

Scientific Writing: Telling a Story



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Inspiration

“clear thinking can emerge from clear writing” – Scott Montgomery



Writing in Science

- Writing is as important a tool in your toolbox as algorithms, data structures, design patterns, etc.
- Improving your writing will help you become successful
- Writing forms the bridge to your audience

Remember: It is the author's job to make the reader's job easy

Writing vs. Rewriting

- Get something down on paper as fast as possible
- Then take this and revise.
 - Goal: each revision, or draft, is clearer and easier to understand
- This rewriting cycle develops both your writing and your thinking -> yielding clarity and power



Storytelling

- It is our job to communicate the story of our science.
 - This requires you to assess your data and evaluate the possible explanations consistent with existing knowledge and theory
 - The story grows from the data, thus we should not go into it with a story in mind before we collect the data.
- Our characters are not people (well sometimes) but rather code, statements, classes, objects, methods, build scripts, docker instances, algorithms, and variables (among others)
 - We develop these characters in our papers and we discuss them and what makes them tick
- We must do more than simply present facts



Finding the Story

- It seems reasonable to simply write a paper as follows:
 - outline everything you did
 - then say something about it
- But within this there is a story waiting to come out
- Our ultimate goal is not to simply present results
- Rather, we want to tell the story of the understanding we derived from them
- From the limits of our data, comes our story
 - What did the outliers tell us?

Aspects of Story Telling

- ① Content – what makes a story engage and stay with us?
- ② Structure – how do you put together that content to make it easy for us to get?
- ③ Language – how do you write the story in the most compelling ways possible?

Making a Story Sticky

Why do some ideas stay with you while others are eminently forgettable?

- Simple
- Unexpected
- Concrete
- Credible
- Emotional
- Stores



Making a Story Sticky

Simple (not simplistic)

- Simple ideas stick
 - contains core essence of an important idea
 - presented in clear compact way

Unexpected (novelty)

- Unexpectedness lies in:
 - Questions you ask
 - Interpretations you develop
- Goal is to highlight the unexpected knowledge
 - engage the readers curiosity

Concrete

- Connect readers to your concepts (abstractions and theory)
- Do this through the use of concrete examples
- Through this, the concept becomes concrete

Credible

- Credibility emerges from grounding our ideas in previous work
- Data credibility is established through describing our methods
- Conclusion credibility grows from credible data
- This all builds a chain extending from past work into future directions
 - Don't break the chain



Making a Story Sticky

Emotional

- Unexpected things create curiosity
- Use this to engage emotion
 - Shift from “what information do I have to offer?”,
 - To “what knowledge do I have to offer?”
- Thus, you must learn to excite your readers

Stories

- Stories are modular
 - A single large story is composed of smaller story units threaded together
- To write a good paper, think about
 - internal structure
 - integration of story modules

Story Structure - OCAR

There are four elements that underlie the structure of all stories (The OCAR Model):

- **Opening (O):**

- Whom is the story about?
- Who are the characters?
- When 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 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.

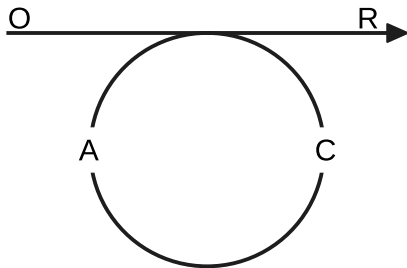
- **Resolution (R):**

- 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?



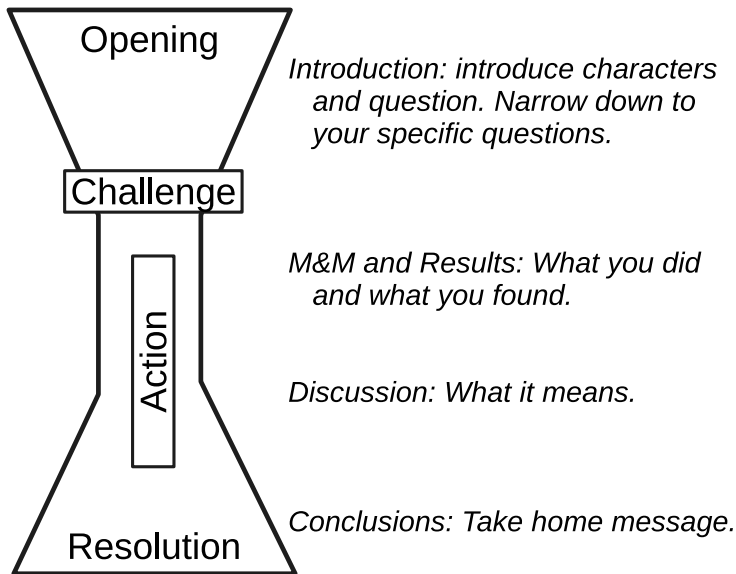
Story Structure

- We want and need to know how our characters have changed for a story to be satisfying
- Thus we must close the loop
 - A good story is a spiral
 - At the end it must come back to the beginning
 - But the beginning has moved





OCAR





The Opening

- You must start well.
- Your first sentences get readers moving and set the direction
- The opening begins with a single sentence but typically encompasses the first paragraph

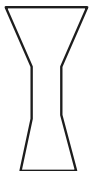
Bad Openings

- Misdirection
- No Direction

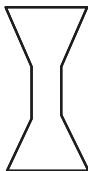


Targeting Your Audience

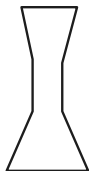
- Know your audience
- Tailor your opening to them
- For a very broad audience, use a two-step opening
 - ① Open with an issue for your target audience, but modulate it for the general audience
 - ② Redefine the focus as you develop the opening
- Your opening should only be as wide as the resolution allows



Opening wider than
Resolution: over-promising
Your readers will feel cheated.



On target.
Your readers will be
Satisfied.



Resolution wider than
Opening: under-promising.
Your readers won't ever see
That you are telling a story that
Would interest them



The Funnel

- The opening identifies a large problem
- The challenge defines a specific question
- The body of the introduction must connect these two
 - This is done through the framing of a knowledge gap.
 - Furthermore, this taps the U of SUCCES
- Remember to first define the problem, then propose a solution
- The goal of the background section should be:
 - To connect the introduction and challenge such that
 - Readers feel the questions you pose are obvious and essential



The Challenge

- Describe the knowledge you hope to gain:
 - First state your research questions
 - Then briefly summarize your approach
- **Good challenges**
 - Clearly state the objectives and questions
 - Clearly lay out the approach
 - Build unexpectedness and curiosity in the reader
- **Bad challenges**
 - Unclear
 - leave reader adrift
 - focus on objectives rather than questions



Action

- The main body of the story including:
 - Methods and Materials
 - Results
 - Discussion (most of it at least)
- In a proposal, this is a description of what you intend to do.
- This section gives your story structure and direction



Methods

- Meant to report the results you achieved and the methods used
- Should follow the Lead/Development (LD) structure
 - provide an initial overview for all
 - then the details for those who need them



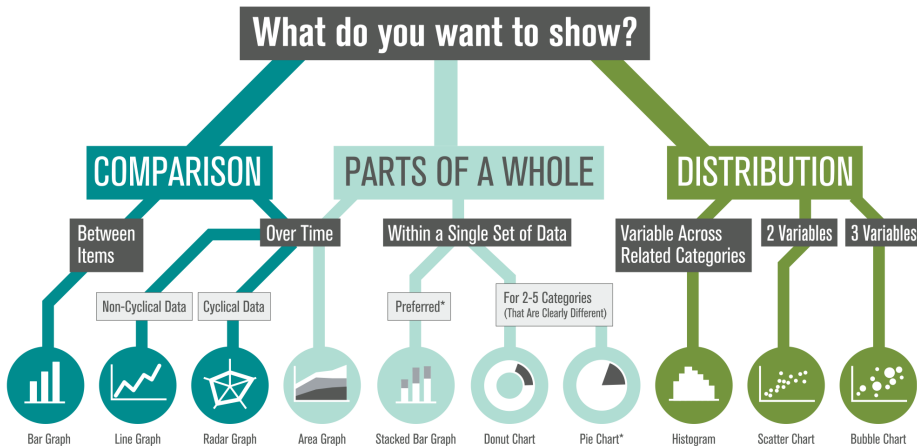
Results & Discussion

- Describe the outcome: your findings and interpretations
- Two core principles
 - ① Make the reader's job easy: present results and interpretation in a way that develops the story
 - ② Readers must be able to distinguish between your findings and your thoughts
- There are 3 types of material in a paper
 - ① Data: the actual results
 - ② Inference: clear and robust interpretations of data that any practitioner would draw
 - ③ Interpretation: your thoughts, hypotheses, and speculation about the results within the context of the larger problem



Presenting Data

- You can't show the raw data
- So select the data that confers the story





Statistics & Stories

- Statistics are quite useful
 - they allow us to distinguish treatment effects from random variation
 - they establish credibility of your conclusions
- Remember, the story is not the statistics, it is the data
 - make the stats support
 - focus on the data
 - your story stays engaging without forgoing rigor
- Statistics values (such as a p-value) are results
- Leave the significance tests to interpretation



Discussion

- This is where you present your thoughts and interpretations
- Presenting your answers to the questions
- Where you show your contribution to the larger problem framed in the opening
- This takes a bit of creativity



The Resolution

- This is your “Take-Home Message”, your strongest and most memorable words
- You want to
 - show how our understanding has been advanced
 - offer new insights into the problem
 - wrap up your story
- If you include anything but the new insight, then
 - you undercut the resolution
 - and with that, the entire paper
 - DON'T BLOW IT

Bad Resolutions

- Are Weak
 - they do not say something concrete
- Are Distracting
 - they neither synopsise nor synthesize results
- Undermine Your Conclusions

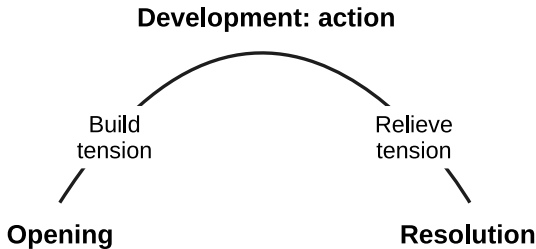
Fixing a Bad Resolution

- Pare away dead tissue
 - remove the fluff, distractions, and new ideas
- Condense to do the following
 - ① Synopsise the key results
 - ② Synthesize those results (show how they answer the questions)
 - ③ Show how this contributes to solving the larger problem



Internal Structure

- OCAR defines the overall structure
 - Opening - grabs attention with characters and setting
 - Challenge - creates uncertainty and curiosity
 - Action - provides info and develops story
 - Resolution - rewards the reader and relieves the tension
- This creates an overall story arc





Are there any questions?