

# Scientific writing: research paper

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## Why publish research paper:

- advance knowledge
- get feedback
- develop and debate new ideas
- present new solutions
- discuss deficiencies and unsolved problems

"The most fundamental ingredient of good paper is **excellent research**. The best papers also **present their story in a clear and logical way**. The thinking behind the paper is clear, so the **writing is clear**."

*Katrina Kelner, Deputy Editor, Life Sciences, at Science magazine*

Day 1, 2 and 3 were about giving you ideas about doing excellent research.

Today is about how to present your story in a clear and logical way.

Based on course given by Dr. Heather Murray, in the 2001/2002 academic year at University of Bern.

- Research paper overview
- Introduction section
- Methods and data section
- Results section
- Discussion/Conclusion section
- Abstract

Research paper has the following sections:

- Introduction: from general to specific
  - provide rationale for the paper, introducing the question/hypothesis under investigation
  - attract interest in the topic
- Methods and data
  - here describe method/processing used
  - also data and procedures applied to it
  - balance the details too many-too little
  - as a rule this is the narrowest part of the paper
- Results
  - findings are presented in this section
- Discussion/Conclusion: from specific to general
  - generalized account what has been learned in this study
  - pointing back to statements in the Introduction section

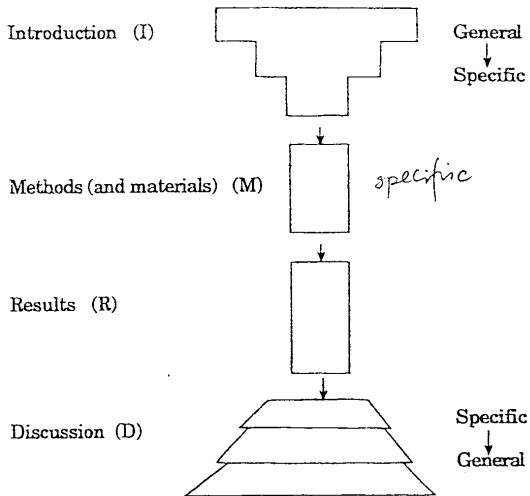


Fig. 1 Overall shape of a research paper

figure from Heather Murrey's lecture notes, 2001/2002

## Introduction: from general to specific

- Move 1: Establish a research territory
  - by showing that the research area is important, central, interesting, problematic or relevant (optional)
  - by introducing and reviewing items in previous research in the area (obligatory)
- Move 2: Establish a niche
  - by indicating a gap in previous research, raising questions about it, extending the previous knowledge (obligatory)
  - example for extending previous knowledge: better temporal and spatial resolution of your GNSS data
- Move 3: Occupy the niche
  - by outlining purposes or stating the nature of the present research (obligatory)
  - by announcing principal findings (optional)
  - by indicating the structure of the article (optional)

## Move 1: Establish a research territory

- Move 1.1: show the research area is important, central, interesting, problematic or relevant
- Move 1.1 example for importance: "Atmospheric water vapour has complex life cycle, which includes vertical and horizontal transports, mixing, condensation, precipitation and evaporation. Due to its short life time (a few days), linked to its relation to atmospheric dynamics and the role of phase changes, it is of essential importance for climate and Numerical Weather Prediction (NWP) and simultaneously very demanding to observe."
- Move 1.1 comment: note this is general statement that everybody can write ... what follow after depends on your research topic i.e. you use radiosonde, GNSS, microwave radiometry etc.
- Move 1.2: introducing and reviewing previous research - in short citing past work
- Move 1.2 examples: 1) Jones et al. (2001) studied ..., 2) Based on case studies it has been concluded that ..., 3) It is suggested that ... (Jones et al. 2001)
- Move 1.2 comment: 1) note past tense is used for single studies, 2) present perfect tense is used when referencing to areas of inquiry and 3) present tense is used to reference the current state of knowledge

## Move 2: Establish a niche

- Move 2 establishes the motivation for the study by indicating a gap in previous research, raising questions about it, extending the previous knowledge
- Move 2 is the key move in the introduction
- Move 2 is the link between Move 1 and Move 3
- by the end of Move 2 the reader should have good idea of what is coming in Move 3
- Move 2 establish a niche by indicating gap - showing that the research story so far is incomplete
- Move 2 is quite short often no more than a sentence
- Move 2 establish a niche by extending the previous knowledge - better temporal and spatial resolution of the GNSS data, or new region not covered in previous studies



## Move 3: Occupy the niche

- Move 3 makes an offer to fill the gap/answer the question that has been created in Move 2
- Move 3 can be purposive i.e. the author indicate the main purpose of the research
- Move 3 example: The aim of this study was to establish a link between GNSS water vapour anomaly and soil moisture anomaly.
- Move 3 can be descriptive i.e. the main features of the paper are described
- Move 3 example: In this study we use the PPP GNSS processing to derive slant path delays in real time.

## Move 3: Occupy the niche 10 sentences:

- 1) The aim of the present paper is to ...
- 2) This paper reports on results obtained ...
- 3) In this paper we give preliminary results for ...
- 4) The main purpose of the experiment reported here was to ...
- 5) This study was designed to evaluate ...
- 6) The present work extends the use of the last model by ...
- 7) We now report the interaction between ...
- 8) The primary focus of this paper is ...
- 9) The aim of this investigation was to test ...
- 10) It is the purpose of the present paper to ...

- often this is the first part of the paper written
- written mostly in past tense
- explain in details the processing of your data: software, parameters, elevation angle cut-off etc. (IGS summary by AC can be your reference)
- conversion of ZTD to IWV or IWV derivation from Radiosonde/NWP model
- in formulas explain each parameter used:  $IWV = k ZWD$ , where  $k$  is a constant and ZWD is Zenith Wet Delay etc.
- do not get into unnecessary details: here you need to be specific on your method
- if you did modifications to the method suggested by other make sure you mention them
- keep in mind other researchers may compare your results with theirs and find they differ likely because their method and tuning is different
- give details but not the "bolts and nuts" of all program and algorithms you develop - nobody will be interested in reading this

- results section has the new knowledge you are contributing to science/society/world
- often consists of two parts:
  - location and/or summary statements
  - location statement example 1: Table 3 shows the monthly mean IWV derived from GNSS and WRF NWP model.
  - location statement example 2: Table 3 provides details of the IWV dependence of elevation-angle cut off.
  - location statement example 3: Figure 1 presents the map of stations along with the IWV trends.
  - highlight and/or comparison statements - discussed in the next slide

# Results section: highlight and comparison example 1

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Why

Research  
paper

Overview

Intro

Move 1

Move 2

Move 3

Method

Results

Discussion

Abstract

Review

The end

Reference

## Comparison among groups

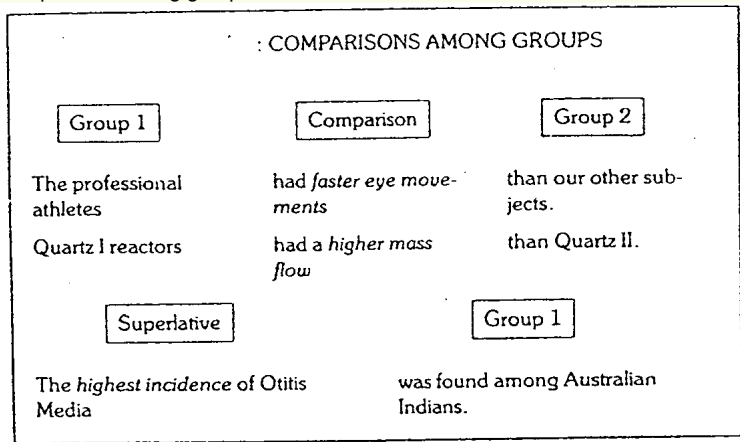


figure from Heather Murrey's lecture notes, 2001/2002

# Results section: highlight and comparison example 2

## Fluctuation of variable over time

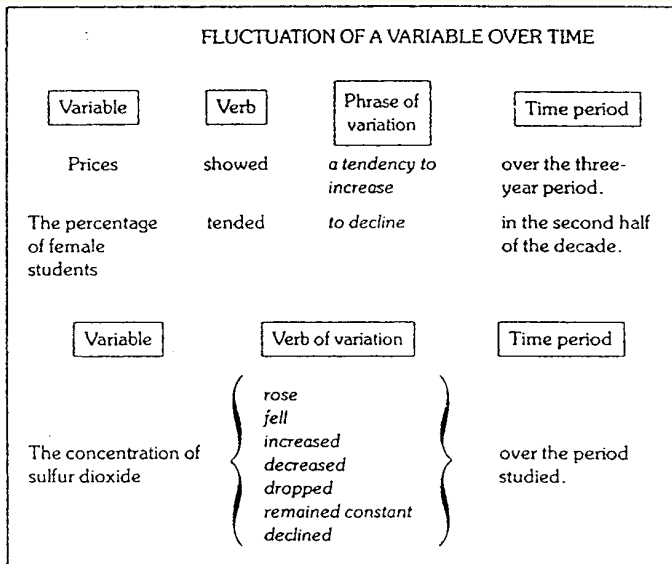


figure from Heather Murrey's lecture notes, 2001/2002

# Results section: highlight and comparison example 3

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paper

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Why

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## Relationship between two or more variables

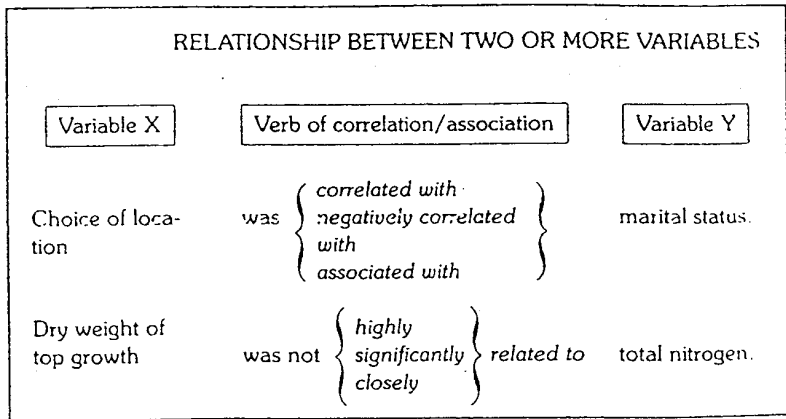


figure from Heather Murrey's lecture notes, 2001/2002

Remember in the Discussion section you go from **specific to general** by:

- original hypothesis i.e. reference to the main hypothesis or purpose of the study
- findings i.e. review the most important findings and whether they support the original hypothesis and agree with finding of other researchers,
- explanation of findings
- limitations i.e. limitations that restrict the extent to which the findings can be generalised
- need for further research or recommendation for practical applications



# Congratulations you have ALMOST written the paper!

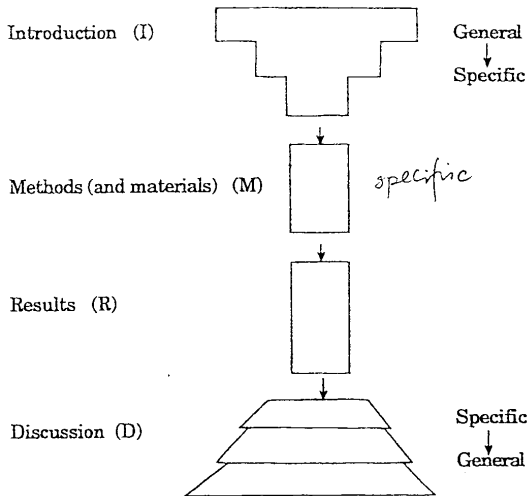


Fig. 1 Overall shape of a research paper

figure from Heather Murrey's lecture notes, 2001/2002

However, we are not yet DONE you need to write the Mini-paper i.e. the Abstract

- background information
- purpose of the study
- methods
- results (major)
- conclusion/implications

Why I need a mini-paper? To facilitate the reader. No need to read 10 pages to find out if this paper is worth reading. No offence but do you want to read a paper for the second most important green house gas - CO<sub>2</sub> if you are researching the first water vapour... and vice versa. The abstract is your key.

# Research paper review at Elsevier

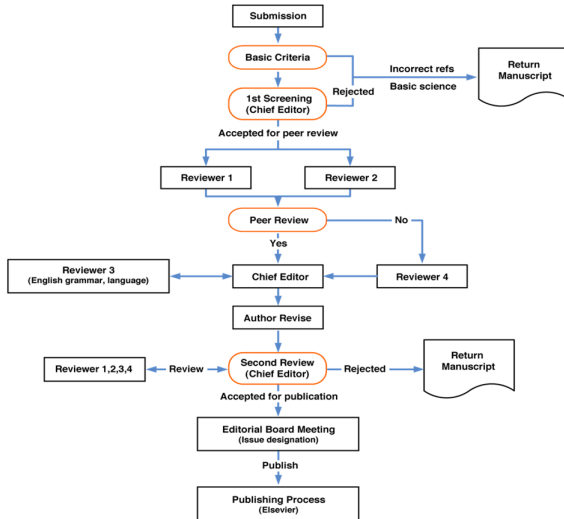


figure from <http://www.elsevier.com/>

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- 1 346 000 peer-reviewed research papers published in 2006
- 1 486 000 peer-reviewed papers published in 2010
- 23 750 journals in 2006

I was very fortunate to have the research paper secrets at the very early stage of my career.

Thank you Dr. Heather Murray for your teaching!  
With this lecture I am passing it on.

Enjoy writing your research papers!  
There is a non zero chance I will read them ;-)  
And even more ;-)

You are the new species in my jungle ;-)

# The jungle and you

Research  
paper

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Why

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Welcome! It is a friendly jungle!

<http://www.elsevier.com/connect/11-steps-to-structuring-a-science-paper-editors-will-take-seriously>

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<http://www.slideshare.net/tejasdesai/how-to-write-a-manuscript-2008-presentation>

<http://www.slideshare.net/Abuznadah/rss-2012-preparing-submitting-the-manuscript?related=2>

<http://pubs.acs.org/bio/ACS-Guide-Writing-Manuscripts-for-the-Digital-Age.pdf>

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