On January 28, 1986, the United States was shocked by the destruction of the space shuttle Challenger and the death of its seven crew members.

"The decision to launch the Challenger was flawed. Those who made that decision were unaware of the recent history of problems concerning the O-rings and the joint and were unaware of the initial written recommendation of the contractor advising against the launch at temperatures below 53 degrees Fahrenheit and the continuing opposition of the engineers at Thiokol after the management reversed its position. They did not have a clear understanding of Rockwell's concern that it was not safe to launch because of ice on the pad. If the decision makers had known all of the facts, it is highly unlikely that they would have decided to launch 51-L on January 28, 1986."—Report of the Presidential Commission on the Space Shuttle Challenger Accident*

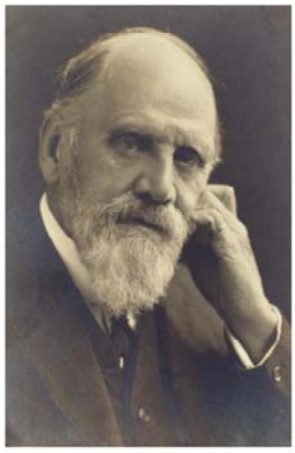
For a highly informative and irreverent inside look at the Presidential Commission deliberations, read *What do you care what other people think? Further adventures of a curious character*, Richard P. Feynman (W.W. Norton & Co, New York, 1988).

Today, we'll look at the three components of persuasion, how to establish credibility in science writing, and the ethics of using persuasion in science.

Persuasion in *science*?

It's not all about ***truth***.

Persuasion in *science*? Yep.

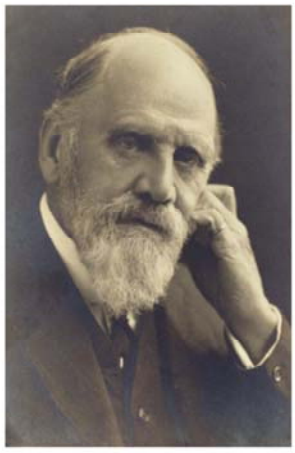


Sir Francis Darwin
Courtesy Down House, Kent

"In science, the credit goes to the man who convinces the world, not to the man to whom the idea first occurs."
— Sir Francis Darwin

Today, we would substitute "person" for "man," but that's not what Darwin, who was a product of a different place and time, said, and I believe people should be quoted accurately.—*cme*

Persuasion in *science*? Yep.



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Persuasion is a social interaction, as is doing science and engineering

- Persuasion is an essential part of the testing, dissemination, and advance of scientific knowledge
- Successful leadership, teamwork, and project management in science and engineering rely on the effectiveness of persuasion
- Commercial success depends on persuasion

Research is not complete, no matter how many experiments have been conducted, no matter how much analysis has been done, no matter many puzzles have been solved, until peers outside of your research team are ***persuaded*** that you've done something significant, your results are valid, and your conclusions are correct.

Not all persuasive failures have the tragic consequences of the Challenger

- But they do have real costs for scientists and engineers
- You paper doesn't get accepted for publication
- Your proposal doesn't get funded
- You don't get tenure
- You don't get hired for that job

Success in science and engineering *requires* good persuasive skills

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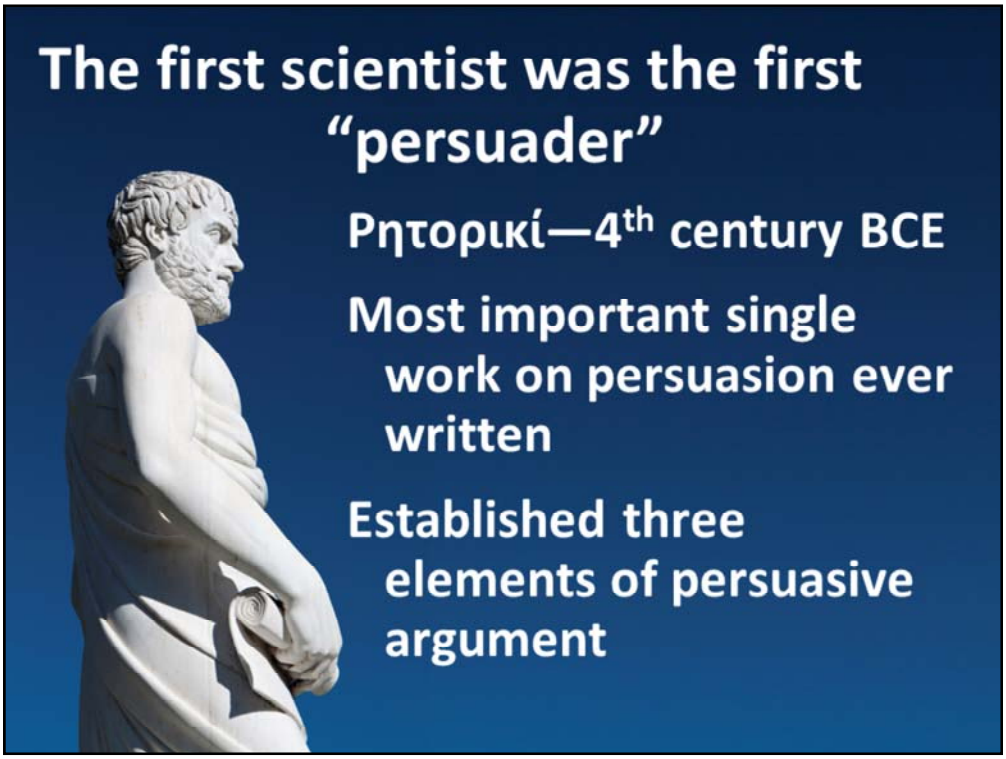
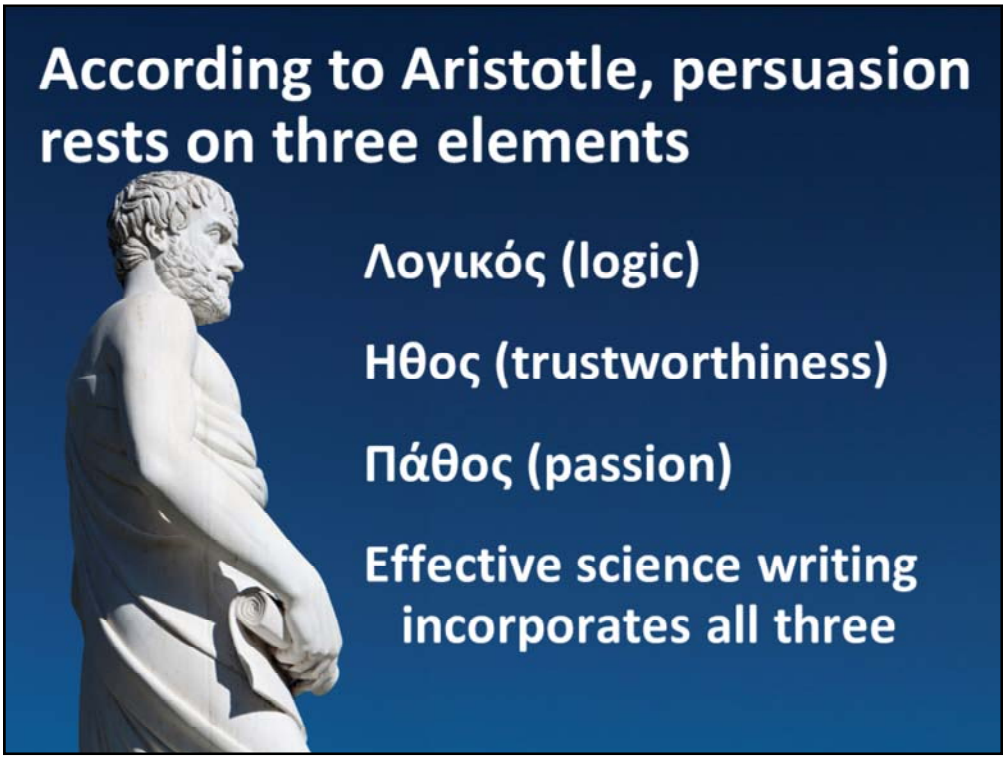


logik̲í prin gl̲óssa (loyeekee prin glōssuh)

Too often, scientists and engineers think of doing research and writing as discrete tasks that have little to do with one another. Today, I'd like you to think of them as a feedback loop, where progress in one informs and drives progress in the other.

From Peter Woodford: "Somehow the discipline of crystallizing a thought into a grammatical sentence with a beginning, a middle, and an end clarifies, sharpens, and delimits the thought.



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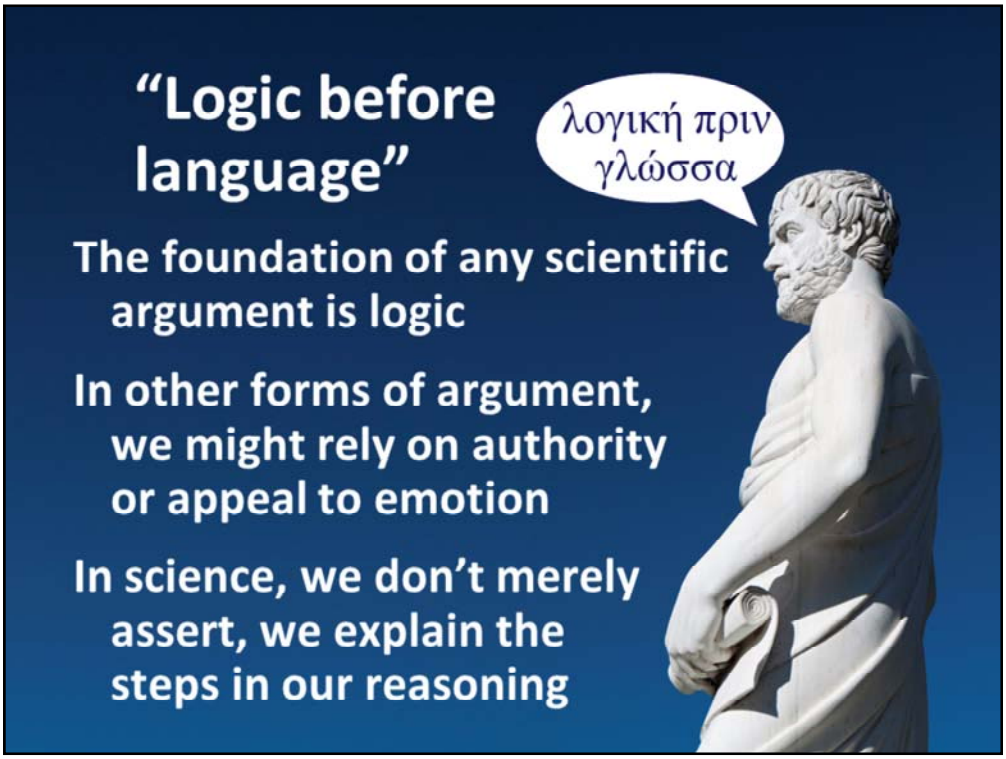

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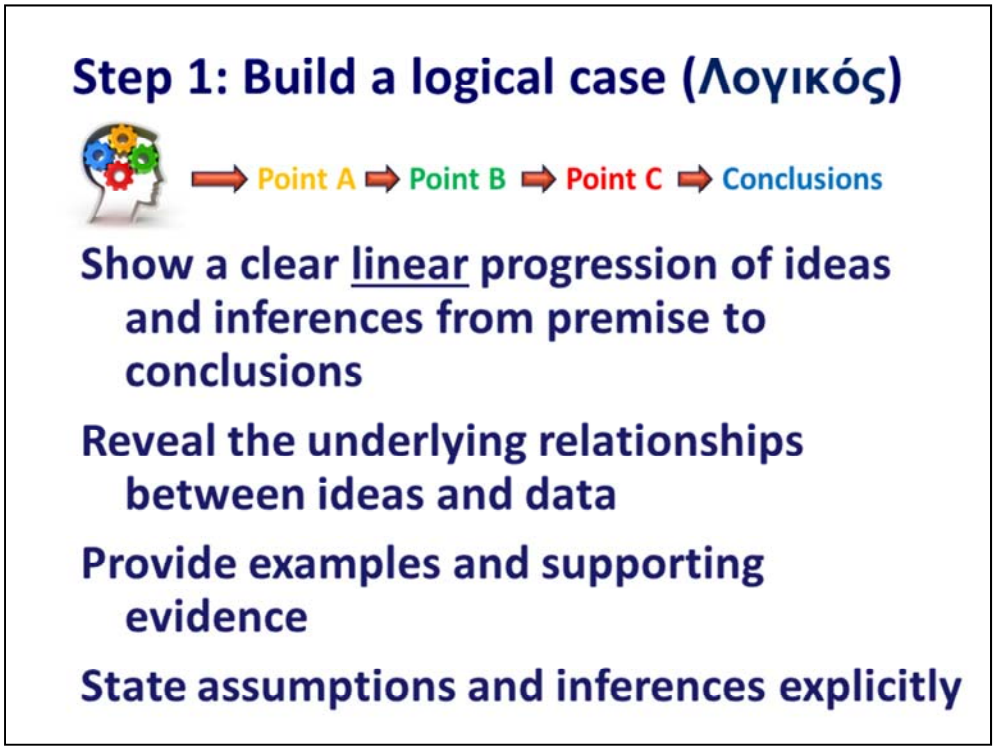
A persuasive argument shepherds the reader step by step along a path the writer has laid out

- **Shows a clear linear progression of ideas and assumptions and inferences from premise to conclusions**
- **No digressions or discursive material**
- **Now, let's apply Ari's three elements of persuasion to technical writing**

Next, arrange the points in a logical order so they provide a coherent storyline.

Think of this step as creating a map to guide your reader through your paper, proposal, or talk.

Each one of these points is going to be a signpost along the journey.



First, decide what conclusions you want your "audience" to reach—that the work you did was important, that the method you used was appropriate, that you actually measured what you think you measured, that your results are valid, your assumptions are sound, and your conclusions are supported by the evidence.

Make a list of all the important points that the audience must know.

Marshall supporting facts and explanatory information.

Arrange the main points and supporting details in a logical order, so that each moves the audience incrementally closer to the desired conclusion (outline!).

Think of the structure of your argument as a roadmap that is going to lead your reader to a predetermined destination. Create "sign posts" to guide the reader through your narrative.

"Sign posts" are reader cues such as graphical highlighting (boldface or italic), use of headings and subheadings, arrangement of text on the page, incorporation of figures and tables, and mathematical proofs.

Use transitional statements to guide the reader

Use *linking expressions*

Thus…	In addition to…
Secondly…	On the other hand…
Despite…	Furthermore…

Repeat a key word or phrase

…because of variations in room temperature and humidity, using automatic settings may not provide *adequate control of frost buildup*.

For more *precise control*, turn off the automatic defrost setting and run a manual defrost cycle as often as necessary to prevent ice buildup on the condenser unit.

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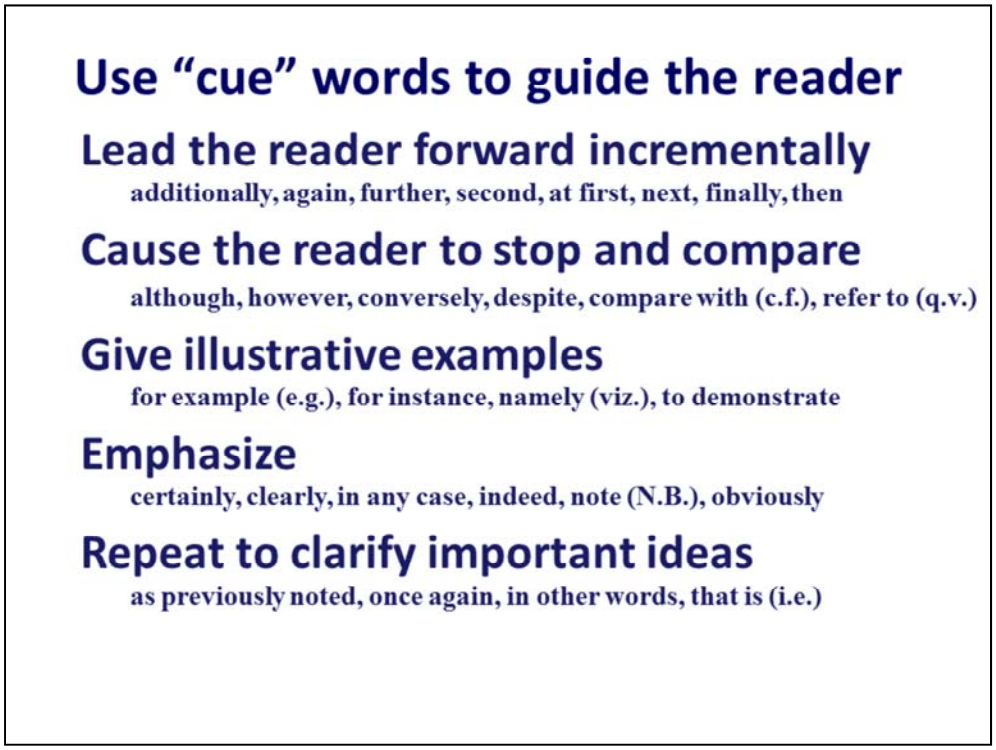

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Use "cue" words to guide the reader

Show a relationship

because of, not only…but also, attributable to, since, arising from, owing to, correlated with, orthogonal to

Introduce conclusions

accordingly, as a result, consequently, hence, therefore, thus

Summarize the main points

overall, in summary, to recap

Use transitional statements and reader cues as sign posts to guide a reader through your logical argument

First, decide what conclusions you want your "audience" to reach—that the work you did was important, that the method you used was appropriate, that you actually measured what you think you measured, that your results are valid, your assumptions are sound, and your conclusions are supported by the evidence.

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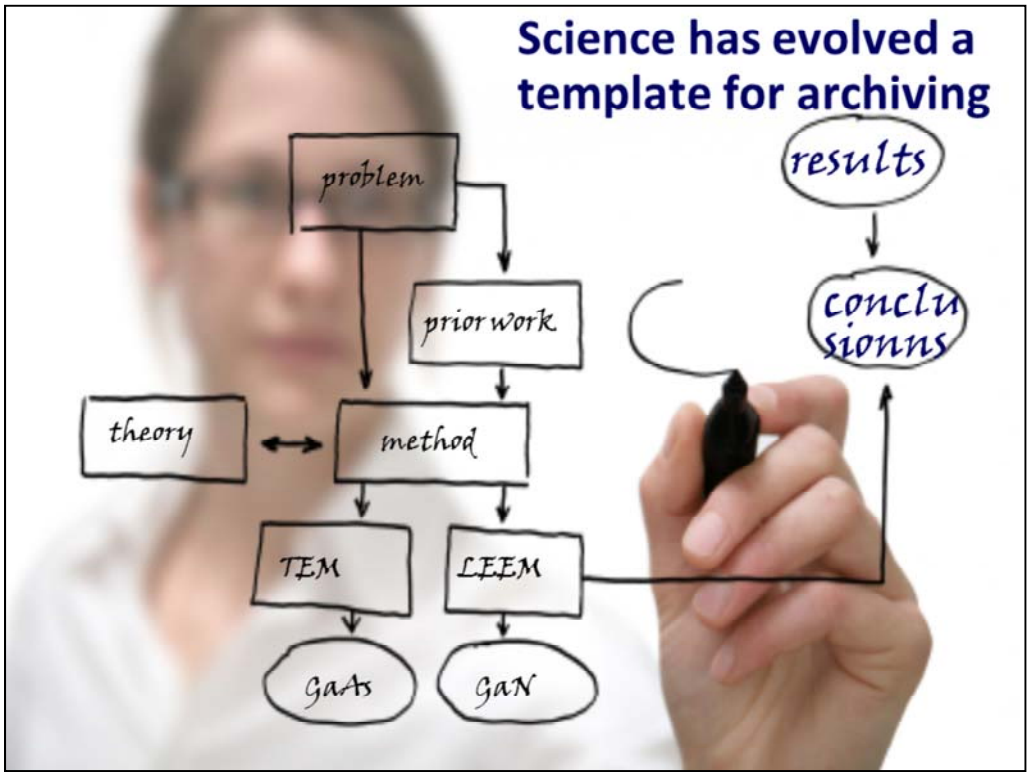
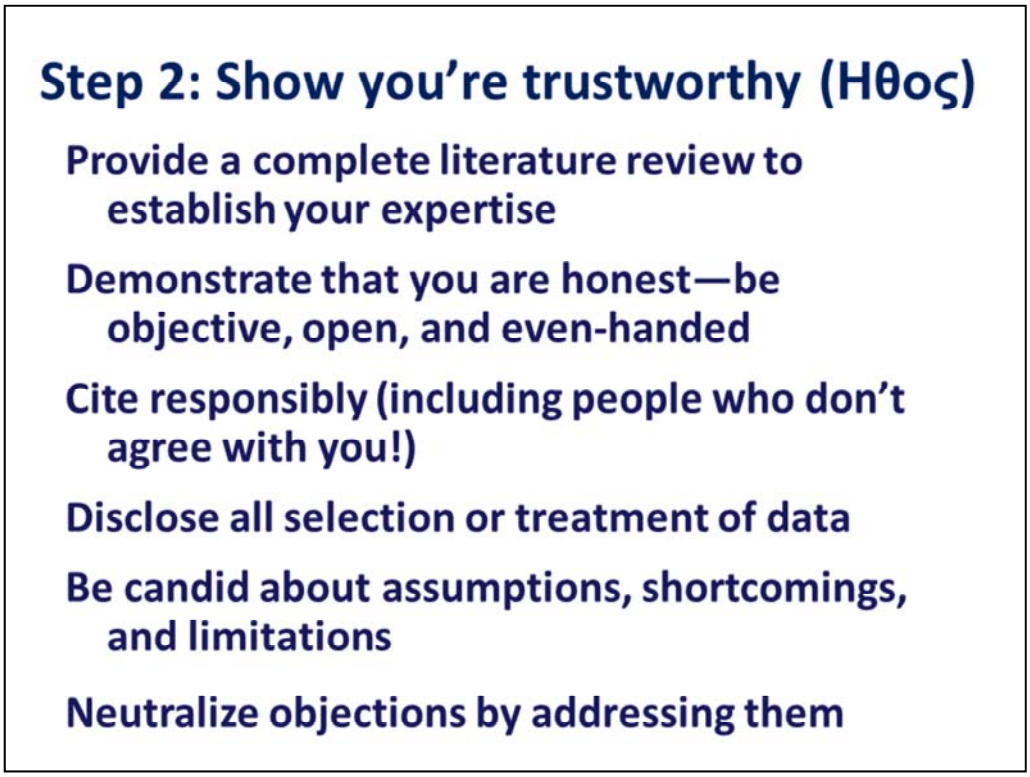


Science articles—and to a large extent, science talks—follow the same basic structure. Hew to it witlessly.

Title
Abstract
Background and Introduction
Methods
Results
Discussion
Conclusions
Acknowledgments
References
Appendices

Build your logical arguments around this formal (and mandatory) structure.



Add authority to your arguments:

Establish your credibility by demonstrating your familiarity with the problem (background and introduction section).

Cite the work and opinion of experts (references).

Don't hide things (methods/procedure section).

Don't overstate your claims or force your data (results section).

Anticipate questions and objections and candidly discuss opposing views (discussion section).

Acknowledge the contributions of others (acknowledgments section).

Evenhandedness is particularly important if your method or results are controversial.

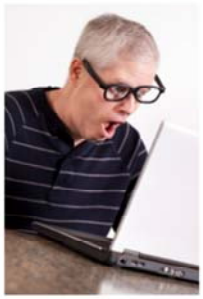
Step 3: Be passionate (Πάθος)

(This is where the scientists get really nervous)

Enthusiasm must be strongly coupled to reality

Use positive language and strong verbs

Don't overstate… but don't use wimpy qualifiers, either

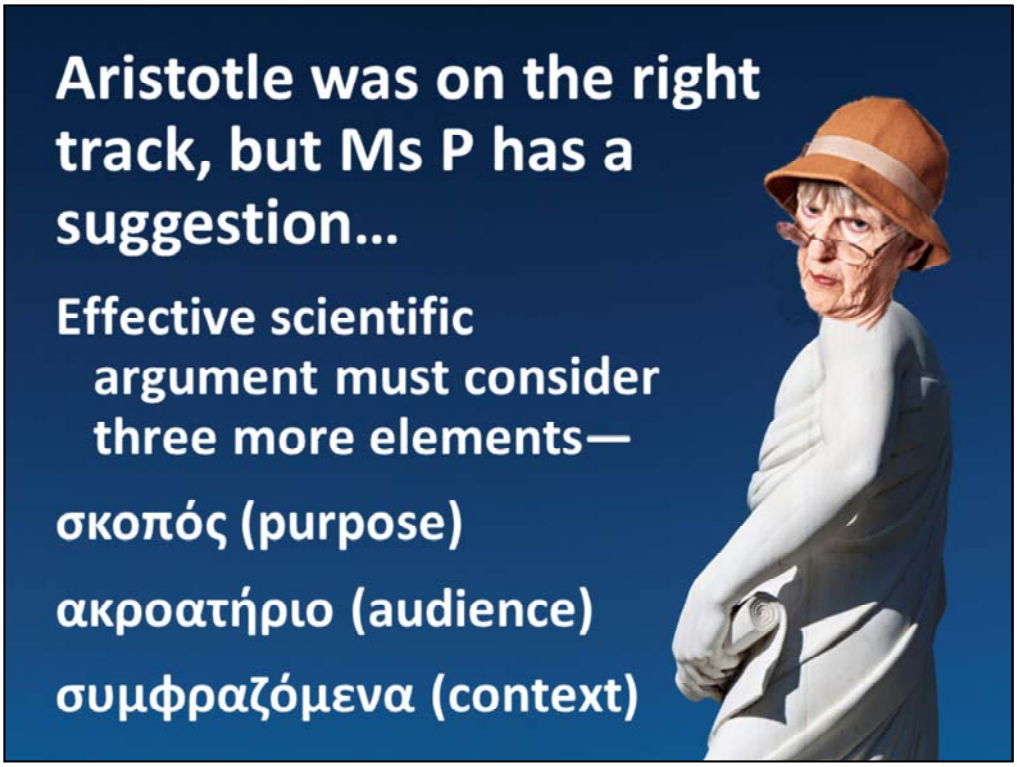


Scientists are suspicious about emotional appeals; calibrate your enthusiasm to what you can *prove*, not what you believe

Enthusiasm must be strongly coupled to reality, but a reader is unlikely to be enthusiastic about your work if you aren't.

Convey that your project is interesting and represented an exciting challenge.

Remember the words of Master Yoda—"Do or do not. There is no try."



Facts must be assembled into arguments.

Adapt to your audience; consider their level of understanding, preconceived notions, and motivation for reading or listening.

Scientists are suspicious about emotional appeals; temper your enthusiasm to what you can ***prove***, not what you believe.

Step 4: What is your purpose?

- Report new results
- Reinterpret other people's results
- Elicit feedback on a new idea
- Promote a new method
- Correct prior work
- Get a job
- Get an order
- Secure research funding

Your purpose affects your style of persuasion

Add authority to your arguments:

Establish your credibility by demonstrating your familiarity with the problem (background and introduction section).

Cite the work and opinion of experts (references).

Don't hide things (methods/procedure section).

Don't overstate your claims or force your data (results section).

Anticipate questions and objections and candidly discuss opposing views (discussion section).

Acknowledge the contributions of others (acknowledgments section).

Evenhandedness is particularly important if your method or results are controversial.

Step 5: Know thy audience!

Who is going to read this paper?

What do they already know? (words, concepts, methods, prior work)

What don't they know that I will have to explain?

What do they already believe?

Where might they become confused?

What words, figures, plots, tabular data will convince them?

What is their motivation for reading my paper or coming to my talk?

Add authority to your arguments:

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Evenhandedness is particularly important if your method or results are controversial.

Step 6: Consider the context

What is the medium?

- Peer-reviewed journal paper
- Abstract for a conference
- Technical report for other scientists and engineers
- Product specifications for the sales team
- Proposal to a funding agency or customer
- Formal conference presentation
- Job talk
- Informal seminar

What is the focus and scope?

What are the constraints (time, page limits)

Add authority to your arguments:

Establish your credibility by demonstrating your familiarity with the problem (background and introduction section).

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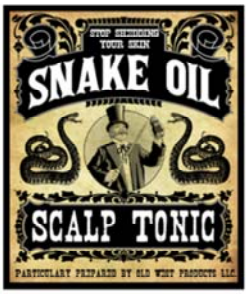
Persuasion is a powerful tool—use it judiciously and ethically



- Don't distort the facts
- Don't choose facts selectively
- Don't exaggerate or give deceptive emphasis
- Don't omit pertinent objections or counter-arguments

***But*—don't be afraid to persuade!**

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http://physics.illinois.edu/people/Celia/

Go beyond the "don't make things up" case.

And if you're not persuaded...come talk to me!

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