

## What's in a Noun Phrase? Judging the Difficulty of a Reading Text by Understanding the Complexity of Noun Phrases

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*Understanding the complexity of noun phrases in reading text – at any level – is vitally important for teaching academic language. But why? And how?*

As teachers, we typically have experience-based intuitions about whether the reading difficulty of a text is appropriate for our students. It can, however, be challenging to pinpoint sources of difficulty. In this article, I describe a process for identifying one common challenge in reading and offer suggestions for teachers to deal with it. We begin, in the next paragraph, with a 'thought experiment.'

*Try this thought experiment...*

Each of the sentences below on the topic of muscles was written for one of these levels: elementary, middle school, high school, adult/GED, and college. Take a minute to think about which sentence belongs to which level.

- (1) *Tough strips of tissue called tendons attach muscles to bones.*
- (2) *Each of the more than 430 voluntary muscles in the body contains various wrappings of fibrous connective tissue.*
- (3) *Muscles are attached to bones by flexible cords of connective tissue called tendons.*
- (4) *When the biceps contracts, it pulls the boy's lower arm toward his shoulder.*
- (5) *Muscles are connected to bones by tendons—strong, fibrous connective tissue.*

The technical vocabulary in (2) very likely helped you to correctly identify it as the college-level sentence, and the specific reference to *the boy* in (4) might have told you that is the elementary-level sentence. The middle school (1), high school (3), and GED-level (5) sentences all have similar vocabulary (*muscles, bones, tendons, tissue*), and these nouns are definitely important words, but even more important is how they are used in phrases which create deeper meanings than the words alone. For example, in (3) the noun *tissue* is part of the noun phrase *flexible cords of connective tissue called tendons*, which contains multiple modifiers to explain one of the tissue's properties (*flexible*), its shape (*cord*), its purpose (*connective*), and its name (*tendons*). A lot of information has been packed into those seven words. (See the original texts in the Appendix below.)

### *Noun phrase complexity*

Densely packed information in noun phrases is considered a hallmark of written academic language (Schleppegrell, 2004; Zwiers, 2008). However, sample sentences (1-5) clearly indicate that the density of noun phrases is not the same across all academic levels. Sentence (4), at the elementary level has two simple noun phrases (*the biceps, his shoulder*) and one more complex one (*the boy's lower arm*), which is still quite a bit simpler than the aforementioned seven-word noun phrase in the high-school level sentence (3). This information density is related to the number

and type of modifiers that precede and follow the main noun in a noun phrase, which I will refer to as the *noun phrase complexity*.

Noun phrase complexity is an important part of overall text complexity. The ability of English learners (EL) to understand and use complex texts is an increasing concern with the adoption of the Common Core Standards, which require that all students “be able to comprehend texts of steadily increasing complexity as they progress through school” (National Governors Association Center for Best Practices, Appendix A, 2010, p.1). Teachers of ELs need a means of understanding how complexity is created in a text and how complexity increases with grade levels. To address these issues, in this article I will use a set of excerpts from science textbooks on the topic of muscles to explore the following question: *How does noun phrase complexity vary across academic levels?*

By providing clear definitions and a detailed process for answering this question, I also hope to provide teachers with a means of analyzing the noun phrases their ESL students encounter so they can spot potential difficulties. Looking more deeply into how noun phrases are used will illuminate the differences among levels and illustrate an important way in which academic language builds complexity with increasing grade levels.

### **Identifying, classifying and analyzing noun phrases**

#### *Defining simple and complex noun phrases*

This section defines terms used in the paper and describes the process used to identify, classify, and analyze noun phrases. Let’s start with definitions. A noun phrase is a group of words that includes an obligatory head noun and all the words that modify it (Biber, Johansson, Leech, Conrad, & Finegan, 1999; Crystal, 2004). The *head noun* is the core of the noun phrase, and it may stand alone or have *determiners* or modifiers before it (*premodifiers*), or after it (*postmodifiers*) as shown in Figure 1. (Note: Some textbooks and teachers use the more student-friendly term “adjectives” to refer to both determiners and premodifiers. The distinction between determiners and premodifiers is important for this analysis, but I don’t mean to imply they should be taught this way.)

<p style="text-align: center;"><b>muscles</b> your four <b>muscles</b> your four shoulder <b>muscles</b> your four strong shoulder <b>muscles</b> the biggest of your four strong shoulder <b>muscles</b> the biggest of your four strong shoulder <b>muscles</b> on each side the biggest of your four strong shoulder <b>muscles</b> connected by tendons on each side</p>
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*Figure 1.* A head noun and its modifiers. The boldfaced word represents the head noun in each noun phrase.

A head noun is typically a content noun (*muscles*) but it could also be a pronoun, as in *the **one** in your arm*, or an adjective being used as a noun, as in *the **biggest** weighs one pound*. Determiners are optional, but if there is one, it must come first, before any premodifiers. Determiners are function words that answer questions such as *Whose? (your)*, *How many? (four)*, and *Which one? (the)*. Specifically, determiners include possessives (e.g., *your, the boy's*), quantifiers and numbers (e.g., *a lot of, four*), articles (*a, the*), and demonstratives (*this, that, these, those*).

Premodifiers are normally adjectives such as *strong* and *flexible*, but they may also be nouns that describe the head noun, such as *shoulder* in the noun phrase *shoulder muscles*. Postmodifiers follow the noun they modify, and they are more complicated than premodifiers because they can be clauses as well as phrases or simply adjectives. Clausal postmodifiers can be further subdivided into *finite clauses*, which means that they include a subject and a verb with tense, and *non-finite clauses*, which means that they do not include a subject or a verb with tense. These types of postmodifiers are shown in Figure 2.

<p>Finite clauses</p> <p><b>tissue</b> <i>that can contract</i> (Mitchell, 2003)</p> <p><b>the fact</b> <i>that muscles can only pull</i></p>
<p>Non-finite clauses</p> <p>a <b>muscle</b> <i>attached to a bone</i> (BSCS, 2006)</p> <p>an example of <b>muscles</b> <i>working in pairs</i> (LaRue, 2004)</p> <p>the <b>power</b> <i>to move a muscle</i></p>
<p>Phrases and adjectives</p> <p>Prepositional phrases</p> <p>e.g., the <b>muscle</b> <i>in your upper arm</i> (Scott Foresman, 2000)</p> <p>Adjectives</p> <p>e.g., <b>something</b> <i>unusual</i></p>

*Figure 2.* Major structures of postmodification of the noun phrase. All head nouns are in bold. All postmodification structures are in italics. Examples with a source listed were drawn from the texts for this study; other examples were constructed for illustration.

Noun phrases can be classified as simple or complex; while there are many ways to make this classification, in this paper I will follow Crystal (2004) and Hillier (2004) in saying that a *simple noun phrase* is a head noun alone or with one determiner. All other noun phrases will be classified as *complex*.

### **A useful process for analyzing noun phrases**

The steps in the process of analyzing noun phrases are

1. identify noun phrases
2. classify the parts of a noun phrase (determiner, premodifier, head noun, postmodifier)
3. classify each postmodifier as a phrase or a clause; if it is a clause, classify it as finite or nonfinite
4. categorize each noun phrase as simple or complex

*Step one: Identifying noun phrases*

Identifying a noun phrase entails finding the head noun and the words before the noun that describe it, which is a relatively straightforward process, plus one tricky bit: Where does the noun phrase end? After finding a noun, we determine the beginning of its noun phrase by looking backwards (left) in the sentence to include determiners and premodifiers, if any. Basically, for each possible modifier, we ask if it describes or specifies the noun; this is the same question which helps identify the postmodifiers. In (6a), the final ends of the noun phrases are clearly marked because of the verbs following *muscles* and *muscle cells*, the connector following *bones*, and the period following *their shape*. In contrast, both (6b) and (6c) have the noun *muscles* followed by a prepositional phrase, which can modify a noun, verb or adjective.

- (6) a. Muscles can move bones because muscle cells can change their shape. (Scott Foresman, 2000)
- b. The muscular system consists of the more than 600 muscles in your body. (LaRue, 2004)
- c. Tough strips of tissue called tendons attach muscles to bones. (LaRue, 2004)

The prepositional phrase *in your body* (6b) describes the location of *muscles* and modifies that noun. On the other hand, the prepositional phrase *to bones* (6c) describes the location where tendons attach, so it modifies the verb *attach* and is not part of the noun phrase *muscles*.

*Step two: Classifying the parts of a noun phrase*

The parts of a noun phrase are determiners, premodifiers, head noun, and postmodifiers, in that order. Highlighting each classification (7) with a different color or shape makes the noun phrase parts clearly visible and aids the analysis.

- (7) the cardiac muscles in the heart

As defined above, possessives, quantifiers, numbers, articles, and demonstratives were classified as determiners. Adjectives and nouns preceding the head noun were classified as premodifiers. Phrases and clauses following the head noun and modifying it were classified as postmodifiers.

*Step three: Classifying postmodifiers*

Postmodifiers were broken down into two classes: phrases and clauses. Color coding is helpful here too (8). **Phrases** include prepositional phrases and adjectives that follow the head noun. **Clauses** include both finite clauses, which have a subject and a tensed verb, and nonfinite clauses, which have a verb form that does not have tense and has no subject.

(8) **flexible** cords **of connective tissue** **called tendons** (BSCS, 2006)

*Step four: Is the noun phrase simple or complex?*

Each noun phrase was categorized as simple or complex based on the number and type of modifiers. Simple noun phrases consist of a head noun alone or with only one determiner. Complex noun phrases are all other noun phrases.

After determining the type of each noun phrase, I calculated the percentages of simple and complex noun phrases at each level. The color coding also helped me see that number of postmodifiers varied by level. These results are shown in the next section.

### **Increasing complexity in multiple ways**

For these texts on the topic of muscles, noun phrase complexity increases with academic level. I will discuss the increasing complexity in terms of percentages of simple and complex noun phrases, types of modifiers (pre or post, phrases or clauses), and the length of complex noun phrases.

#### *Simple and complex noun phrases*

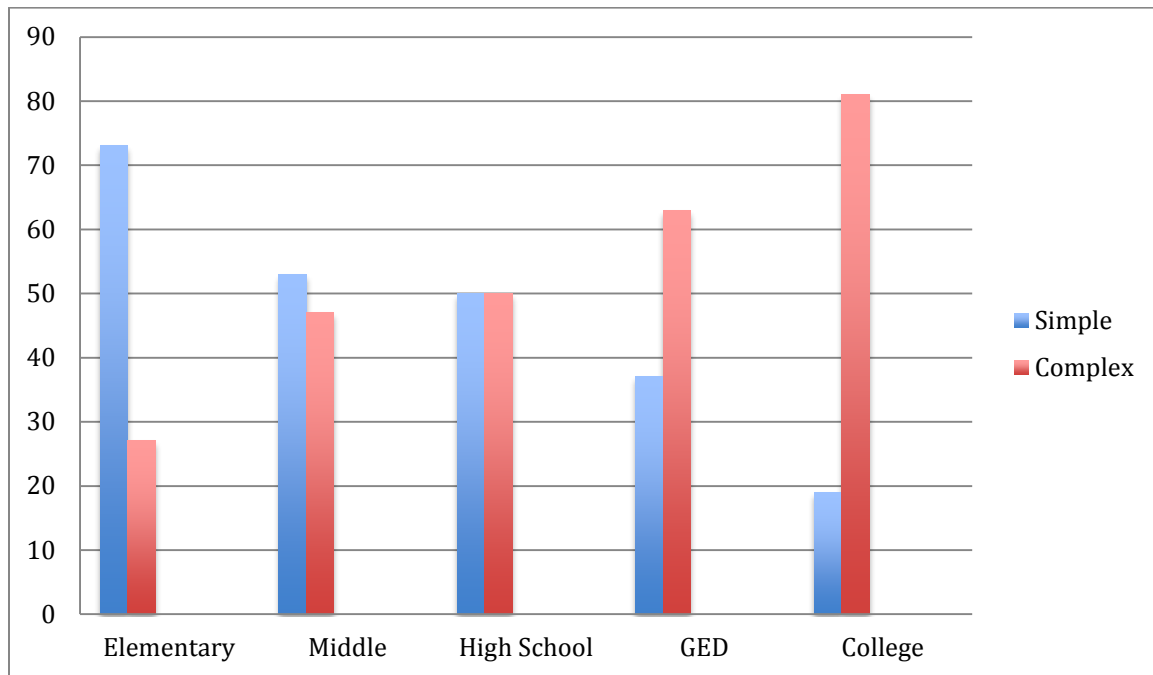
As shown in Figure 3, the percentage of complex noun phrases rises steadily from 27% at the elementary level to 81% at the college level. At the elementary level, most of the noun phrases (73%) are simple, consisting of one determiner and a noun (9a). Complex noun phrases at this level typically have one premodifier (9b) or one postmodifier which is a prepositional phrase of location (9c).

- (9) a. **one** muscle  
b. the **muscle** cells  
c. the muscle **in your upper arm** (Scott Foresman, 2000)

At the middle school level, slightly more of the noun phrases are simple (53%) than complex (47%). The complex noun phrases typically still have only one premodifier; however, in two cases the premodifier is an adjective derived from a verb (10a), which may cause confusion for readers. In addition to prepositional phrases of location as postmodifiers, there are two middle school level noun phrases which include both prepositional phrases with *of* and nonfinite clauses (10b).

- (10) a. the **attached** bone  
b. tough strips **of tissue** **called tendons** (LaRue, 2004)

The preposition *of* is the most widely used preposition after a noun (Biber et al., 1999), but the meaning it creates is harder to understand than prepositions of location such as *in* or *on*. Thus, it is not surprising to find that the more concrete prepositions of location in the elementary text give way to the more abstract *of* in higher academic levels, creating greater noun phrase complexity with these modifiers.



*Figure 3.* Percentage of simple and complex noun phrases by academic level. At the high school level, all the prepositional phrases after the head nouns use *of*, thus increasing the difficulty over the middle school text. The high school noun phrases are evenly split between simple and complex (50% each).

The GED level is the first level at which there are more complex (63%) than simple (37%) noun phrases. Most of the complex noun phrases still only have one premodifier. The prepositional phrases used as postmodifiers all describe location (11), but two of them use *of* for location (11b).

- (11) a. the cardiac muscles in the heart  
 b. skeletal muscles of the arm and shoulder (Mitchell, 2004)

Complex noun phrases (81%) dominate the college level text. While most of the noun phrases still have only one premodifier, two of them have three premodifiers (12 a, b). Noun phrases at this level are heavily postmodified. Only one of the postmodifying prepositional phrases describes location; all the rest use *of* to describe various relationships (12b).

- (12) a. these long, slender multinucleated fibers whose number is probably fixed by the end of the second trimester of fetal development

b. the dense strong connective tissue of the tendons (McArdle, Katch & Katch, 1981)

*Types of modifiers*

In this section, we look more closely at just the complex noun phrases, discussing what creates the complexity: premodifiers, postmodifiers or both. As shown in Table 1, the elementary, middle school and GED levels have more premodifiers than postmodifiers. At these three levels, premodifiers are repeated; for example, *lower* is used twice in both the elementary and middle-school texts, and *involuntary* is used three times in the GED text.

In contrast, noun phrases at the high school and college level have a lower percentage of premodifiers than postmodifiers, and each premodifier at these levels is only used once.

Table 1. Number and Frequency of Modifiers

	Number of Complex NPs	Complex NPs with premodifiers	Complex NPs with postmodifiers	Complex NPs with both pre- and post modifiers
Elementary	9	6 67%	4 44%	1 11%
Middle School	15	12 80%	6 40%	3 20%
High School	16	6 37%	7 44%	1 6%
GED	17	15 88%	7 41%	5 29%
College	22	14 64%	16 73%	7 32%

At first glance, the figures in Table 1 seem to indicate that the high school text has a low level of complexity, with the lowest percentage (37%) of premodifiers and a percentage of postmodifiers (44%) that is the same as the elementary level. However, looking at the actual noun phrases in more depth shows the true complexity. Of the seven noun phrases with postmodifiers, five of them (13) have either more than one modifier (13a, b), nonfinite clauses (13c, d) or a long prepositional phrase with an adjective (*opposing*) that could be mistaken for a verb (13e).

- (13) a. flexible cords of connective tissue called tendons
- b. these two sets of muscles, called flexors and extensors, respectively
- c. a muscle attached to a bone
- d. a rope attached to a wagon
- e. contraction and relaxation of opposing sets of muscles (BSCS, 2006)

The college text has the highest percentage of postmodifiers (73%), and similar to the high school text, the modifiers often occur in pairs (14) with a nonfinite clause providing a technical term for the combination of head noun plus prepositional phrase.

- (14) a. a bundle of up to 150 fibers called a fasciculus  
b. a fascia of fibrous connective tissue known as the epimysium (McArdle, Katch, & Katch, 1981)

In addition, the college text has the highest percentage (32%) of noun phrases with both pre- and postmodifiers. This leads to some very long noun phrases, which will be discussed in the next section.

Although the GED text has nearly as high a percentage (29%) of noun phrases with both pre- and postmodifiers as the college text, it does not have any phrases with more than one postmodifier, and none of the noun phrases have embedded definitions like (14).

#### *Length of noun phrases*

Complex noun phrases in the muscles texts ranged from the minimal two words to the extremely long 17-word phrase shown in (15).

- (15) these long, slender multinucleated fibers whose number is probably fixed by the second trimester of fetal development (McArdle, Katch, & Katch, 1981)

As Figure 4 indicates, the number of words in complex noun phrases at the elementary level was between two and six. At the middle school level, the range was three to ten, with the majority of phrases having three words. In the high school text, the numbers ranged from two to ten, again with the majority being three words. The GED text again has a similar range (two to nine words), but the most common length is only two words. The college text's word lengths are scattered between two and 17 words, with the majority having six or fewer words.



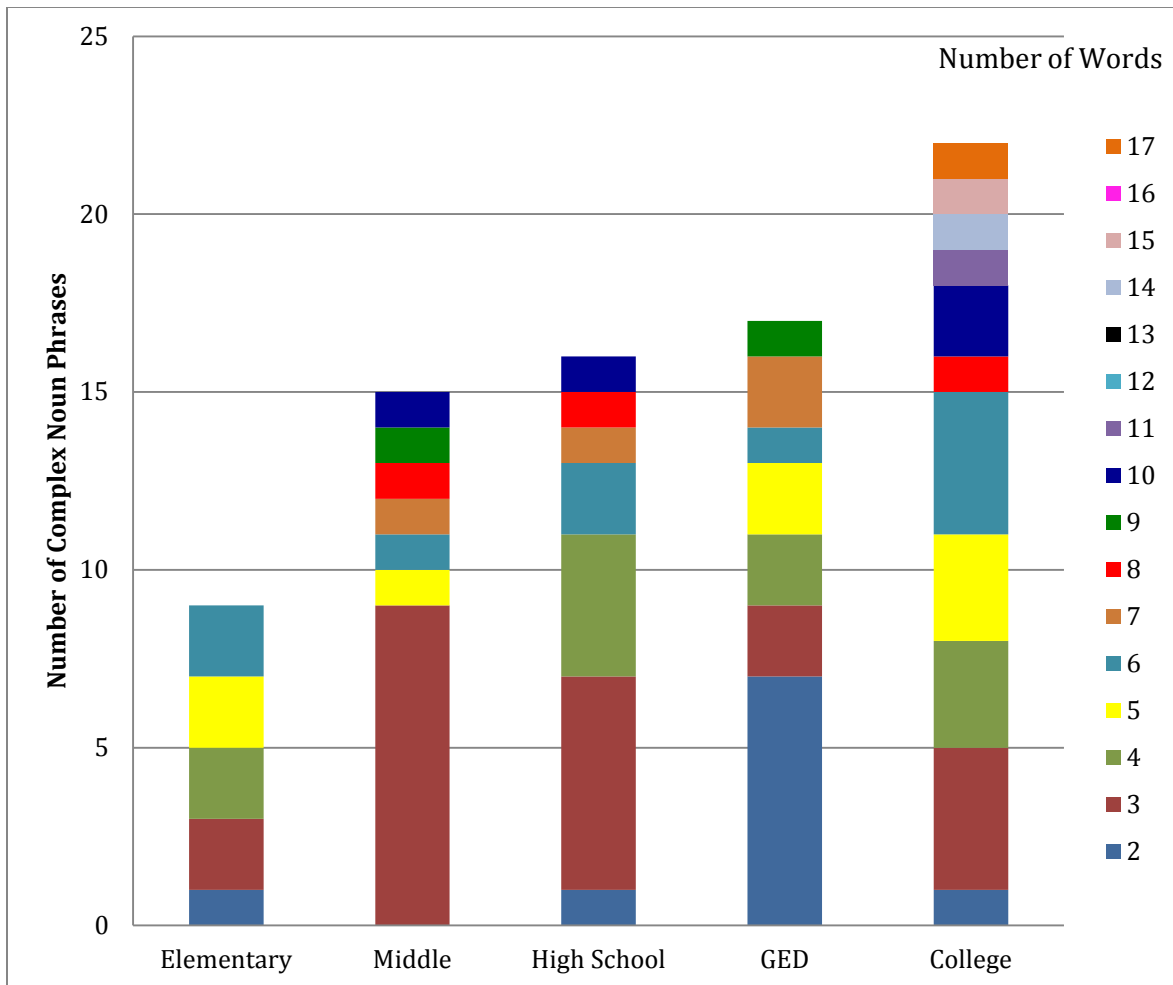


Figure 4. Number of words in complex noun phrases by academic level

In most cases longer length signals greater complexity, it does not always do so, which is illustrated in the examples in (16).

- (16) a. the smooth muscles of the lungs, intestines, and bladder (Mitchell, 2004)  
 b. a fascia of fibrous connective tissue known as the epimysium (McArdle, Katch, & Katch, 1981)

The length of noun phrase (16a), from the GED text, comes mostly from the six-word prepositional phrase that lists body parts to tell the location of certain muscles. GED students may not be familiar with some of these terms, but if they know one of them, it would be fairly easy to infer from the context that they are all body parts. Noun phrase (16b), drawn from the college text, has a similar length, but the length comes from two postmodifiers: a prepositional phrase with two adjectives, and a nonfinite clause that provides the technical term for the structure. The multiple modifiers allow a heavy information load in the noun phrase. Compared to the GED phrase, it would be relatively difficult for readers to discern the meaning of this phrase.

In summary, the percentage of complex noun phrases compared to simple noun phrases increases with academic level in these texts. It was also found in this case that the complex noun phrases at the elementary, middle school and GED levels have more premodifiers than postmodifiers, the number of pre- and postmodifiers are fairly even at the high school level while the college noun phrases are heavily postmodified. The fact that postmodifiers are typically phrases and clauses leads to longer complex noun phrases at the higher academic levels. The next section discusses how this type of analysis and results like these can be applied to teaching ELs in many content areas.

### **Noun phrase complexities in every academic area**

Complex noun phrases occur in many different academic areas in addition to science. For instance, a second grade math textbook is the source of (17), which contains a 17-word noun phrase with two long postmodifiers.

- (17) *Name a group of nickels, dimes and quarters that has the same value as the 1 half dollar* (Harcourt Math, Grade Two, p. 207, as cited in de Oliveira & Cheng, 2011).

Social studies texts include complex noun phrases built up with prepositional phrases to specify a location (18a) or that contain complex and abstract causes of events (18b).

- (18) a. an island in a lake in the Valley of Mexico  
b. famine, disease, warfare or some combination of factors (Helgren, Sager, & Brooks, 2003)

Literary texts frequently use complex noun phrases to add rich details which create visual imagery (19); both these examples are drawn from *When the Emperor was Divine*, a novel about the internment of Japanese-Americans during World War II (Otsuka, 2002) frequently assigned in high school and college English courses (Freedman, 2005).

- (19) a. She made them *paper kites with tails woven out of potato sack strings*  
b. *a city of tar-paper barracks behind a barbed-wire fence on a dusty alkaline plain*

In all of these areas, there are strategies that teachers can use to identify complex noun phrases and help students comprehend them.

### **Strategies to help your learners**

Teachers can use strategies both to find complex noun phrases prior to students' work with a particular text and with students as they are learning academic content in the text. A valuable strategy for teachers is learning how to identify complex noun phrases, using the process described above. After a little practice using the color

coding technique, teachers will be able to spot the long modifiers that mark difficult phrases without that scaffolding. In addition, simplified variants of the color coding technique can be taught to students so they can learn to unpack the meaning in complex noun phrases with less assistance from their teachers.

The strategies listed below for teachers to use with students center around areas that ELs find difficult: identifying the head noun in a complex noun phrase, constructing and deconstructing noun phrases, and using academic noun phrases to replace or condense the verb phrases that are typical of oral social language.

*Strategy #1: Identifying the head noun*

1. Help students identify the head noun in a noun phrase by asking the probe question *Who or what are we talking about?*
2. Point out grammatical clues that indicate what the head noun is. For example, with the sentence *The muscles of any healthy organism are always in a state of partial contraction*, students may think that the head noun of *the muscles of any healthy organism* is *organism* because it is directly before the verb *are*; however, the head noun must be *muscles* because, unlike *organism*, it agrees with *are*.

*Strategy #2: Constructing and deconstructing complex noun phrases*

1. Help students see how particular words in a noun phrase such as *those four strong shoulder muscles on each side of your* body answer certain questions:
  - Which muscles? *those* muscles
  - How many muscles? *four* muscles
  - What are they like? *strong* muscles
  - What type? *shoulder* muscles
  - Where? muscles *on each side of your body*
2. Explore the potential of noun phrases to provide detailed meaning by starting with a noun (perhaps from a story the class is reading) and adding as many modifiers as students can. For example, as students read *The Rainbow Fish* (Pfister, 1992), they might describe the main character as *proud, shiny, beautiful*, and *he doesn't have any friends*. The teacher can model adding one modifier at a time to the noun *fish* to end up with one noun phrase: *a proud, shiny, beautiful fish who doesn't have any friends*.
3. Use a simple graphic organizer (Figures 5 and 6) to illustrate the parts of a noun phrase. In Figure 5, optional parts of a noun phrase are in parentheses, and more student-friendly terms are listed in italics below each part. Community college students who have been taught to break down complex noun phrases with this organizer report that simply identifying the parts makes the meaning clearer (L. K. O'Malley, personal communication, September 27, 2013). Figure 6 is similar, and it can be expanded to accommodate and compare multiple noun phrases.

(Determiners) <i>Pointers</i>	(Premodifiers) <i>Describers</i> <i>Adjectives</i>	Head Noun <i>Noun</i> <i>Who, what</i>	(Postmodifiers) <i>Qualifiers</i>
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Figure 5. Graphic organizer for complex noun phrases

(Determiners)	(Premodifiers)	Head Noun	(Postmodifiers)

Figure 6. Another graphic organizer for complex noun phrases (O'Malley, 2013)

*Strategy #3: Using noun phrases to replace or condense verb phrases*

1. The teacher can explicitly use both more informal verb phrases like *add the two numbers* and the more academic noun phrases like *the sum of the two numbers*. Another example is replacing *When we subtract, we get...*, with the more academic *Subtraction results in...*
2. Teachers can pause occasionally during their oral explanations to contrast their words with those in the textbook, showing, for instance, how *people from the north invaded central Mexico around A. D. 1200* would be stated in writing: *People from the north launched invasions of central Mexico around A. D. 1200*. In addition, students' attention should be drawn to how the verb and object *invaded central Mexico* becomes a complex noun phrase with a preposition, *invasions of central Mexico*.
3. For a persuasive essay that begins, for example, *I think students should wear school uniforms*, the teacher can model how to turn the verb and object into a phrase to continue the argument: *Wearing school uniforms is good because...*, providing an increased level of abstraction.

**Why worry about understanding and teaching noun phrases?**

A significant purpose of academic language is to clearly describe complex ideas (Schleppegrell, 2004). Complex thought requires complex language. In particular, as we saw in the academic science texts in this study, as academic levels rise, noun phrase complexity increases to express increasingly complicated and difficult concepts.

To express these ideas, nouns are important because they are technical terms that are specific to an academic area—what are often called *bricks* (Dutro & Moran, 2003, Zwiers, 2008). The importance of ELs' knowing nouns is apparent, but noun phrases are even more important because the context for the noun creates a more specific meaning than the noun itself. For example, in (20), drawn from the elementary text, the noun phrase *the top muscle in each upper arm* requires the modifiers *top* and *in*

each upper arm to define exactly which muscle the biceps is. The noun *muscle* is the head of the phrase but by itself tells us little in this context.

(20) The top **muscle** in each upper arm is called the biceps.

Similarly, knowing the word categories such as verb, noun, adjective, and so on is important, but knowing how words are put together to make meaning is even more so (Derewianka, 2011). As she says, "It is important to see how individual words function within a group so that students can see how the words relate to each other" (p. 11). Complex noun phrases are a crucial academic language feature to teach explicitly.

A list of additional resources can be found below.

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## **Appendix: Analyzed Texts**

### *Elementary*

Muscles can move bones because muscle cells can change their shape. Make a fist and lift it toward your shoulder. Notice how the muscle in your upper arm feels thick and hard. That is because the muscle cells contracted, or got shorter, to make the movement.

Muscles cannot push bones. Muscles can only pull. That is why muscles work in pairs. One muscle pulls a bone one way. Another muscle pulls the bone the opposite way.

Look at the muscles in the picture. The top muscle in each upper arm is called the biceps. The muscle opposite the biceps is the triceps. When the biceps contracts, it pulls the boy's lower arm toward his shoulder. His arm bends. When the triceps contracts, it pulls the boy's lower arm away from his shoulder. His arm then straightens out. (137 words, Scott Foresman, 2000)

### *Middle School*

The muscular system consists of the more than 600 muscles in your body. The skeletal and muscular systems work together to produce movement. Tough strips of tissue called tendons attach muscles to bones.

Most muscles work in pairs. When a muscle contracts, or shortens, it pulls on the tendon. The tendon pulls on the attached bone, and the bone moves. A muscle cannot push. Therefore, a different muscle on the opposite side of the bone contracts to return the bone to its starting position.

The diagram below shows an example of muscles working in pairs. When you bend your arm, the biceps muscle contracts. You can feel how the muscle shortens and hardens as it contracts. The biceps pulls on the tendon, which pulls your lower arm toward you. The triceps muscle on the underside of your arm is relaxed. (140 words, LaRue, 2004)

### *High School*

Muscles are attached to bones by flexible cords of connective tissue called tendons. Tendons span joints so that when a muscle contracts, the force is applied at the joint and movement occurs. A muscle attached to a bone is like a rope attached to a wagon. You can pull a wagon with a rope, but you cannot push it. To move the wagon back to its original position, you must attach a rope to the other end and pull it. Muscles act in the same way: in opposing pairs. To touch your hand to your shoulder, you contract one set of muscles, producing the flexed position. When you return your hand and arm to the extended position, you contract another set of muscles and relax the first set. These two sets of muscles, called flexors and extensors respectively, work in opposition to each other. All your skeletal movements are performed by contraction and relaxation of opposing sets of muscles. (159 words, Biological Sciences Curriculum Study, 2006)

### *GED*

Movement in the human body is made possible by muscles. A muscle is tissue that can contract (shorten or pull together). Muscles are connected to bones by

tendons—strong, fibrous connective tissue. Because a muscle can only contract, every joint is controlled by opposing muscles. This enables back-and-forth movement to occur. As shown below, you contract your biceps muscle to bend your arm. You contract your triceps muscle to straighten it.

Muscles may be voluntary or involuntary.

- Voluntary muscles are those that you can consciously control. Skeletal muscles, used to control bone movement, are all voluntary muscles. To raise your hand, you consciously use skeletal muscles of the arm and shoulder.
- Involuntary muscles are those over which you normally have limited control. The smooth muscles of the lungs, intestines, and bladder are involuntary muscles. The cardiac muscles in the heart are involuntary muscles that cause heartbeat. (146 words, Mitchell, 2003)

### *College*

Each of the more than 430 voluntary muscles in the body contains various wrappings of fibrous connective tissue. Figure 18-1 shows the cross section of a muscle consisting of thousands of cylindrical muscle cells called fibers. These long, slender multinucleated fibers whose number is probably fixed by the second trimester of fetal development lie parallel to one another and the force of contraction is along the long axis of the fiber. Each fiber is wrapped and separated from its neighboring fibers by a fine layer of connective tissue, the endomysium. Another layer of connective tissue, the perimysium, surrounds a bundle of up to 150 fibers called a fasciculus.

A fascia of fibrous connective tissue known as the epimysium is surrounding the entire muscle. This protective sheath is tapered at its distal ends as it blends into and joins the intramuscular tissue sheaths to form the dense strong connective tissue of the tendons. The tendons connect both ends of the muscle to the outermost covering of the skeleton, the periosteum.

Thus the force of muscular contraction is transmitted directly from the muscle's connective harness to the tendons, which in turn pull on the bones at their points of attachment. (197 words, McArdle, Katch, & Katch, 1981)



## Additional Resource List

Bonnie Swierzbini

Most of these resources view teaching language with a functional approach; that is, they are concerned more with the relationship between meaning and form, and less with prescriptive rules for correctness. They focus on what students CAN do and on what language resources they need for the meaning they want or need to express. The authors use three questions to organize their analysis of both students' work and the texts students are expected to comprehend.

1. What is the text about?
2. How is judgment or evaluation expressed?
3. How is the text organized?

1. Schleppegrell, M. & Go, A. (2007, July). [Analyzing the writing of English learners: A functional approach](#). *Language Arts*, 84(6), 529-538.

This is a very readable introduction to a functional approach. Resources 2-4 are aimed at elementary school teachers; however, they include very useful information for teachers at all levels. Derewianka does a terrific job of writing in teacher-friendly terms. Despite the somewhat challenging title, resource 4 is a readable study of report writing in grades 1-5.

2. Derewianka, B. (2011). *A new grammar companion for teachers* (2<sup>nd</sup> ed.). Marrickville Metro, NSW, Australia: Primary English Teaching Association Australia.

3. Derewianka, B. (1990). *Exploring how texts work*. Marrickville Metro, NSW, Australia: Primary English Teaching Association Australia.

4. Brisk, M., Hodgson-Drysdale, T., & O'Connor, C. (2010/2011). A study of a collaborative instructional project informed by Systemic Functional Linguistic theory: Report writing in elementary grades. *Journal of Education* 191(1), 1-12.

5. Zwiers, J. (2008) *Building academic language: Essential practices for content classrooms, grades 5-12*. San Francisco, CA: Jossey-Bass.

Zwiers' book, although aimed at middle- and high-school teachers, is jam-packed with ideas that work at a wide range of ages and proficiency levels. This is a book teachers turn to again and again. Many of the materials mentioned in it can be obtained at <http://www.jeffzwiers.com/resources.html>

6. Fang, Z. & Schleppegrell, M. (2008). *Reading in secondary content areas: A language-based pedagogy*. Ann Arbor, MI: University of Michigan Press. This book targets the high school level and would also be very useful for GED and college educators. It is also a great resource for a study group since it has a study guide in the back.