A discussion on the book “**Writing Science**” by Joshua Schimel

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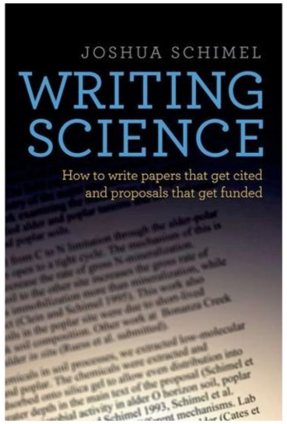
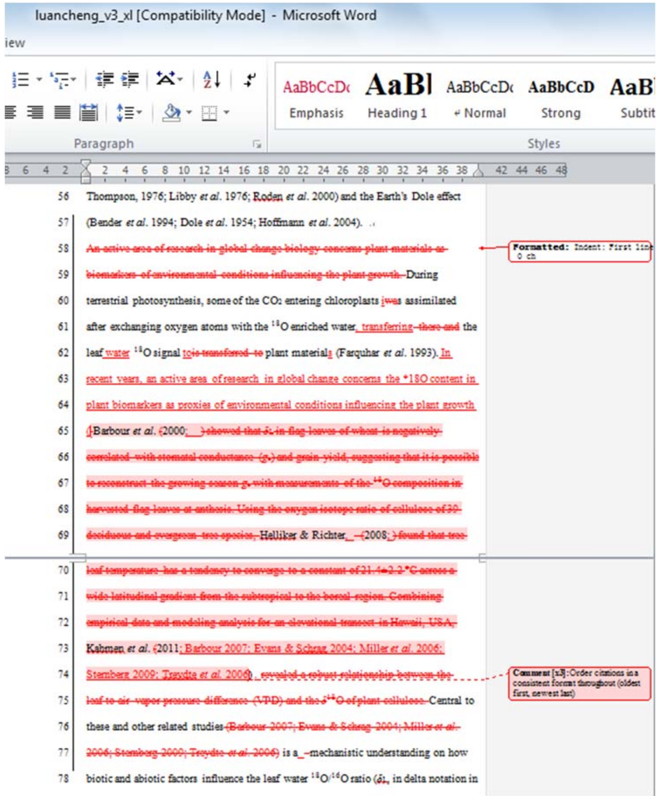


A. SCIENTIFIC WRITING VERSUS STORYTELLING

1. Writing in Science

- As a scientist, you are a professional writer.
- Success as a scientist is not simply a function of the quality of the ideas we hold in our heads, or of the data we hold in our hands, but also of the language we use to describe them.
- “publish or perish” is about surviving, not succeeding.
- You don’t succeed as a scientist by getting papers *published*. You succeed as a scientist by getting them *cited.*
- H-factor: if you have 10 publications that have each been cited 10 if you have times, you have an H of 10. If you have published 100 papers and none have been cited, H-factor -0.
- It is the author’s job to make the reader’s job easy.

My first SCI paper



My fourth SCI paper at its third version

My NSFC proposal…

2010.3 2010.7 2010.9 2011.3 2011.9



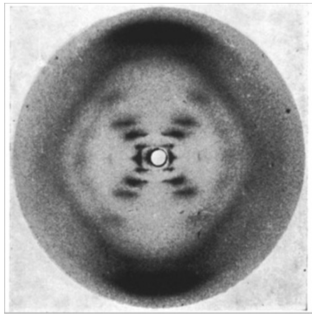


2. Science writing as storytelling

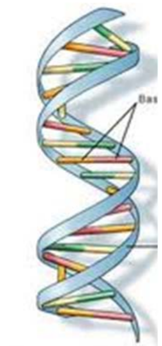
Finding the story

The role of scientists is to collect data and transform them into understanding.

A. Photo 51



B. Model of DNA



(Photo 51, Rosalind Franklin's critical X-ray diffraction image of crystallized DNA and the simple model of its structure developed by James Watson and Francis Crick)

Data → Information → Knowledge → Understanding

(The flow of science, from data to understanding)

3. Making a story sticky

- SUCCES
  - S: Simple
    - A simple idea contains the core essence of an important idea in a clear compact way. Simple ideas have power.
    - “it’s the economy, stupid” – Bill Cliton
  - U: Unexpected
    - Incremental science can be important, but really good papers go beyond incremental to *novel* – they say something new and unexpected.
  - C: Concrete
    - “If those who have studied the art of writing are in accord on any one point, it is this: the surest way to arouse and hold the reader’s attention is by being specific, definite, and concrete.”

3. Making a story sticky

- SUCCES
  - C: Credible
    - Science writing that isn’t credible is science fiction.
    - Credibility goes hand in hand with being concrete.
  - E: Emotional
    - Curious
    - Excitement
    - “what information do I have to offer?” to “what knowledge do I have to offer?”
  - S: Stories
    - Stories are modular; a single large story is crafted rom a collection of smaller story units, threaded together.
    - To write a good paper, you need to think about internal structure and how to integrate story modules.

B: HOW TO BUILD EFFECTIVE STORY ARCS

4. Story structure

- OCAR: Slowest – take your tie working into the story.
- ABDCE: Faster – get right into the action.
- LDR: Faster yet – but people will read to the end.
- LD: Fastest – the whole story is up front.

- LDR (Lead-development-resolution)
- LD (Lead-development)

OCAR Structure

- **Opening (O):** Whom is the story about? Who are the characters? Where does it take place: What do you need to understand about the situation to follow the story? What is the larger problem you are addressing?
- **Challenge (C)**: What do your characters need to accomplish? What specific question do you propose to answer?
- **Action (A)**: What happens to address the challenge? In a paper, this describes the work you did; in a proposal, it describes the work you hope to do.
- **Resolution (R)**: How have the characters and their world changed as a result of the action? This is your conclusion – what did you learn from your work?

ABDCE Structure

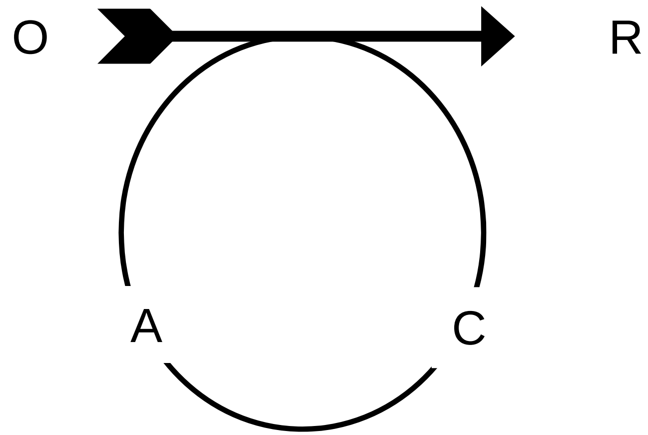
- **Action (A):** Start with a dramatic action to immediately engage readers and entice them to keep reading.

- **Background (B)**: Fill the readers in on the characters and setting so they can understand the story as it develops.

- **Development (D)**: Follow the action as the story development to the climax.
- **Climax (C)**: Bring all the threads of the story together and address them.

- **Ending (E)**: What happened to the characters after the climax? (This is the same as resolution.)

One aspect to both the OCAR and ABDCE structures is that they have a resolution that shows how overcoming the challenge has changed the characters and their world.



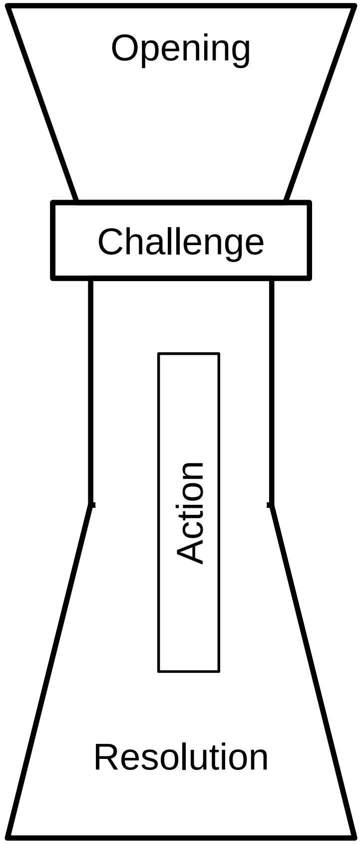
How an OCAR story makes a spiral: the story comes back to its starting point, but that point has moved.

Highlighting this spiral structure is key to making an OCAR or ABDCE story powerful.

Physical structure for science papers -- IMRaD

- Introduction:
  - *Opening*: the first paragraph that introduces the larger problem the paper is targeting. What is the context? What are the characters we are studying?
  - *Background*: What information does the reader need? Why it is important, what it will contribute to the larger issue?
  - *Challenge*: What are the specific hypotheses/questions/goals of the current work?
- Materials and Methods: What did you do?
- Results: Your findings.
- Discussion: the climax and the resolution. What did it all mean, and what have you learned? It often ends with a conclusions subsection that is the resolution.

Mapping OCAR onto IMRaD



Introduction: introduce characters and question. Narrow down to your specific questions

M&M and Results: What you did and what you found

Discussion: What it means

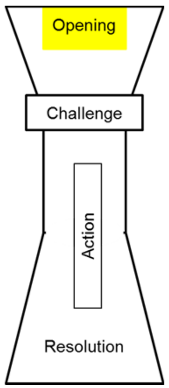
Conclusions: Take home message

The hourglass structure of a paper. It starts wide with the opening, narrows with the challenge and action, and widens back out again at the resolution.

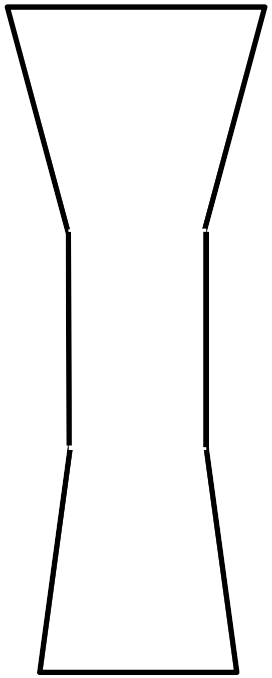
5. The opening

The most important sentence in any article is the first one.
--William Zinsser, *On writing Well*

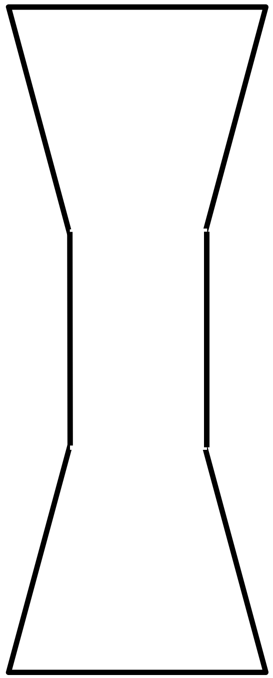
- Good openings:
  - Identify the problem that drives the research;
  - Introduce the characters;
  - Target an audience.
  - Example:
    - Since the late 1800s, N mineralization has been the perceived center point of the soil N cycle and the process that controls N availability to plants.
- Bad openings:
  - Misdirection
  - No Direction
  - Example:



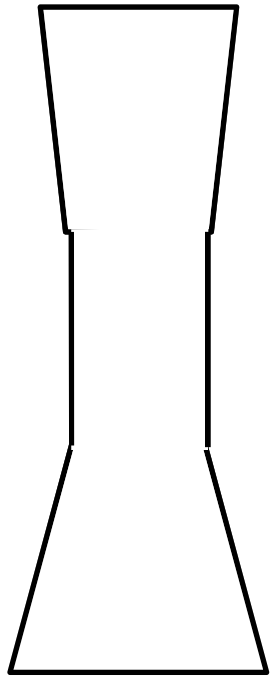
How wide should your opening be?
Matching the opening to the resolution.



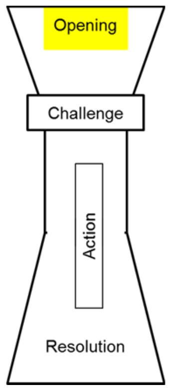
A. Opening wider than resolution: overpromising. Your readers will feel cheated.



B. On target. Your readers will be satisfied.

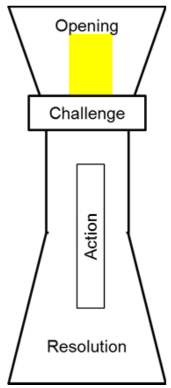


C. Resolution wider than opening: underpromising. Your readers won’t ever see that you are telling a story that would interest them.



6. The funnel: Connecting O and C

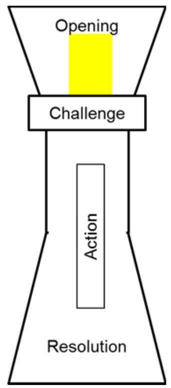
- A large problem (Opening) →A specific question (Challenge)
- The main body of the Introduction must connect these elements. It forms the funnel in the hourglass; it narrows the focus and leads readers from the general to the specific, drawing them along the story and framing in the knowledge gap.
- Example:
  - To understand the global climate system
  - To study bacteria in the frozen soils of the arctic tundra during winter
- Bad introduction
  - Failing to identify the problem
  - Offering solution before defining a problem



Introduction versus literature review

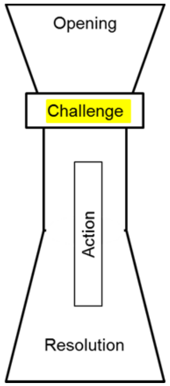
- **Review**:
  - Synopsize what we know about a topic.
  - Build a solid wall -- describing *knowledge.*
  - When you describe something we know, do you use it to identify the boundaries of that knowledge? If so, introduction, **if not, literature review**.
  - "Smith (2003) found X"

- **introduction**
  - Show us what we *don't* know and why it is important.
  - Focus on the hole in that wall -- describing *ignorance*.
  - **If so, introduction**, if not, literature review.
  - "X occurs (Smith 203)"



7. Challenge

- In the challenge, you describe the specific knowledge you hope to gain.
- This starts with the question that drove you to do the research. You did the work to discover the answer.
- Hypothesis
- Specific objectives
- Questions



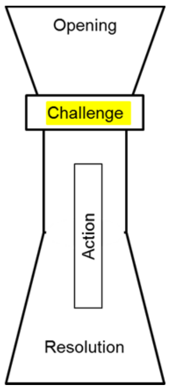
Questions versus objectives

Objectives

- “Our objectives were”
- Focus on the information they will collect.
- Weak science and weak storytelling.
- Doesn’t engage SUCCES
- Doesn’t create unexpectedness or curiosity.

Questions

- “Our question was”
- Focus on the knowledge they hope to gain.
- You have a question that drove your work.
- Make it clear.
- Then you can tell us how you answer it.



Good challenge versus bad challenge

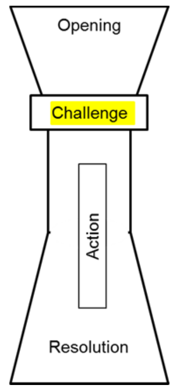
Good challenge

- “ to learn X, we did Y.”

- Present the question
- Lay out an approach to answering it.

Bad challenge

- “ to learn X…”
- Or “we did Y…”

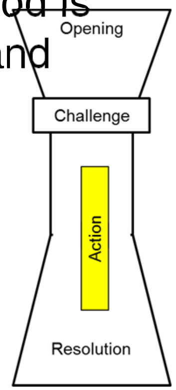


8. Action

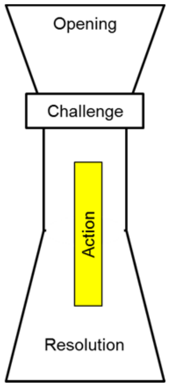
- In OCAR, action makes up the main body of the story and includes everything between the challenge and the resolution.

- Two distinct parts:
  - Describing what you did (Materials and Methods)
  - What came of it (Results and Discussion)

- Methods:
  - To serve the needs of all possible readers, the best way to describe a method is use a lead/development (LD) structure, providing an initial overview for all and then the details for those who need them.



Results and discussion



- To separate, or not to separate: that is the question

- Make the reader's job easy (our principle no.1): present results and interpretations in a way that best develops the story.

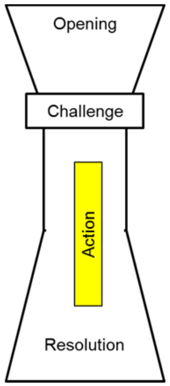
- Readers must be able to distinguish what you found from what you think.

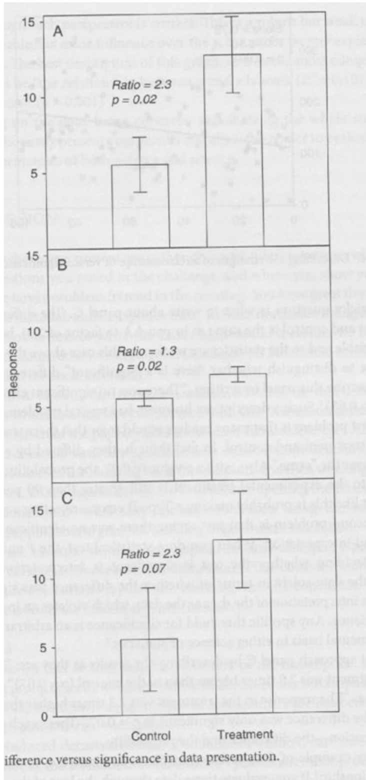
Results

- Choosing data to present
  - The most important decision in describing results is not *how* to present your data but *which* data to present.

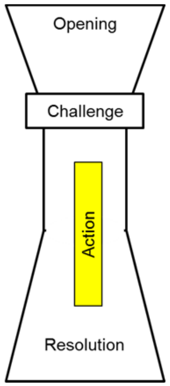
- Presenting data
  - To make it easy for the reader to understand your results, you need give us more than the raw data.
  - You need to synthesize them into a pattern and fit them into the larger story to provide context.
  - Most results call for an LD structure: first frame the major point or pattern, then flesh out the detail.

- Statistics and stories
  - The story is not in the statistics – it is in the data themselves.



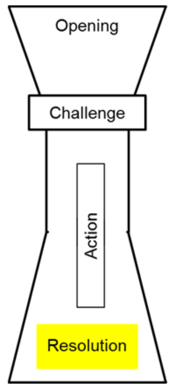


Discussion



- Discussion is
  - Where you present your thoughts and interpretations,
  - Where you answer the questions you posed in the challenge,
  - Where you show your contribution to the larger problem frames in the opening.
- Writing a good Discussion is *the* critical act of creativity in science that no book can teach.
- Both OCAR and LDR work well for the Discussion – they each provide a coherent structure that allows you to develop a clear and compelling story.

9. The resolution



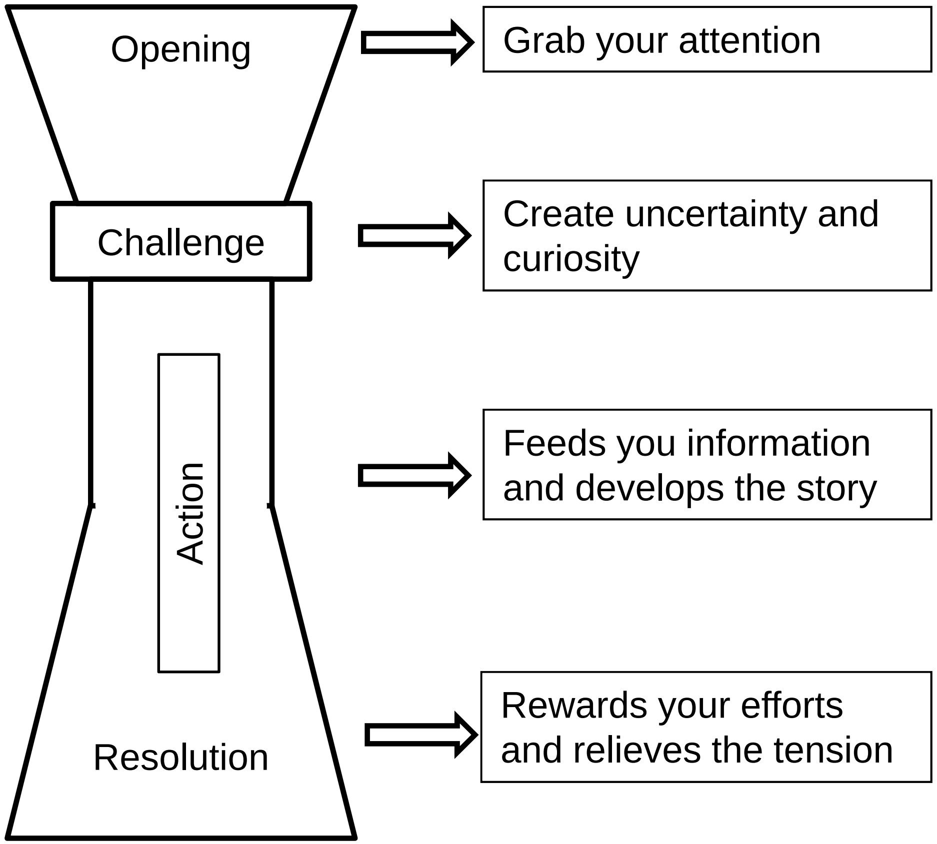
Good resolutions

- Shows us how our understanding of nature has advanced, and by offering new insights into the problem identified in the opening, **it wraps up the story**.
- Reiterates the action, answers the questions raised in the challenge, demonstrates how those answers contribute to the larger problem.

Bad resolutions

- Weak
  – Usually synopsize their results and then tell you that they are important, but don’t clarify how –they don’t answer the questions they were asking and don’t synthesize their information into knowledge.
- Distracting
  – Conclude with material that is distracting– ideas that should be in the Introduction or is already in textbooks and that neither synopsizes nor synthesizes the results.
- Undermining your conclusions
  – “more research is needed to clarify our findings.”

10. Internal structure



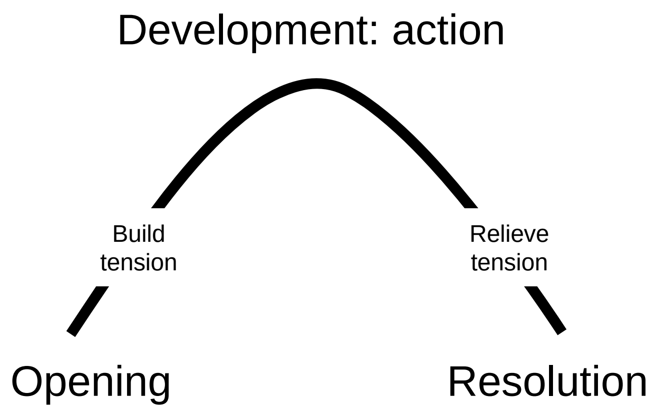


Figure 10.1. A story arc.

- **Introduction**: why you did the work—it opens, narrows, and resolves with the paper's overall challenge.
- **Materials and Methods**: starts with the study system, then the measurements, and wraps up with how you analyzed the data.
- **Discussion**: opens by restating the issue, discusses the evidence, and resolves with the paper's conclusion.

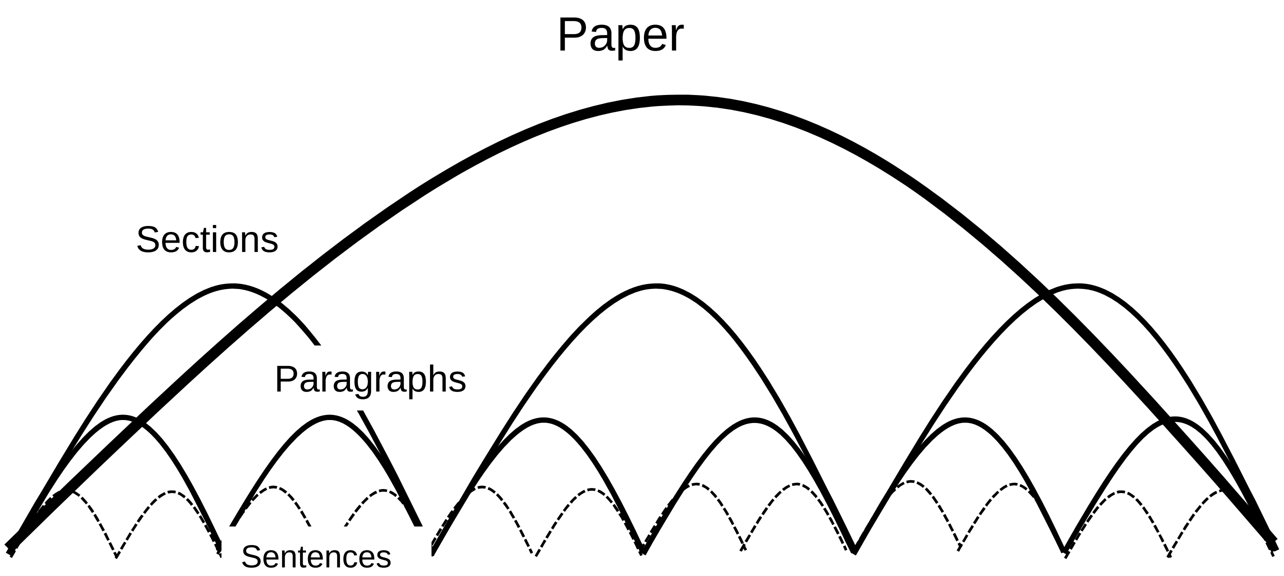


Figure 10.2. A story is a set of nested arcs.

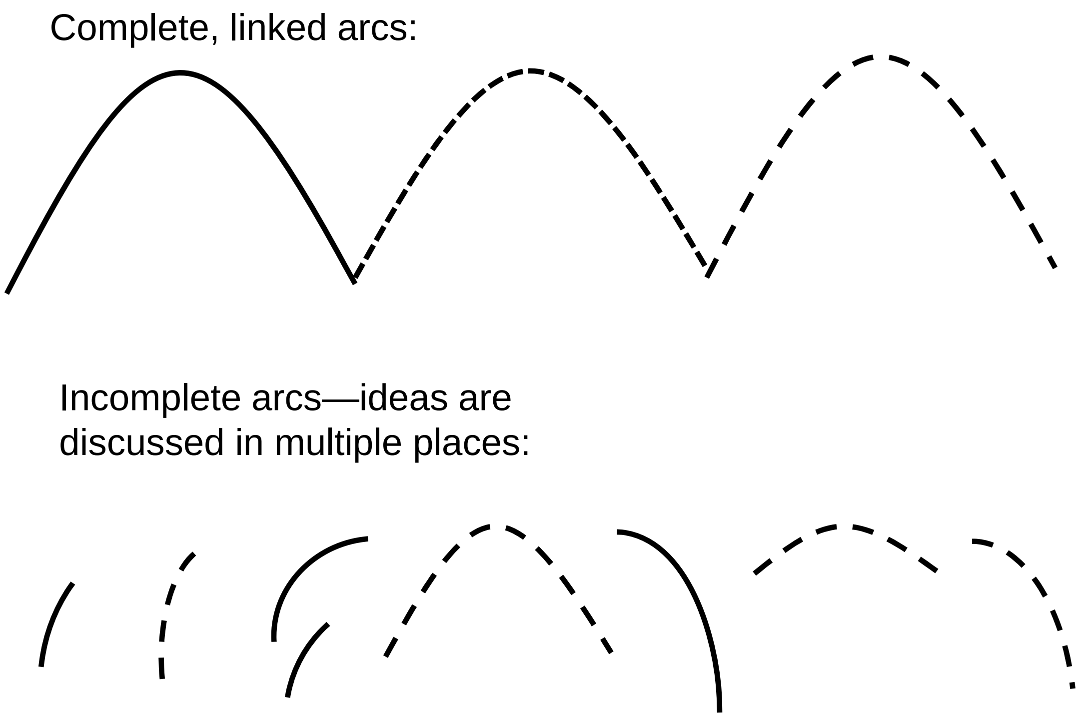


Figure 10.3. Complete versus broken story arcs: beginnings and endings are power positions.

- Creating arcs compartmentalizes your thoughts and makes them manageable.
- Effective arcs make it easier for readers to deal with multiple ideas in a single paper.
- Arc structure is effective as well because beginnings and endings are power positions.

Arcless writing

- California supports rich fisheries off its coast. The high productivity of fish is supported by high rates of algal production. Algal growth in the ocean is typically limited by nitrogen supply, but this is high off California because N-rich deep water wells up to the surface along the coast. This upwelling is driven by winds that push the south-flowing surface water away from the shore, allowing deep water to rise to the surface. These off-shore winds are driven by regional climate patterns, including El Nino, that are being intensified by the greenhouse effect, which results from increased CO_2 in the atmosphere. Increased CO_2 in the atmosphere also increases the amount of O_2 dissolved in the ocean, which reacts with water to form carbonic acid (H_2CO_2), reducing the ocean's pH. This reduced pH makes it hard for shell-forming organisms to make calcium carbonate shells, and so may reduce the productivity of important marine species such as abalone, oysters, and even sea urchins. Thus, increasing atmospheric CO_2 is going to have many important effects on marine ecosystems.

- California…fisheries
- Fish…algae
- Algae…nitrogen…upwelling
- Upwelling…winds
- Winds…climate
- Climate…greenhouse effect…CO_2
- CO_2…acid…reduced pH
- Reduced pH…damage to shell-forming organisms
- Thus, …CO_2 will affect marine ecosystems.

Thank you!