

Anatomy of a research paper

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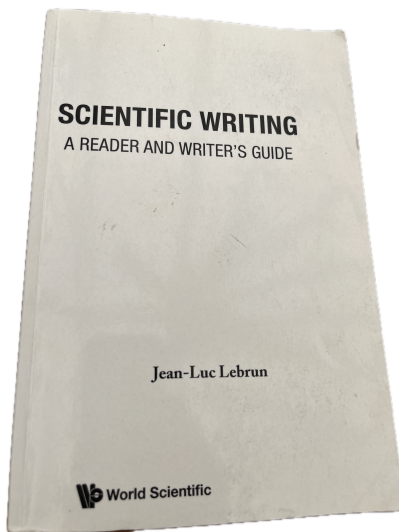
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Abstract:

This talk discusses how to structure a research paper, which in medical speak is like learning about the anatomy of a human body. Based on the concepts presented in the book, 'Scientific Writing: A Reader and Writer's Guide' by Jean-Luc Lebrun, I discuss why the title is declared as the face, the abstract is the heart and the introduction is compared to the hands. The visuals, e.g., tables and diagrams, presented in a paper are termed as the vocals and the conclusion is labelled as the smile on a human face. The talk is thus aimed at early career researchers in medical science and it is hoped that more analogies may be discovered with active participation from learned members of the audience.

Anatomy of a research paper



- **Anatomy?**

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Materials taken from Jean Luc Lebrun's book (2007).

Parts of a research paper

- Title



- Abstract



- Introduction



- Headings/Sub-headings



- Conclusion



Title: The face of your paper



- Your face is unique - and so should be the title.
- The title obviously gives a first impression of your contribution.
- It catches the attention of the reader and states the nature of your contribution.
- The reader will decide whether to read any further.
- The title is also entered into various databases of articles on a topic or subject.

Title: The face of your paper ...

- The title should be clear to both experts and non-experts.
- Add a verb to give energy boost, e.g., we are doing something or a new therapy improves the old.
- Place contribution upfront if possible with some adjectives and numbers to describe the strong point of the article.
- For example, a fast and highly efficient technique cures most patients in a few days..

Title: The face of your paper ...

- A title is **UNIQUE**. It differentiates your title from all others (present or future).
- A title is **LASTING**. Try not to use new in it. A title may outlive you. Ask Darwin!
- A title is **CONCISE**. Some keywords are overly detailed. Remove the details if your title is unique without them.
- A title is **CLEAR**. Avoid long modified nouns (a major source of imprecision and misunderstanding).
- A title is **EASY TO FIND**. Its keywords are carefully chosen.
- A title is **HONEST** and **REPRESENTATIVE** of the contribution and the paper. It sets the expectations and answers them.
- A title is as **CATCHY** as can be. Remember, you only have one chance and 2 seconds to interest the reader.

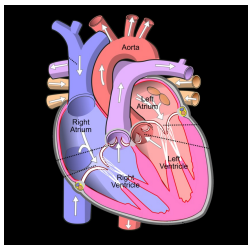
Title: The face of your paper ...

- A shorter title is more attractive than a longer one
- So is a more general title
- Include verbal forms (energy) and adjectives (strength)
- Careful choice of keywords to attract attention and fuel curiosity.
- Avoid questions.

Smart choice of keywords

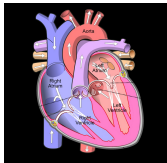
- General - breadth (Domain/Genre)
- Intermediate
- Specific - depth (particular topic)
- It is a good idea to choose a mixture of keywords from the general and specific categories.

Abstract: The heart of your Paper



- The heart plays an essential role in the human body.
- The essence of an article is its *abstract*.
- *The heart always lives for the present.*
- An abstract is always written in the **present tense** to keep it fresh and current.
- The heart has four chambers. The abstract is also composed of four easily identifiable parts.

Abstract: The four parts of an abstract



- 1 What is the problem? What is the topic of this paper?
- 2 How is the problem solved (methodology)?
- 3 How good is the solution? What are the specific results?
- 4 So what? How useful is this to science or to the reader?

- Abstracts having less than four parts are less informative and are of less value to the reader.
- Remember: The reader decides whether to read the rest of the paper depending on the quality of the abstract.
- Next: Coherence between Abstract and Title:

Title and Abstract coherence

- Having read your title, the reader expects to learn more about the topic in the title as soon as possible.
- Count the words, T , (not the articles, *a*, *an*, *the* and the prepositions (*of*, *on* etc.) in the title.
- Count the words, U , which are present **both** in the first sentence of the abstract and the title. Calculate the percentage $100 \times U/T$.
- The ideal percentage of overlapping words should be between 30–80%. Percentages outside this range indicate problems.

Title and Abstract coherence

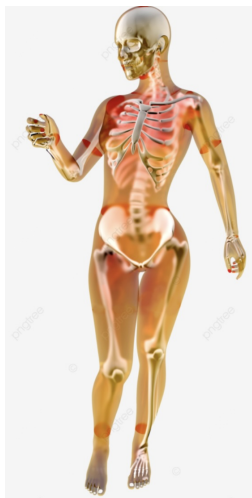
- **0%** The first sentence deals with generalities loosely related to the topic of the paper. Re-write the sentence.
- **20%** The first sentence contains one or two title words. This can be fine as long as the sentences 2 and 3 mention most of the other title words. Otherwise, the background is too long and, as a result the abstract lacks conciseness.
- **90%-100%**. Not ideal again. The first sentence is almost a repeat of the title. Why repeat? The reader expects to learn more - not to be bored by the same words.

The first sentence of the abstract should contain at least one third of the words in the title. The title merely whets the appetite. The abstract expands with more details.

Title and Abstract coherence

- An abstract is COMPLETE with four parts.
- An abstract is TIED TO THE TITLE. All title words are found in the abstract.
- An abstract is CONCISE. It is not longer than necessary.
- An abstract is STAND-ALONE. It lives by itself in its own world: data bases of abstracts, journal abstracts. It needs nothing.
- An abstract is REPRESENTATIVE of the contribution. It sets expectations for the reader.
- An abstract is PRESENT. Real News.

Headings/Subheadings: The skeleton of your paper



- The skeleton gives a frame to the body.
- Without it, the human would be a jellyfish.
- Composed of headings and subheadings set in a logical order, the structure reinforces the scientific contribution.

Headings/Subheadings: The skeleton of your paper

- The skeleton is standard, but it allows for variations in shape and size.
- Headings are generally the same from one article to the next (introduction, methods, discussion, conclusion), but subheadings differ.
- The most sophisticated parts of the skeleton are also the most detailed (backbone, metacarpus, metatarsus).
- The most detailed part of a structure contains the largest amount of contributed details.

Three principles of a good structure

- 1 The contribution guides its shape.
- 2 Title words are repeated in its headings and subheadings.
- 3 It tells a story clearly and completely in its broad lines.

By studying the structure of your paper, you may be able to identify important problems:

- Is it too complex?
- Is it too detailed?
- Too premature?
- Too shallow?

Examine an example structure

Title: Nonlinear *finite element simulation* to elucidate the efficacy of *slit* arteriotomy for end-to-side *arterial* anastomosis in microsurgery. ¹

1. Introduction
2. Mechanical factors underlying *slit* opening
3. Methodology for computer simulation
 - 3.1 Reference configuration for the *finite element* model
 - 3.2 Geometry details and boundary conditions of the *finite element* model in the reference configuration
 - 3.3 Hyperelastic material for the *arteries*
 - 3.4 *Simulation* procedure for the operation
4. Results and discussion
5. Conclusion

References

¹ Reprinted from Gu, Chua, Tan and Hung (2006) published in *Biomech*, **39**, 435-443.

Examine a structure

- Title: “Nonlinear finite element simulation to elucidate the efficacy” **[Contribution]** of slit arteriotomy for end-to-side arterial anastomosis in microsurgery. **[Context]**
- Standard headings: ‘Introduction’, ‘Results and discussion’, and ‘Conclusion’.
- Headings 1. and 2. cover the background. They have no subheadings. Headings 4 and 5 have no subheadings.
- Heading 3 dominates this structure. With four subheadings it provides much detail of the contribution.
- A structure should be the most detailed where the author has the most to write about, namely the scientific contribution of the paper.

Problematic structures

- 1 When excessively detailed parts do not contain much contribution the structure has a problem.
- 2 When headings and subheadings are disconnected from the title of a paper, the structure has a problem.
- 3 When headings and subheadings read in sequence tell a nonsensical story, the structure has a problem.

Recommendation: Read just the bare-bone Contents of the article and see if there are any obvious problems.

Qualities of a structure

- A structure is **INFORMATIVE**.
- A structure is **TIED TO TITLE AND ABSTRACT**. Keywords from the title and abstract are found in the structure.
- A structure is **LOGICAL**. A reader is able to see the logic of the order chosen.
- A structure is **CONSISTENT** at the syntax level. Each parent heading has more than one child subheading. Syntax is parallel.
- A structure is **CONCISE**. Neither overly detailed nor too condensed. The structure helps the reader discover the essential.

Introduction: The hands of your paper



- *Extended hands welcome. They invite to enter and guide someone unfamiliar with a new place.*

- The introduction plays a similar role.
- It provides guidance, greets, and introduces a topic not familiar to the reader.
- *Hands point to something worthy of attention, and invite the eyes to follow.*
- The introduction also points to the related work of other scientists.

Introduction: The hands of your paper

- It is usually difficult to write the introduction.
- Some authors keep it short: a concise paragraph to describe and justify the problem, a brief related work section to insert many references, and a final paragraph to introduce the main headings that follow.
- This would be problematic for many readers with a significant knowledge gap.

Introduction: The hands of your paper

- It is safe to assume that many scientists (a reasonable 40%) will require an introduction to your paper.
- Could reviewers be among them?
- They could be. Therefore, write an introduction that will bridge their knowledge gap, otherwise they will not be able to evaluate your paper correctly.
- Reviewers have veto power over the selection of your paper for publication!

Introduction: The hands of your paper

- Read the title and abstract. Write the main question they answer. Is this question clearly stated in your introduction?
- Now that you know the main question, include it in your introduction as soon as you can.
- It helps reviewers and readers understand the problem in a clear, attention-grabbing, and succinct way.
- It helps you to remain focused.
- Thus the Introduction answers key reader questions.

Main questions to answer in the introduction

- 1 **Why now?** Perhaps, because previous studies produced conflicting results.
- 2 **Why this?** Because, it was challenging.
- 3 **Why this way?** Because, it worked more widely or in a better way.
- 4 **Why should the reader care?** Because, it can do a better job or estimate/predict something better.

Reviewer's questions

- 1 Is the problem good and is solving it useful?
- 2 Is the solution new, clear, and effective compared to others?
- 3 Is the solution best one for this problem?
- 4 How does this paper help the readers of the journal?
 - The authors have to keep both reader and reviewer in mind when writing the introduction.
 - The introduction sets the foundations of your credibility.
 - Intellectual honesty needs to be demonstrated.
 - The reader would like to know the scope of your work.
 - Because, they want to benefit from it.

The introduction is active and personal

- The introduction is the place to write about your findings and your reasoning in story form.
- Because this story is about you, make it lively, engaging and personal.
- Use pronouns such as *we* or *our*.
- It is okay to use the passive voice in the rest of the paper.
- The introduction is the story of “what’s” and the “why’s”; it is a story, not a report.
- This is the one place in the whole paper where you, as a writer, can relax and write in a way very close to the way you would write to a friend, your friend the reader, to whom you offer your contribution in the hope it will be useful.

The introduction is engaging and motivating

- It engages and motivates readers to read the rest of the paper.
- After reading it , they must be “fired up”, wanting to know more.
- If everything goes well, readers will appreciate you as a writer, not just as a scientist.

An example story

1. My father ♠ is on the front lawn cleaning the mower.
2. My sister ♦ is in the back kitchen making a cake.
3. My mum ♥ has gone shopping,
4. I ♣ am playing my electric guitar in my bedroom.
 - Do you like my story? No?!!!
 - It's a great story. What's that you are saying?
 - My story has no plot?
 - Of course there is a plot! See, it describes my family's activities, starting with my father.

The story re-written

I'm so excited. I'm going to tell you a great story. My father ♠ is on the front lawn cleaning the mower. And do you know what that means? Trouble! He hates it. He wants everyone to help him. but because he wants us to stand there and watch idly while he works. So my sister ♦ is taking refuge in the back kitchen and plunging her hands in flour slowly to make a cake. My mum ♥ has suddenly discovered that she is missing something or the other, and has rushed out to shop, saying she'll be gone for an hour or so. As for me, ♣ I am in my bedroom playing the electric guitar with my amplifier at maximum volume.

The story told with a common thread

- A thread that links all the parts together is necessary to make an interesting story plot.
- The difference is striking, is it not?
- The story has a direction and its parts are all connected.

Things to avoid: Plagiarism

- 1 Just changing words and altering sentences is not good enough.
- 2 Plagiarism is very subtle.
- 3 Plagiarism is often due to a less than perfect methodology to collect and annotate the background material.
- 4 Keeping relevant documentation about the information source when capturing information electronically is simply good practice.

Things to avoid: Imprecision

Words that are indicators of a lack of precision in scientific writing.

Typically	A number of	Several	Many	Most
Generally	The majority of	Less	Others	A few
Commonly	Substantial	Various	More	The main
Can / May	Probably	Frequent	Often	...

Things to avoid: Judgemental Adjectives

- 1 Some adjectives and adverbs are dangerous when used in the related works section of your paper.
- 2 The danger comes from their use in judgemental comparisons.
- 3 Adjectives such as poor, good, fast, faster, not reliable, primitive, naive, or limited can do a lot of damage.
- 4 They make your work look good at the expense of others who came before you.

Avoid direct judgement

- 1 State that your work agrees (disagrees) with another paper's conclusions, or state that your results are coherent with (different from) those found in another paper.
- 2 Use facts and numbers (quantitative instead of qualitative comparisons).
- 3 Define your uniqueness, your difference (nothing is comparable to what you do).
- 4 Quote another paper that independently supports your views.

Qualities of an introduction

- An introduction is MINDFUL. The author makes a real effort to assess and bridge the knowledge gap.
- An introduction is STORY-LIKE. It has a plot that answers all the “why” questions of the reader one by one.
- An introduction is LOGICAL. A reader is able to see the logic of the order chosen.
- An introduction is AUTHORITATIVE. References are accurate and numerous, comparisons are full of facts (not judgemental), related works are closely related, and imprecise words are absent.
- An introduction is COMPLETE. All “why’s” have their “because”. The key references are mentioned.
- An introduction is CONCISE. No considerable or vacuous beginnings, no excessive details. etc.

Visuals: The voice of your paper

- The voice gets out of the body. It is not necessary to see the body to hear its voice.
- A voice has its own language, a universal and wordless language, like that of a child who babbles, laughs and cries.



- A voice attracts attention; it announces, it warns.

- It is a substitute to writing: one can read a book or listen to an audio version.
- Visuals have their own language: the universal language of graphic arts.

Functions of visuals

To compare and contrast	To represent complexity
To give precision and detail	To provide context
To summarise	To reveal sequence
To classify	To reveal patterns
To establish relationships	...

Purpose of the visual for the reader

- 1 It allows self-discovery of the paper.
- 2 It helps readers verify the written claims of the writer.
- 3 It saves reading time by allowing faster understanding of complex information and faster understanding of problem and solution.
- 4 It provides a direct (shortcut) and pleasurable (memorable) access to the writer's contribution (in an increasing number of scientific journals, the table of contents is visual).

Purpose of the visual for the writer

- 1 It makes the paper more concise by replacing many words, particularly in the introduction where it provides fast context, and helps bridge the knowledge gap.
- 2 It motivates readers to read more, yet allows them not to read all.
- 3 It provides compelling evidence, in particular evidence of contribution.
- 4 It enables the writer to represent complex relationships succinctly.
- 5 It (re)captures the reader's attention and improves memory recall.

Qualities of a visual

- 1 A visual is SELF-CONTAINED. Besides the caption, no other element is necessary to understand it. The caption and the visual answer all reader questions.
- 2 A visual is CLEAR. It has a structure, it is readable, and it includes visual cues to help readers focus on key points.
- 3 A visual is CONCISE. It contains no superfluous detail. It cannot be combined with other visuals without loss of essential information or clarity, nor can it be simplified.
- 4 A visual is RELEVANT. It is essential to the purpose and the contribution of the writer. It does not distract the reader.

Checklist for visuals

Examine each visual in your paper.

- Is it concise?
- Can you hide details in appendices or footnotes?
- Is the visual essential?
- Is it understandable to a reader who is not an expert in your field?
- Is it autonomous and understandable without any support from your main text?
- Should it appear earlier or later in the paper?

Conclusion: The smile of your paper



- Whenever the structure takes shape, the writer feels the joy of the potter seeing the clay change into a vase - most fittingly with a smile!
- The part of the body that best represents the conclusion is the smile!
- Future works: My work ends here, and now yours starts.

Purpose of the conclusion

For the reader:

- 1 It brings better closure to what has been announced in the introduction by contrasting pre-contribution with post-contribution. What was unproven, unverified, unexplained, unknown, partial, or limited is now proven, verified, explained, known, complete, or general.
- 2 It allows readers to understand the contribution better and in greater detail than in the abstract so as to evaluate its usefulness to them.

For the writer

- 1 It restates the contribution, with a particular emphasis on what it allows others to do.
- 2 It proposes new research directions to prevent duplication of effort or to encourage collaboration.

Qualities of a conclusion

- 1 A conclusion is **POSITIVELY CHARGED**. It maintains the excitement created in the introduction.
- 2 A conclusion has **PREDICTABLE** content. There are no surprises. Everything has been stated in the other parts of the paper.
- 3 A conclusion is **CONCISE**. Restate the contribution. Close the door. Open new doors.
- 4 A conclusion is **COHERENT** with the title, abstract, and introduction. It is a part of one same story.

The reader is always right!

- 1 Value your reader friends. They spend time to read your paper.
- 2 That time is their gift to you. Accept that gift with a grateful heart, and accept their remarks without reservation.
- 3 Do not take negative remarks personally; instead, consider them as golden opportunities towards improvement.
- 4 Do not try to justify yourself because, in the end, the reader is always right.
- 5 Accept readers' questions, and do not think that answering them face to face will help you.
- 6 Readers of a scientific journal do not have the privilege of having you by their side to explain.
- 7 Just take note of the remarks and questions, and work to remove whatever has caused your reader friends to stumble. On occasion, thank them for their help.
- 8 Being French, I recommend giving them a bottle of red Bordeaux for their services, but feel free to offer other vintages or to offer to review their own papers.

- 1 Let your introduction convey a research that is exciting, and let your conclusion leave the readers enthused as they look towards the future your research has opened.
- 2 Show the world that scientific papers can be interesting to read.
- 3 Create expectations, drive reading forward, sustain attention, and decrease the demands on your readers' memory.
- 4 To make reading as smooth as silk, iron out the quirks in your drafts with the steam of your efforts.

May the fun of writing be with you.