



A photograph of a person's hands writing on a piece of paper with a pen. Overlaid on the image is a large teal circle containing the text "Communicating your science". Around this central circle are several smaller, semi-transparent circles in various colors (white, yellow, orange, red, blue) containing icons related to science communication: a DNA helix, a lightbulb, a thumbs-up, and a brain.

# Communicating your science



Why does  
it matter?

Why should YOU do it?

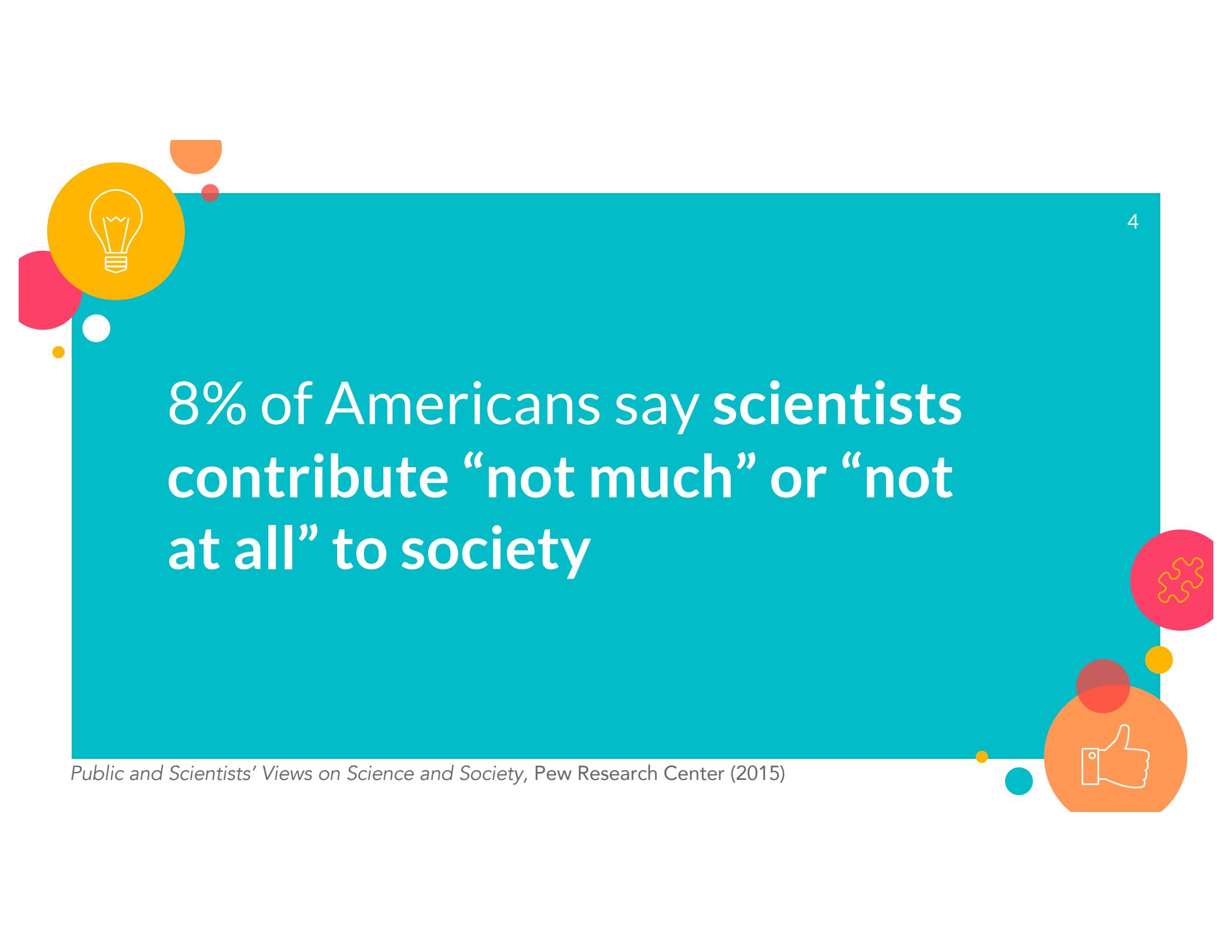




The Internet is the primary source of science information for 60% of Americans.



*Science & Engineering Indicators, ed. J. Gawalt (2008)*



8% of Americans say scientists contribute “not much” or “not at all” to society

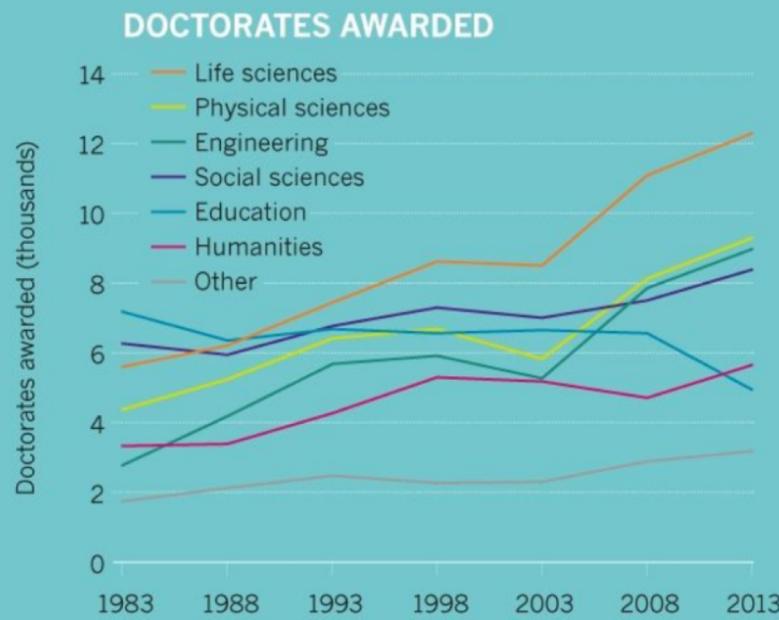
*Public and Scientists' Views on Science and Society, Pew Research Center (2015)*

## A crowded PhD market

5

### UPS AND DOWNS OF PHDS

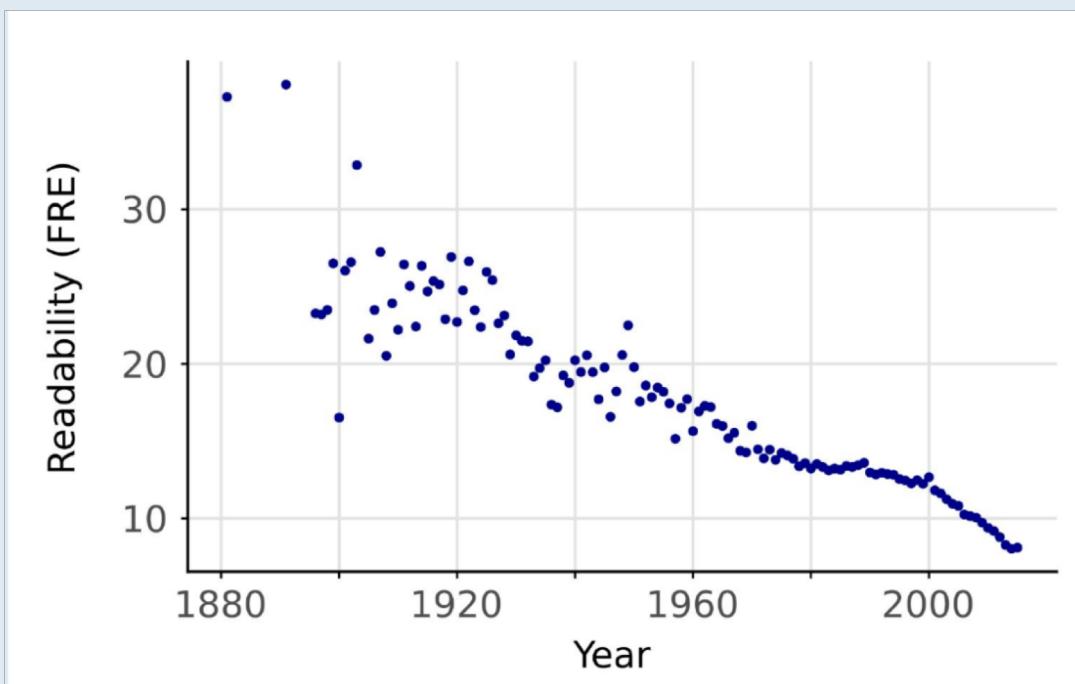
The number of students in the United States who graduate with a doctorate has increased, with the most rapid rise in life-sciences degrees. The proportion of PhDs in permanent academic positions is falling, and the number graduating with no job or postdoc lined up is on the rise.



National Center for Science & Engineering Statistics & Nature (Dec 2015)

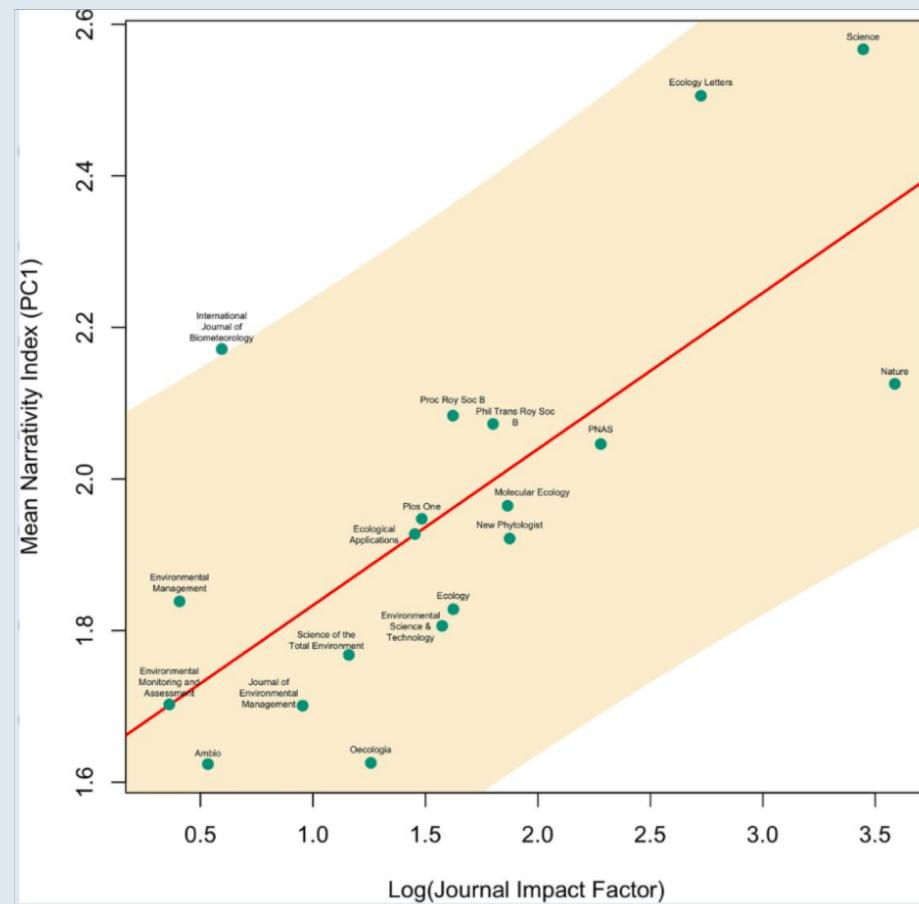
# Readability of Scientific Journal Articles

6

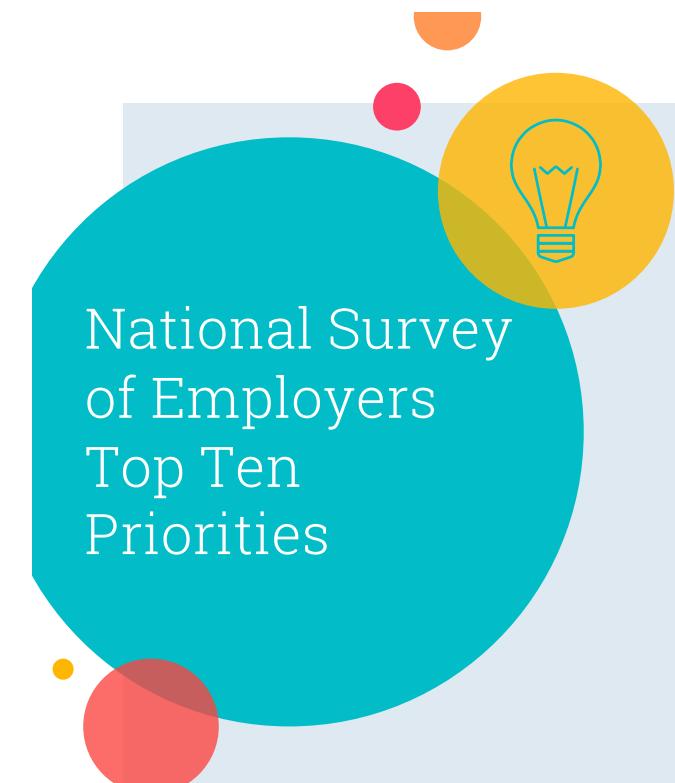


Plaven-Sigray, Matheson, Schiffler, Thompson (2017)

# Narrativity of Journal Abstracts



A Hiller et al, Narrative Style Influences Citation Frequency in Climate Change Science, PLoS ONE (2016)

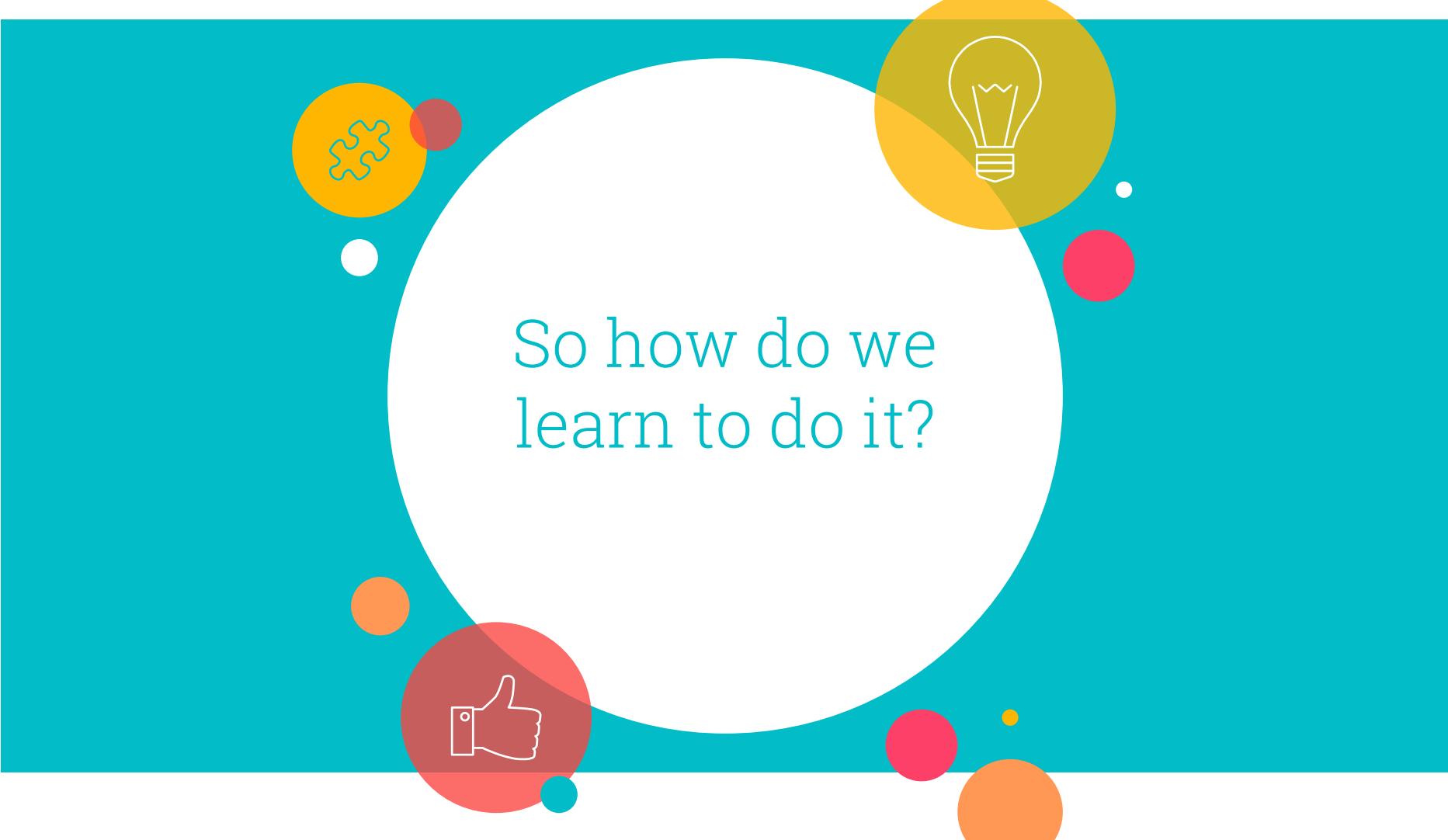


National Survey  
of Employers  
Top Ten  
Priorities

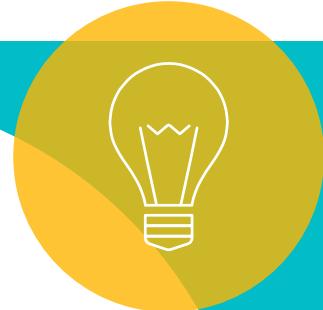
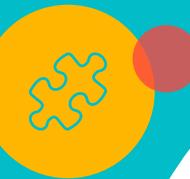
# #1: Verbally communicate with persons inside and outside the organization



National Association of Colleges and Employers Survey (2016)



So how do we  
learn to do it?



- In 1990, Gopen & Swan published an essential article on scientific writing.

**American Scientist online**  
THE MAGAZINE OF SIGMA XI, THE SCIENTIFIC RESEARCH SOCIETY

**The Science of Scientific Writing**

If the reader is to grasp what the writer means, the writer must understand what the reader needs  
[George D. Gopen, Judith A. Swan](#)

*This article was originally published in the November-December 1990 issue of American Scientist.*

Science is often hard to read. Most people assume that its difficulties are born out of necessity, out of the extreme complexity of scientific concepts, data and analysis. We argue here that complexity of thought need not lead to impenetrability of expression; we demonstrate a number of rhetorical principles that can produce clarity in communication without oversimplifying scientific issues. The results are substantive, not merely cosmetic: Improving the quality of writing actually improves the quality of thought.

The fundamental purpose of scientific discourse is not the mere presentation of information and thought, but rather its actual communication. It does not matter how pleased an author might be to have converted all the right data into sentences and paragraphs; it matters only whether a large majority of the reading audience accurately perceives what the author had in mind. Therefore, in order to understand how best to improve writing, we would do well to understand better how readers go about reading. Such an understanding has recently become available through work done in the fields of rhetoric, linguistics and cognitive psychology. It has helped to produce a methodology based on the concept of reader expectations.

**Writing with the Reader in Mind: Expectation and Context**

Readers do not simply read; they interpret. Any piece of prose, no matter how short, may "mean" in 10 (or more) different ways to 10 different readers. This methodology of reader expectations is founded on the recognition that readers make many of their most important interpretive decisions about the substance of prose based on clues they receive from its structure.

This interplay between substance and structure can be demonstrated by something as basic as a simple table. Let us say that in tracking the temperature of a liquid over a period of time, an investigator takes measurements every three minutes and records a list of temperatures. Those data could be presented by a number of written structures. Here are two possibilities:

time (min)	temperature(°C)
0	25
3	27
6	29
9	31
12	32
15	32

t(time)=15', T(temperature)=320, t=0', T=250; t=6', T=290; t=3', T=270; t=12', T=320; t=9'



“



The smallest of the URF's (URFA6L), a 207-nucleotide (nt) reading frame overlapping out of phase the NH<sub>2</sub>-terminal portion of the adenosinetriphosphatase (ATPase) subunit 6 gene has been identified as the animal equivalent of the recently discovered yeast H<sup>+</sup>-ATPase subunit 8 gene. The functional significance of the other URF's has been, on the contrary, elusive. Recently, however, immunoprecipitation experiments with antibodies to purified, rotenone-sensitive NADH-ubiquinone oxido-reductase [hereafter referred to as respiratory chain NADH dehydrogenase or complex I] from bovine heart, as well as enzyme fractionation studies, have indicated that six human URF's (that is, URF1, URF2, URF3, URF4, URF4L, and URF5, hereafter referred to as ND1, ND2, ND3, ND4, ND4L, and ND5) encode subunits of complex I. This is a large complex that also contains many subunits synthesized in the cytoplasm.



The smallest of the URF's, and [A], has been identified as a [B] subunit 8 gene. The functional significance of the other URF's has been, on the contrary, elusive. Recently, however, [C] experiments, as well as [D] studies, have indicated that six human URF's [1-6] encode subunits of Complex I. This is a large complex that also contains many subunits synthesized in the cytoplasm.

## Subject-Verb Separation

The smallest of the URF's (URFA6L), a 207-nucleotide (nt) reading frame overlapping out of phase the NH<sub>2</sub>-terminal portion of the adenosinetriphosphatase (ATPase) subunit 6 gene has been identified as the animal equivalent of the recently discovered yeast H<sup>+</sup>-ATPase subunit 8 gene.



“



## Subject-Verb Separation

The smallest of the URF's (URFA6L), a 207-nucleotide (nt) reading frame overlapping out of phase the NH<sub>2</sub>-terminal portion of the adenosinetriphosphatase (ATPase) subunit 6 gene **has been identified** as the animal equivalent of the recently discovered yeast H<sup>+</sup>-ATPase subunit 8 gene.

The smallest of the URF's is URFA6L, a 207-nucleotide (nt) reading frame overlapping out of phase the NH<sub>2</sub>-terminal portion of the adenosinetriphosphatase (ATPase) subunit 6 gene; **it has been identified** as the animal equivalent of the recently discovered yeast H<sup>+</sup>-ATPase subunit 8 gene.



## Stress-Position

Don't attempt to emphasize more than one important piece of information in a sentence. And highlight that information by placing it at the beginning or end of a sentence.



## Stress-Position

Recently, however, immunoprecipitation experiments with antibodies to purified, rotenone-sensitive NADH-ubiquinone oxidoreductase [hereafter referred to as respiratory chain NADH dehydrogenase or complex I] from bovine heart, as well as enzyme fractionation studies, have indicated that six human URF's (that is, URF1, URF2, URF3, URF4, URF4L, and URF5, hereafter referred to as ND1, ND2, ND3, ND4, ND4L, and ND5) encode subunits of complex I.

Recently, however, several human URF's have been shown to encode subunits of rotenone-sensitive NADH-ubiquinone oxidoreductase. This is a large complex that also contains many subunits synthesized in the cytoplasm; it will be referred to hereafter as respiratory chain NADH dehydrogenase or complex I. Six subunits of Complex I were shown by enzyme fractionation studies and immunoprecipitation experiments to be encoded by six human URF's (URF1, URF2, URF3, URF4, URF4L, and URF5); these URF's will be referred to subsequently as ND1, ND2, ND3, ND4, ND4L and ND5.



Calcium blockers can control muscle spasms. Sarcomeres are the small units of muscle fibers in which these drugs work. Two filaments, one thick and one thin, are in each sarcomere. The proteins actin and myosin are contained in thin filament. When actin and myosin interact, your heart contracts.

**Calcium blockers** can control muscle spasms. **Sarcomeres** are the small units of muscle fibers in which these drugs work. **Two filaments**, one thick and one thin, are in each sarcomere. **The proteins actin and myosin** are contained in thin filament. When **actin and myosin** interact, your heart contracts.

## Stress-Position

Put old information at the beginning of sentences, new information at the end.

## Stress-Position

Calcium blockers can control muscle spasms. Sarcomeres are the small units of muscle fibers in which these drugs work. Two filaments, one thick and one thin, are in each sarcomere. The proteins actin and myosin are contained in thin filament. When actin and myosin interact, your heart contracts.

Muscle spasms can be controlled with drugs known as calcium blockers. Calcium blockers work in small units of muscle fibers called sarcomeres. Each sarcomere has two filaments, one thick and one thin. The thin filament contains two proteins, actin and myosin. When actin and myosin interact, your heart contracts.

- Transcription of the 5S RNA genes in the egg extract is TFIIIA-dependent. This is surprising, because the concentration of TFIIIA is the same as in the oocyte nuclear extract. The other transcription factors and RNA polymerase III are presumed to be in excess over available TFIIIA, because tRNA genes are transcribed in the egg extract. The addition of egg extract to the oocyte nuclear extract has two effects on transcription efficiency. First, there is a general inhibition of transcription that can be alleviated in part by supplementation with high concentrations of RNA polymerase III. Second, egg extract destabilizes transcription complexes formed with oocyte but not somatic 5S RNA genes.

## Focus

Make a single topic the focus of a paragraph whenever possible. Use the stress positions to emphasize that establish that focus.

## Verbs

Use strong verbs that indicate the action that you aim to express.

## Focus & Verb Position

Transcription of the 5S RNA genes in the egg extract is TFIIIA-dependent. This is surprising, because the concentration of TFIIIA is the same as in the oocyte nuclear extract. The other transcription factors and RNA polymerase III are presumed to be in excess over available TFIIIA, because tRNA genes are transcribed in the egg extract. The addition of egg extract to the oocyte nuclear extract has two effects on transcription efficiency. First, there is a general inhibition of transcription that can be alleviated in part by supplementation with high concentrations of RNA polymerase III. Second, egg extract destabilizes transcription complexes formed with oocyte but not somatic 5S RNA genes.

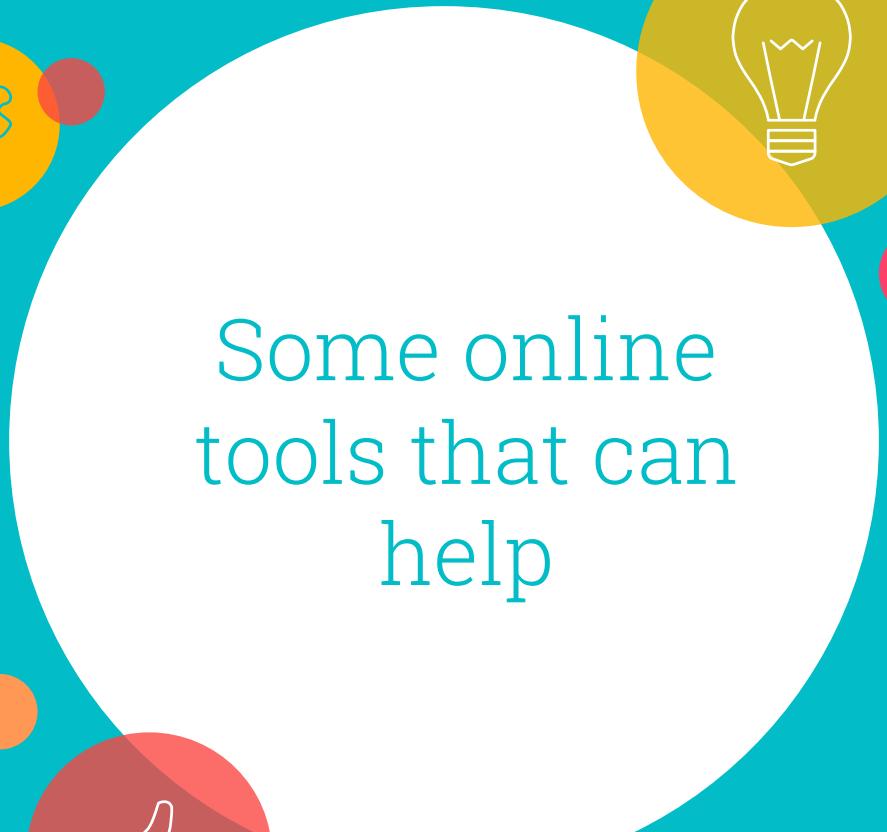
In the egg extract, the availability of TFIIIA limits transcription of the 5S RNA genes. This is surprising because the same concentration of TFIIIA does not limit transcription in the oocyte nuclear extract. In the egg extract, transcription is not limited by RNA polymerase or other factors because transcription of tRNA genes indicates that these factors are in excess over available TFIIIA. When added to the nuclear extract, the egg extract affected the efficiency of transcription in two ways. First, it inhibited transcription generally; this inhibition could be alleviated in part by supplementing the mixture with high concentrations of RNA polymerase III. Second, the egg extract destabilized transcription complexes formed by oocyte but not by somatic 5S genes.



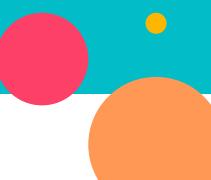
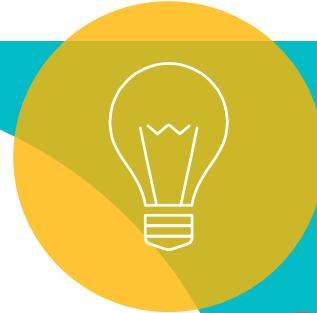
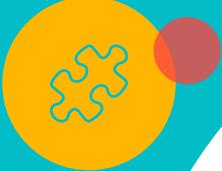
## Summary of principles

25

- Place subjects & verbs as closely together as possible
  - Use stress positions to introduce new topics/concepts, establish relationships between topics, and establish a primary topic for a given paragraph
  - Use strong verbs to emphasize your points
- 



Some online  
tools that can  
help



# Hemingway App

[www.hemingwayapp.com](http://www.hemingwayapp.com)

Wolf 359 (GJ 406; CN Leo), at a distance of  $2.41 \pm 0.01$  pc, is the nearest star, after  $\alpha$  Cen and Barnard's Star. Wolf 359 is a chromospherically active M6 V star with strong H $\alpha$  emission (Pavlenko et al. 2006; Mann et al. 2015) and moderate coronal X-ray emissions ( $LX \approx 1-5 \times 10^{27}$  erg s $^{-1}$ —Fuhrmeister et al. 2007). The star's strong chromospheric emissions, fast rotation (see below), and frequent flares, indicate that Wolf 359 is a young star (age 0.8 Gyr). But the lack of Lithium lines and moderately large space motions ( $U, V, W = -26, -44, -18$  km s $^{-1}$ ) could indicate an older age. Wolf 359 also has a special place in science fiction folklore, as it is where the United Federation of Planets suffered a devastating defeat at the hands of the Borg Collective in 2367 (Okuda et al. 1999).

Wolf 359 has been included in our *Living with a Red Dwarf* program (Engle et al. 2009; Guinan et al. 2016) for several years with the goals of determining its rotation period and starspot activity as well as its X–UV fluxes (and variability) that could affect possible hosted planets (if present). An important element of the program is CCD photometry carried out during 2011 and 2017/18 with the 1.3 m *Robotically Controlled Telescope* (RCT—Strolger et al. 2014). Analysis of the RCT *V*-band photometry indicates a period of  $P \approx 2.72 \pm 0.04$  days (Figure 1 bottom right) and a light amplitude of  $0.021 \pm 0.003$  mag.

## Hemingway Editor

### Readability

Grade 7

Good

Words: 258

Show More ▾

3 adverbs. Aim for 1 or fewer.

1 use of passive voice, meeting the goal of 3 or fewer.

2 phrases have simpler alternatives.

2 of 15 sentences are hard to read.

3 of 15 sentences are very hard to read.

# Dr-Jargonizer

scienceandpublic.com

The screenshot shows a web browser window with the URL [scienceandpublic.com](http://scienceandpublic.com) in the address bar. The page title is "Result". The main content is an article about the star Wolf 359. The text discusses its distance (2.41 ± 0.01 pc), stellar type (M6 V), chromospheric activity, X-ray emissions, rotation, flares, and its appearance in science fiction. It also mentions the Living with a Red Dwarf program and the RCT telescope.

**Result**

Wolf 359 (GJ 406; CN Leo), at a distance of  $2.41 \pm 0.01$  pc, is the **nearest** star, after **a Cen** and Barnard's Star. Wolf 359 is a **chromospherically** active M6 V star with strong **H $\alpha$**  emission (Pavlenko et al. 2006; Mann et al. 2015) and moderate **coronal** X-ray emissions ( $L_X \approx 1-5 \times 10^{27}$  erg s $^{-1}$ —Fuhrmeister et al. 2007). The star's strong **chromospheric** emissions, fast **rotation** (see below), and frequent **flares**, indicate that Wolf 359 is a young star (age **less than** 0.8 Gyr). But the lack of **Lithium** lines and **moderately** large space **motions** ( $U, V, W = -26, -44, -18$  km s $^{-1}$ ) could indicate an older age. Wolf 359 also has a special place in science fiction **folklore**, as it is where the United Federation of **Planets** suffered a devastating defeat at the hands of the **Borg** Collective in 2367 (Okuda et al. 1999).

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**Common:** 72%, 159  
**Mid-Frequency:** 16%, 35  
**Rare:** 12%, 26  
**Suitability for general audience score:** 80  
**Number Of Words:** 220

**Download** **Share**

## Helpful reading

- The Science of Scientific Writing,  
Gopen & Swan
- Writing Science in Plain English,  
Anne Greene
- Scientific Writing & Communication,  
Angelika Hofmann



# Thanks!

## Any questions?

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