami of spinal cord segments C6-C8.**

(e) The palm is covered with a thick layer of skin**, which contains numerous sweat glands and a tough fibrous palmar aponeurosis.**

They mostly give more information about objects or organ in our bodies, such as *filum* as in (28a), *cisterna chyli* in (28b), *the adnexa* in (28c), *the thoracodorsal nerve* in (28d) and *skin* in (28e). This corresponds to the use of the relativizer *which* in grammar books (Swan, 2016) in that *which* is regularly used to modify things and objects. The relativizer *who* is the head complementizer of patients, as in (29).

(29)

(a) In the 1980s, multislice (multidetector) CT scanners were developed that capture many slices as the tubes rotates in a helical pattern around the patient**, who is moving through the scanner on a table.**

(b) Chronic subdural hematomas are most common in elderly persons and alcoholic patients, **who have some brain atrophy.**

The use of *which* and *who* in English clinical anatomy textbooks seem predictable in that anatomical textbooks usually explain the parts of the human body and patients. However, the semantic denotations of NRRCs in English clinical anatomy textbooks are likely to appear differently.

The semantic denotations of Table 4 are classified based upon literature reviews in previous studies (Orwell, 1946; Hwang, 1994; Master, 2002; Arnold, 2005; Locck, 2007; Loock, 2012; Adika & Sennanu, 2014)

Table 4 Semantic denotations of NRRCs in English clinical anatomy textbooks

(30)

Denotations	Examples	Frequency	Percentage
Movement	(a) There is the coronary sinus**, which returns blood from the walls of the heart itself.**	45	24.46%
Formation	(b) Inferior to the thoracic vertebrae are five lumbar vertebrae**, which form the skeletal support for the posterior abdominal wall and are characterized by their large size.**	29	15.76%
Components	(c) Skeletal muscle is divided into fascicles (bundles)**, which are composed of muscle fibers.**	29	15.76%

Denotations	Examples	Frequency	Percentage
Subjectivity	(d) This results in a postnatal shunt of blood from the aorta into the pulmonary trunk**, which may lead to congestive heart failure.**	20	10.87%
Description of terms	(e) The walls of the abdominopelvic cavity are lined by parietal peritoneum, which can reflect off the abdominal walls in a double layer of peritoneum called **a mesentery, which embraces and suspends a visceral structure.**	17	9.24%
Position of Organs	(f) The spinal cord is anchored inferiorly by the terminal filum**, which is attached to the coccyx.**	13	7.06%
Encompass	(g) Pus fills the psoas muscle but is limited from further spread by the psoas fascia**, which surrounds the muscle and extends inferiorly into the groin pointing below the inguinal ligament.**	13	7.06%
Result	(h) Friction and sexual stimulation evoke the excitation of parasympathetic fibers**, which lead to relaxation of the cavernous vessels and engorgement of the erectile tissue with blood.**	11	5.97%
Extension	(i) The posterior surface of the anterior arch has an articular facet for the dens**, which projects superiorly from the vertebral body of the axis.**	7	3.80%
	Total	**184**	**100%**

The semantic denotations of NRRCs in English clinical anatomy textbooks are systematic. They occur in different classification such as movement at 24.46 percent, formation at 15.76 percent, components at 15.76 percent, subjectivity at 10.87 percent, definition of terms at 9.24 percent, positions of organs at 7.06 percent, encompass at 7.06 percent, results at 5.97 percent and extension at 3.80 percent. These percentages lead to the following discussion regarding the functions of non-restrictive relative clauses in English clinical anatomy textbooks. More information about semantic denotations is given as follows:

Although a number of previous studies claimed that medical texts are usually used with passive voice, this study contradictorily shows that the majority of non-restrictive relative clauses

are used with active voice, excepting the denotation of components and positions that are sometimes used with passive voice.

(31)

(a) Skeletal muscle is divided into fascicles (bundles)**, which are composed of muscle fibers.**

(b) For example, the latissimus dorsi muscle is innervated by the thoracodorsal nerve**, which is composed of nerves from the anterior rami of spinal cord segments C6-C8.**

In regard to the position of non-restrictive relative clauses, the non-restrictive relative clauses usually occur in the final position. This also applies with the text variety of English clinical anatomy textbooks as in (31). The use of non-restrictive relative clauses in the final position better supports the flow of information.

Definition of Terms

Hwang (2015) said that non-restrictive relative clauses are used to provide background information about the head noun (Hwang, 1994) as in *once upon a time there was a little girl, who lived alone with her father.* This study found a similar concept of use whereby the non-restrictive relative clauses in the English clinical anatomy textbooks describes the definition of terms as in (32).

(32)

(a) These neurovascular elements are enclosed in a fascial sleeve called **the axilliary sheath, which is a direction continuation of the prevertebral fascia of the neck.**

(b) As a derivative of the embryonic foregut, the gallbladder is supplied by the **cystic artery, which is usually a branch of the right hepatic artery, a branch of the proper hepatic artery.**

(c) Pancreatic secretion is under neural and hormonal control, and the exocrine secretions empty primarily into the main **pancreatic duct, which joins the common bile duct at the hepatopancreatic ampulla.**

These non-restrictive relative clauses function as postmodifiers in order to give supplementary information about terms. For example, the writer describes the meaning of the *axilliary sheath* as in (24a). The physician describes the terms *the cystic artery* and the *pancreatic duct*, in (32b)-(32c), respectively.

Positions

After the writer provides the definition of terms, he tends to explain the position of certain physical organs via the use of non-restrictive relative clauses as in (33).

(33)

(a) The spinal cord is anchored inferiorly by the terminal filum**, which is attached to the coccyx.**

(b) The spinal cord ends as a tapered region called the conus medullaris**, which is situated at about the L1-L2 vertebral level.**

In (33), non-restrictive relative clauses are used with the form of passive voice to indicate the position of certain organs in the human bodies, such as *the terminal filum* and *the conus.*

Compositions

After the positions of certain organs are addressed, the non-restrictive relative clauses are used to indicate the composition of certain organs. The denotation of composition in the English clinical anatomy textbook refers to the parts, elements or components as in (34).

(34)

(a) Skeletal muscle is divided into fascicles (bundles)**, which are composed of muscle fibers.**

(b) For example, the latissimus dorsi muscle is innervated by the thoracodorsal nerve**, which is composed of nerves from the anterior rami of spinal cord segments C6-C8.**

The writer explains the component of fascicles bundles which has the element of muscle fibers. In (34b), the writer addresses the thoracodorsal nerve and it is made up of anterior rami of spinal cord segments.

Formation

In addition to composition, another denotation as found in anatomy clinical textbooks is formation, referring to the forming of composition in our bodies as in (35).

(35)

(a) The spinal cord gives rise to 31 pairs of spinal nerves**, which then form two major branches (rami).**

(b) The blood supply to the hand is by the radial and ulnar arteries**, which anastomose with each other through two palmar arches.**

(c) The white matter surrounds the gray matter and is rich in nerve cell processes**, which form large bundles or tracts that ascend and descend in the cord to other spinal cord levels or carry information to and from the brain.**

(d) Retroperitoneal structure includes the kidneys and ureters**, which develop in the region between the peritoneum and the abdominal wall and remain in this position in the adult.**

The non-restrictive relative clause in (35a) addresses the forming of two branches called *rami* and these formations are derived from 31 pairs of spinal nerves. The non-restrictive relative clause (29b) points out the connection of the radial and ulnar arteries by two palmar arches. The forming of large bundles in (29c) is derived from nerve cell processes. (35d) indicates the development of the kidneys and ureters in certain regions.

Encompass

After the formation of certain of organs is depicted, the writer then explains elements that are built to cover the organs as in (36).

(36)

(a) As a result, the surface of the lung**, which is covered by visceral pleura, directly opposes and freely slides over the parietal pleura attached to the wall.**

(b) Immediately outside the renal capsule, there is an accumulation of extraperitoneal fat-the perinephric fat (perirenal fat)**, which completely surrounds the kidney.**

In (36a), the writers explain the encompassment of lungs by visceral pleura. The non-restrictive relative clause in (36b) modifies a certain type of fat called *perirenal fat* that covers the kidney.

Extension

Another denotation as appeared in clinical anatomy textbooks is extension as in (37).

(37)

(a) The posterior surface of the anterior arch has an articular facet for the dens**, which projects superiorly from the vertebral body of the axis.**

(b) The apex of each triangular is directed laterally and is formed by the medial margin of the coracoid process**, which extends anteriorly from the superior margin of the scapula**.

(c) The highest thoracic dermatome on the anterior chest wall is T2**, which also extends into the upper limbs.**

The non-restrictive relative clause in (37a) addresses the projection of an articular facet. The extension in (37b) comes from the coracoid process. (37c) is the extension of T2 into the upper limbs.

Movement

In addition to the extension of organs in the human body, another denotation in relation

to this composition is movement. The writer uses non-restrictive relative clauses to address either the flow or the movement of liquid of certain organs as in (38).

(38)

(a) The inferior vena cava (IVC) drains abdominal structures other than the GI tract and the spleen**, which are drained by the hepatic portal system.**

(b) The major exception is the drainage from the ovaries and the adjacent uterine tubes and upper uterus, and from the testes and scrotal structures**, which flows directly back to the aortic nodes of the midabdomen.**

(c) The heart tube receives blood from the embryonic body**, which passes through its heart tube segments in the following sequence.**

(38a) describes how fluids are moved from certain organ. (38b) is an explanation of different movement of fluids. The non-restrictive relative cause in (38c) describes the flow of blood.

Results

Non-restrictive relative clauses in English clinical anatomy textbooks also indicate results. In this use, the physician will use non-restrictive relative clauses to explain about the consequence of organ damage. In other words, if the organs have been damaged, what are the results or consequences that may take place as illustrated in (39).

(39)

(a) Children possess 20 deciduous teeth**, which usually have erupted by the third year of life**.

(b) Chronic subdural hematomas are most common in elderly persons and alcoholic patients who have some brain atrophy**, which increases the space traversed by the bridging veins and renders the stretched vein susceptible to tearing.**

(c) Friction and sexual stimulation evoke the excitation of parasympathetic fibers**, which lead to relaxation of the cavernous vessels and engorgement of the erectile tissue with blood.**

In (39a), the children's deciduous teeth will be visible at the age of three years old. (39b) addresses the result of the decline of one's brain. In (39c) the NRRC talks about the results of the excitation of parasympathetic fibers.

Subjectivity

Sometimes the damage of organs and side effects of certain diseases might not always occur as they are the physician's prediction, referring to subjectivity (Loock, 2007). Subjectivity

refers to one's opinions or comments toward certain events (Loock, 2007). This interpretation is applicable with the use of non-restrictive relative clauses in the English clinical anatomy textbooks where the physician shows their opinion in regard to the side effects of diseases. However, the special thing about applying subjectivity in English clinical anatomy textbooks is about the use of modal verbs with the degrees of possibility, such as *may*. This is because these side effects may only occur with some cases as in (40).

(40)

(a) The most common type is an infiltrating ductal carcinoma**, which may involve the suspensory ligaments,** causing retraction of the ligaments and dimpling of the overlying skin.

(b) This results in a postnatal shunt of blood from the aorta into the pulmonary trunk**, which may lead to congestive heart failure.**

In (40a), the physician provides his opinion in regard to a kind of cancer as given in the main clause that is possible to involve ligaments. In (40b), the doctor addresses the possibility to cause congestive heart failure.

With the above explanation, most people seem to understand that anatomy is the explanation of individual parts of the human body that function individually. In fact, it is how the different parts of the human body seem to work cooperatively as a whole. They seem to link and join with each other in different ways. Not only does the writer give the explanation of the components of our body as well as how they are formed together, but also the flow or the movement of liquid between, through or from certain organs.

The higher frequency is also shown with the semantic denotation of subjectivity via physician's prediction, referring to subjectivity (Loock, 2007). Subjectivity refers to one's opinions or comments toward certain events (Loock, 2007). This interpretation is applicable with the use of NRRCs in the English clinical anatomy textbooks where it is important for the physicians to show their opinion concerning the side effects of diseases. However, the special thing about applying subjectivity in English clinical anatomy textbooks is about the use of modal verbs with the degrees of possibility, such as *may*.

As indicated by Master (2002), the semantic denotation on NRRCs could be used for the definition of technical terms such as *a mesentery*. This use complies with Loock's explanation (2007) in that readers can use less effort in order to understand new difficult terms.

The writer provides the position of certain physical organs via the use of NRRCs. The patterns tend to receive lower frequency as the English clinical anatomy textbooks also provide the picture to illustrate the position of each organ clearly, so this aspect might not be important to elaborate further as the readers can see the illustrations.

As indicated by Arnold (2005), the semantic denotation of NRRCs can also be found to be as a result of the main clause. The writer tends to provide the result of certain actions in the human body as in *Friction and sexual stimulation evoke the excitation of parasympathetic fibers, which lead to relaxation of the cavernous vessels and engorgement of the erectile tissue with blood*.

The use of NRRCs is also found in English clinical anatomy textbooks as extension and could be applied with Loock (2007) in regard to continuation, which allows the flow of smoother reading, instead of cutting them into two sentences. For example, *the posterior surface of the anterior arch has an articular facet for the dens. They project superiorly from the vertebral body of the axis.* This could result it the bluntness of the first sentence. This use of NNRCs could be supported by Krulj, Prodanovic and Trbojevic (2011) who reported that medical textbooks frequently use complex sentences and formal language.

Conclusion

This study has investigated the use NRRCs in English clinical anatomy textbooks in order to answer the research questions: what are the frequencies of NRRCs used with the relative pronouns *which, who, whom* and *whose* in English clinical anatomy textbooks? and what are the semantic denotations of NRRCs used with the relative pronouns *which, who, whom* and *whose* in English clinical anatomy textbooks?

The results show that the use of the non-restrictive relative pronoun *which* occurs at about 98.91 percent, as the focus of the anatomy textbook is an object, which is a human organ. This could explain why the use of *which* to modify these objects reaches the highest frequency. As mentioned by Swan (2016), the relativizer *which* is used to modify objects, while the relative pronoun *who* is only used with people, as in *patient*.

The use of NRRCs in English clinical anatomy textbooks is quite different from other text varieties. It is conventional as the use of NRRCs has its own formal patterns. Unlike novels where *who* can be used with animals, the use of the relative pronoun *who* only occurs with human beings, and the use of the relative pronoun *which* is only used with objects. This study contributes to the field of medical English. This will help develop the medical industry, especially in countries that can provide effective treatment to patients, but the doctors may lack proficient English skills.

Over 60 percent of NRRCs are used with the semantic denotation of formation, components and liquid movement in the body. The NRRCs in English clinical anatomy textbooks help create our understanding that the anatomy of the human body is isolated into parts, but it is the study of how one organ links to others to function.

The results of NRRCs in this study are limited to only English clinical anatomy textbooks. Generalizing the results of this data to other types of texts may not be applicable to optimal level since this study shows that different text varieties show their own preference of grammar, meaning and use. Comparing the use of NRRCs with other text varieties would contribute something new in the field. Also, comparing the use of NRRCs in different varieties of English would be interesting in the area of Worlds Englishes. However, since the data in this study is limited, it is suggested that adding more data to any future study may make the result of the study become generalizable.

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