Were it not for complex constructions in science texts:* Grappling with counterfactual conditionals and covert comparatives

Cathy O'Connor
Boston University

*Expands on work begun with Charles J. Fillmore and Lily Wong Fillmore

NGSS Practice 8: Obtaining, evaluating, and communicating information

Beyond the science textbook:

- News media
- Reference works
- Adapted primary sources
- Blogs,
- STEM magazines,
- Wikipedia articles

Practice 8. Obtaining, evaluating, and communicating information

ScienceNews for Students

ScienceNews
MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC

DEFENDERS MAGAZINE

ScienceNews for Students

How can a relatively tiny koala belt out mating songs in a bass range more typical of elephants? The answer is outside their voice box.

Male koalas can emit very loud low sounds even though they are tiny creatures.
No one knew how they made those sounds.
Scientists have now discovered how they can do it.

SCIENTIFIC AMERICAN

ADVANCES: Physics

Just how small is the proton?

We thought we knew what the proton's radius was.

Scientists just learned (after 12 years of hard work) that it is four percent smaller than that.

This has implications for two very large theoretical issues.

nature

LETTERS

Nature: Letters The size of the proton. Vol 466|8 July 2010| doi:10.1038/nature09250 Pohl, R. et al.

Texts like these bring more than description of scientific phenomena or new findings.

They bring in stories that embody some of the *central activities* of science:

- Expanding and refining ideas about the physical and natural world and human experience
- Finding new ways to solve persistent problems, using new tools and repurposing old tools.

But these articles also bring with them a lot of complex language.

20 times lower than would be expected from

….These bonus vocal cords allow males to hit tones **20 times lower than would be expected from** an animal its size.

ADVANCES: Physics

Just how small is the proton?

Physicists have been scratching their heads since July, when a research team announced that the proton, the basic building block of matter, is

4 percent smaller than previously thought.

ADVANCES: Physics

Just how small is the proton?

Physicists have been scratching their heads since July, when a research team announced that the proton, the basic building block of matter, is **4 percent smaller than previously thought.**

ScienceNews for Students

Eureka! Lab

High school student finds baby dino

Hadrosaur fossil is one of the most complete specimens found

by Bethany Brookshire [1] 7:00pm, October 22, 2013

ScienceNews for Students

Eureka! Lab

High school student finds baby dino

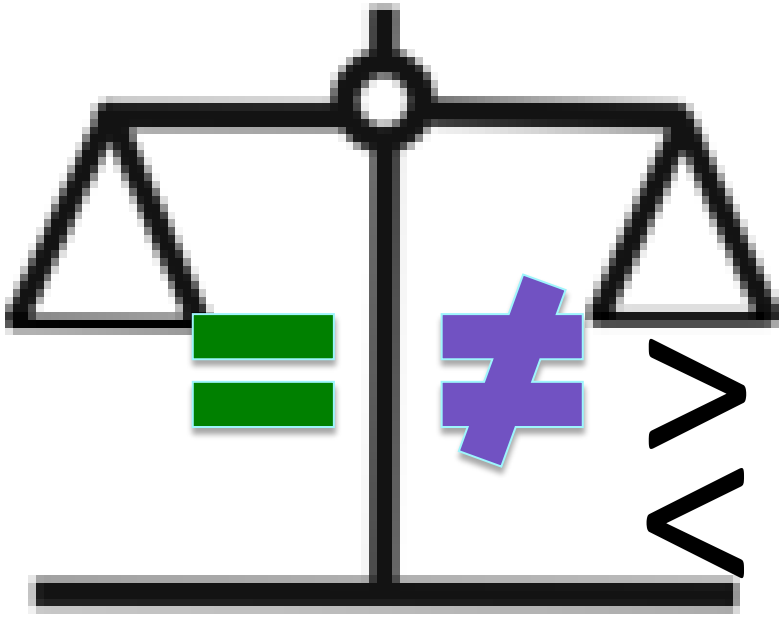
Hadrosaur fossil is one of the most complete specimens found

by Bethany Brookshire [1] 7:00pm, October 22, 2013

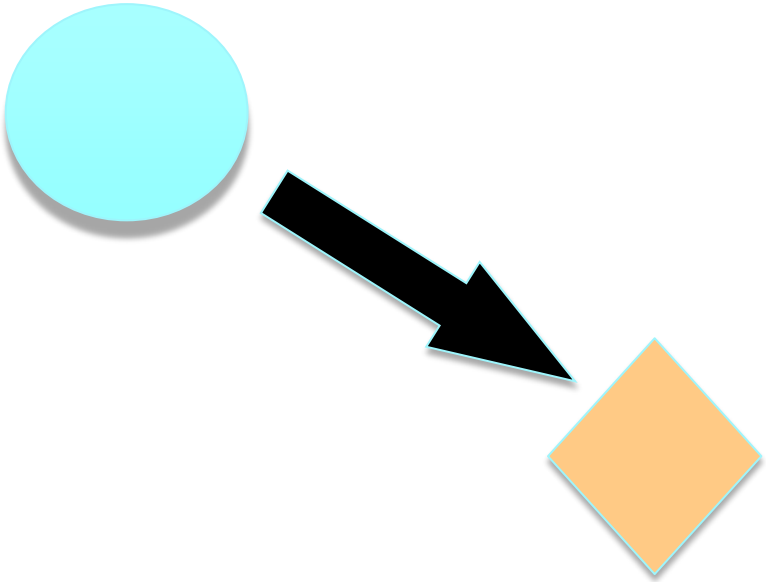
Born at roughly the size of a human baby, Joe was already six feet long by the time he died. **Had he survived** to become an adult, **he would have reached** 25 feet long.

These grammatical constructions are members of **families**:

Comparatives



Conditionals

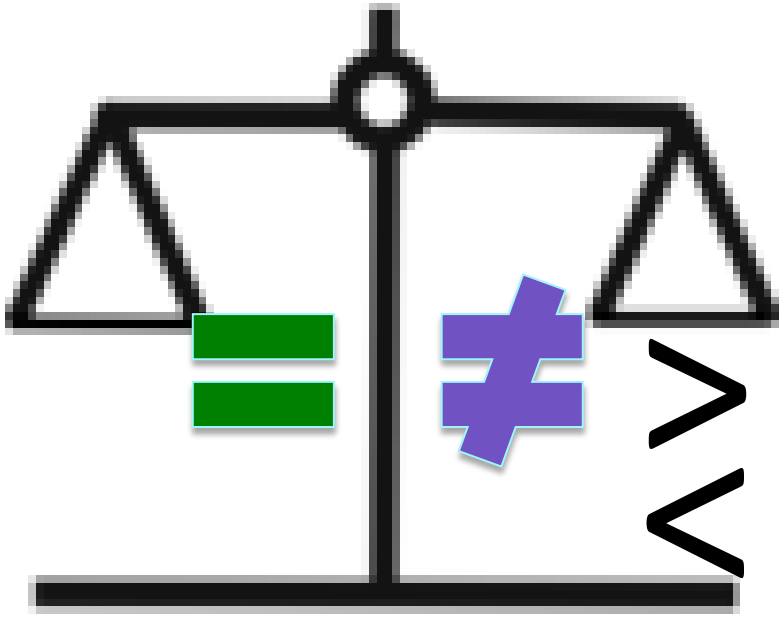


20 times lower than…

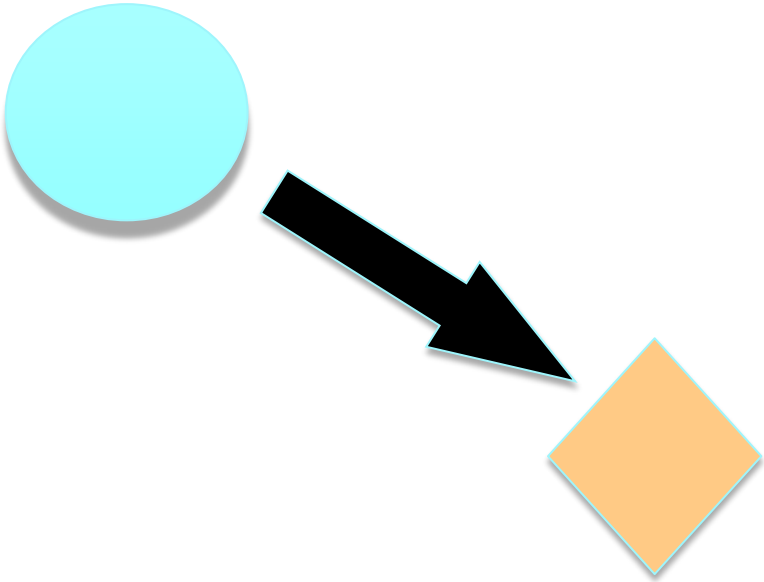
4% smaller than…

Had he survived, he would have…

Comparatives

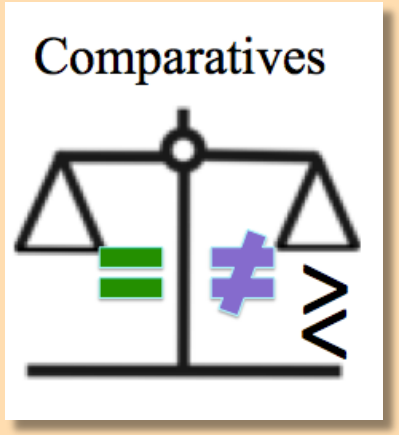


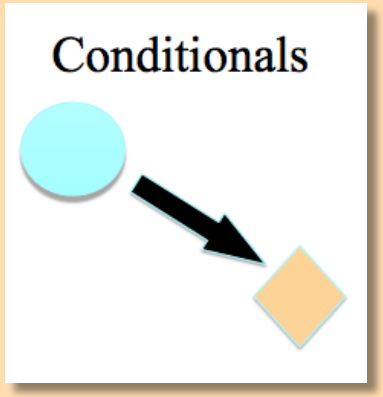
Conditionals



Complex constructions like these are important: they signal logic and purpose, and temporal and quantitative relations, among other things…

They help readers go from the "text model" to the "situation model" (Zwaan et al.; Van Dijk & Kintsch).





And there are many more such complex constructions. . .

Science News › *Vol 159 Issue 24*

Coming to Terms with Death

Accurate descriptions of a cell's demise may offer clues to diseases and treatments

by Janet Raloff

Death is a part of living --and an essential one. From conception onward, cells divide over and over again. Their endless proliferation **would quickly lead** to elephantine bodies **were it not for** a compensating death of cells.

Science News › *Vol 159 Issue 24*

Coming to Terms with Death

Accurate descriptions of a cell's demise may offer clues to diseases and treatments

by Janet Raloff

Death is a part of living --and an essential one. From conception onward, cells divide over and over again. Their endless proliferation **xxxxx xxxxxxx xxxx** to elephantine bodies **xxxx xx xxx xxx** a compensating death of cells.

Science News › *Vol 159 Issue 24*

Coming to Terms with Death

Accurate descriptions of a cell's demise may offer clues to diseases and treatments

by Janet Raloff

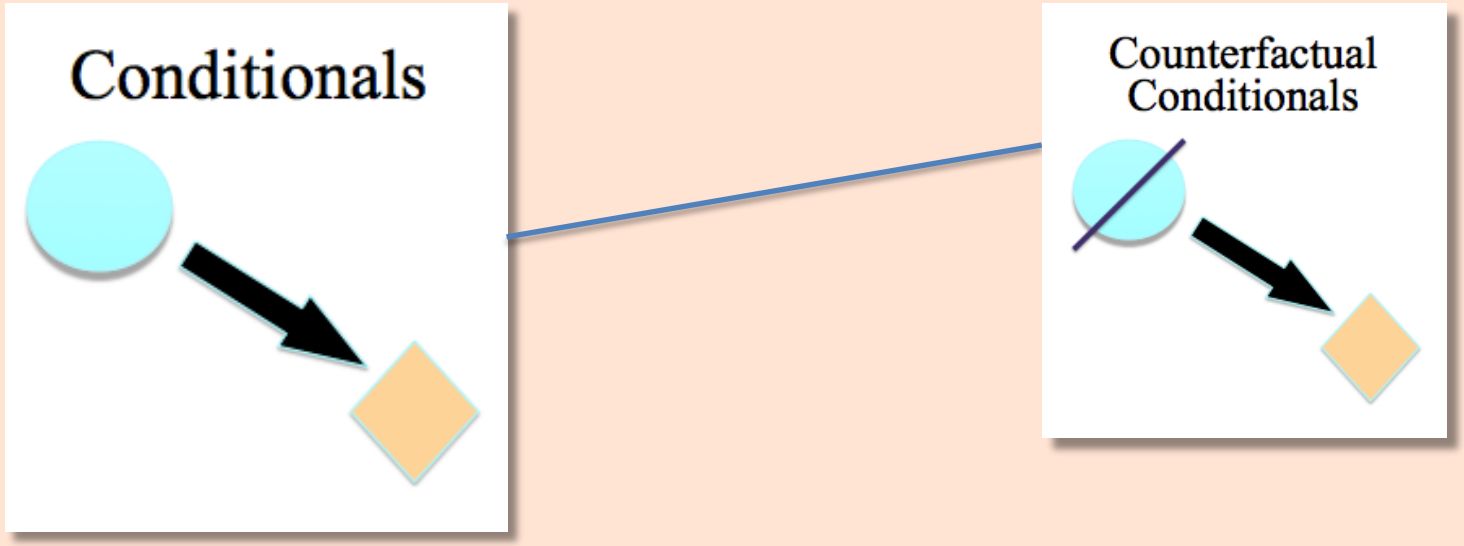
Death is a part of living --and an essential one. From conception onward, cells divide over and over again. Their endless proliferation **would quickly lead** to elephantine bodies **were it not for** a compensating death of cells.

would quickly lead to elephantine bodies

were it not for a compensating death of cells

had he survived to become an adult

he **would have reached** a length of 25 feet



These examples are very noticeable in their “marking”—they carry clear signs of the counterfactual conditional.

They are formulaic—you can’t change them:

Were it not for my teacher…

**Were it for my teacher…

**Were she not for my teacher…

But these fixed, formulaic conditionals are clearly related to more “everyday” ways of expressing the same idea:

If it hadn’t been for my teacher…

If she hadn’t been my teacher…

If someone else had been my teacher…

So even something like this:

Were it not for a compensating cell death…

can be expressed in everyday language:

If those cells hadn’t kept dying,

We’ll come back to this relationship to “everyday” ways of expressing the same idea.

(This is an important form of student knowledge that we can recruit in the process of working through texts.)

Now let’s look at an example where are are no markings of the constructional family--

“covert comparatives”:

DEFENDERS MAGAZINE

Spring 2011.
(Defenders of Wildlife Advocacy Group)

Snippets: A Defenders Roundup

- **Lions Need Help**
- It's hard to believe a population can plummet so quickly. In the 1940s, an estimated 450,000 lions roamed across most of Africa and parts of Asia. Today African lions number as few as 40,000, occupying just 22 percent of their historical range. Given this alarming decline, Defenders of Wildlife and other groups are petitioning the U.S. Fish and Wildlife Service to protect the African lion under the Endangered Species Act. Listing lions would focus global attention on their plight, prohibit the importation of lion trophies and body parts into the United States and could encourage Congress to provide funding to start up lion conservation projects in Africa.

What would an overt comparison look like?

It's hard to believe a population can plummet so quickly.

Today there are many **fewer** lions **than** there were in the 1940s.

They occupy a much **smaller** range **than** they used to.

An overt comparison

It's hard to believe a population can plummet so quickly.

Today there are many **fewer** lions **than** there were in the 1940s.

They occupy a much **smaller** range **than** they used to.

A covert comparison

It's hard to believe a population can plummet so quickly.

In the 1940s, an estimated 450,000 lions roamed across most of Africa and parts of Asia.

A covert comparison

It's hard to believe a population can plummet so quickly.

In the 1940s, an estimated 450,000 lions roamed across most of Africa and parts of Asia.

Today, African lions number as few as 40,000, occupying just 22 percent of their historical range.

A covert comparison

It's hard to believe a population can plummet so quickly.

In the 1940s, an estimated 450,000 lions roamed across most of Africa and parts of Asia.

Today, African lions number as few as 40,000, occupying just 22 percent of their historical range.

A covert comparison

It's hard to believe a population can plummet so quickly.

In the 1940s, **an estimated 450,000 lions** roamed across most of Africa and parts of Asia.

Today, **African lions number as few as 40,000**, occupying just 22 percent of their historical range.

A covert comparison

It's hard to believe a population can plummet so quickly.

In the 1940s, an estimated 450,000 lions **roamed across most of Africa and parts of Asia.**

Today, African lions number as few as 40,000, **occupying just 22 percent of their historical range.**

This covert comparison carries three dimensions of comparison:

In the 1940s

450,000 lions

most of Africa
&
parts of Asia

Today

40,000 lions

22% of their historical range

A covert comparison

It's hard to believe **a population can plummet so quickly**.

In the 1940s, an estimated 450,000 lions roamed across most of Africa and parts of Asia.

Today, African lions number as few as 40,000, occupying just 22 percent of their historical range.

But is this advocacy magazine article a “science text”?

How about a Scientific American article by Stephen Hawking and Leonard Mlodinow?

Hawking & Mlodinaw *The (elusive) theory of everything.*

Sci Am Oct. 2010. p. 70.

"The way physics has been going, realism is becoming difficult to defend.

In classical physics—the physics of Newton that so accurately describes our everyday experience—the interpretation of terms such as object and position is for the most part in harmony with our commonsense "realistic" understandings of those concepts. …."

The reality of quantum theory is a radical departure from that of classical physics.

In the framework of **quantum theory,** particles have neither definite positions nor definite velocities unless and until an observer measures those quantities.
In some cases, individual objects do not even have an independent existence…

Quantum physics also has important implications for our concept of the past.

In **classical physics,** the past is assumed to exist as a definite series of events,

but according to **quantum physics**, the past, like the future, is indefinite and exists only as a spectrum of possibilitiies Even the universe as a whole has no single past or history.

So understanding complex constructions like the comparative (whether covert or overt) and the conditional (whether counterfactual or not) is part of learning to *obtain, evaluate, and communicate information.*

But how do we help students grapple with these challenging linguistic objects in real time, as the class reads an article together? Or as students read it together in a small group?

A brief look at one approach that we have been developing in the context of Lily Wong Fillmore's work with English learners:

The teacher takes 5 minutes or so to allow an intensive focus on one complex sentence within the complex text it is part of…

Basic principles:

1. The teacher is not teaching grammar: teacher and students are working together to make meaning of the text.
(No linguistic terminology necessary!)

2. The power of the paraphrase: students are called on to hypothesize about what a sentence means, what the writer is trying to convey. (cf. "questioning the author"—Beck & McKeown)

They are asked to “put this sentence into your own words” or “work with your partner to find one thing you think this writer is trying to tell us—in your own words.”

3. As they do this, the teacher encourages them to look “up” to the story line, and “down” into the further details--

Digging in…

It's hard to believe a population can plummet so quickly.

In the 1940s, an estimated 450,000 lions roamed across most of Africa and parts of Asia.

Today, African lions number as few as 40,000, occupying just 22 percent of their historical range.

As they dig into the comparison, they observe that there's a missing piece, the second half of the comparison, and they go back to try to figure it out in light of the comparison.

In the 1940s	Today
450,000 lions	40,000 lions
roaming most of Africa and parts of Asia	?????

In conclusion:

Texts like these can help you dig deeper into the complex language of science texts.

Their story lines impart knowledge about the work of science/engineering;

They provide facts and arguments needed to support these story lines;

Their contents can scaffold your work on the complex language that students must grapple with.

Don’t shy away from complex constructions;
bring them
into the meaning-making
enterprise through discussion and paraphrase.

Thank you!