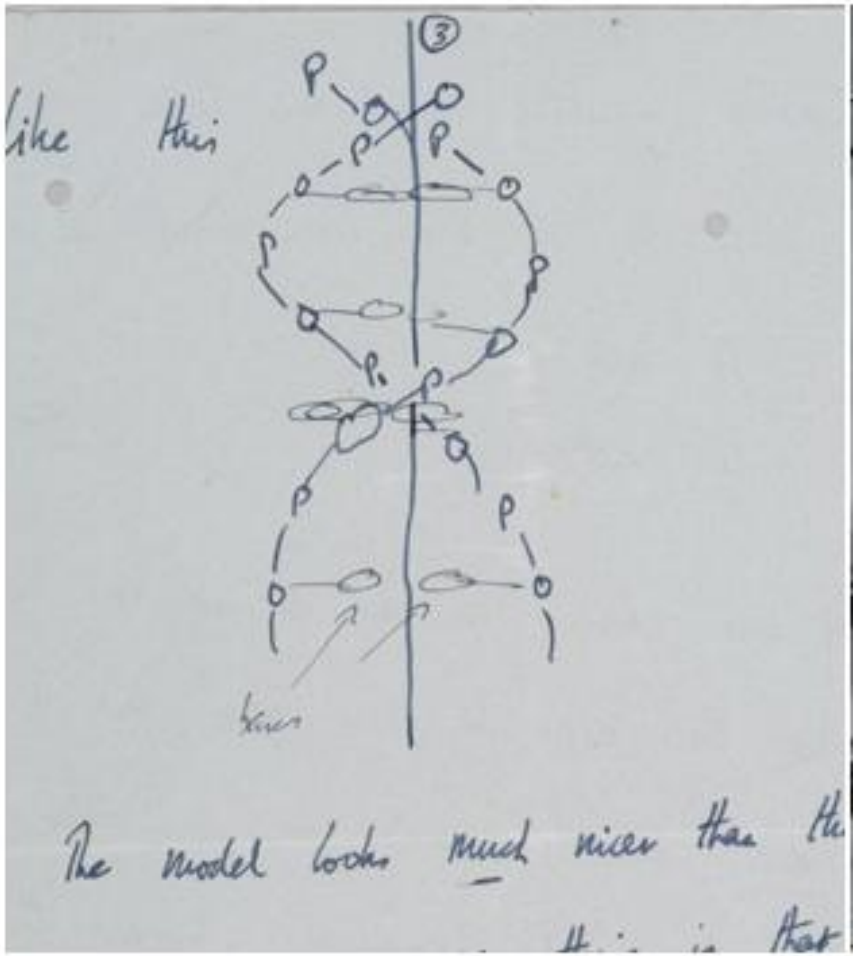
Turun yliopisto
University of Turku



The Art of Scientific Writing

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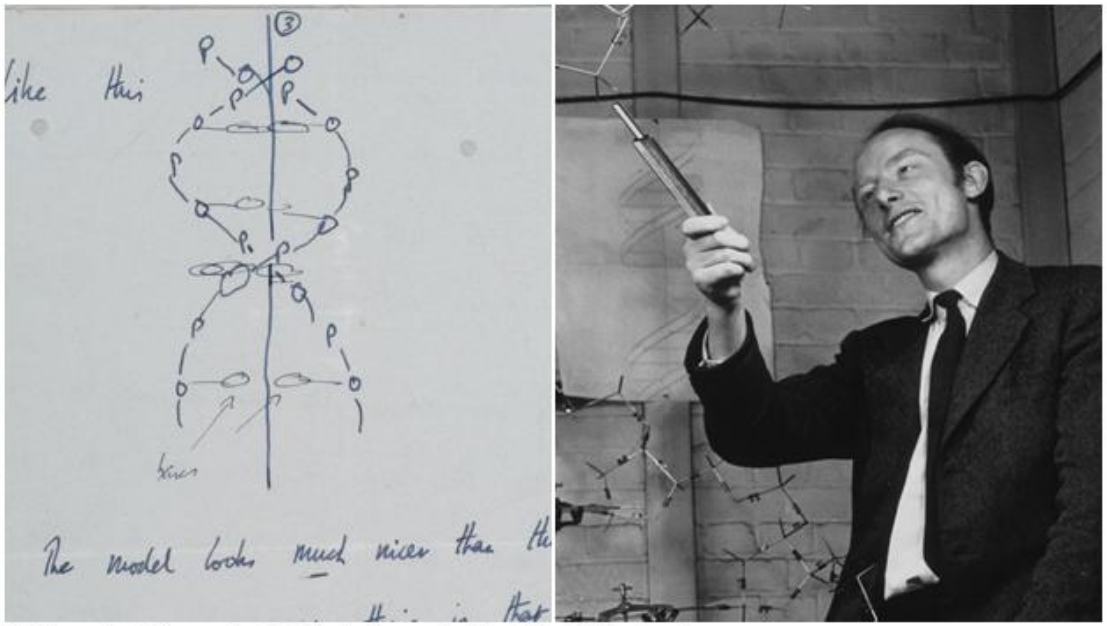
Share

DNA pioneer Francis Crick letter sells for $5.3m at New York auction



Crick wrote to his son in 1953 including a sketch of the DNA structure

A letter written by scientist Francis Crick describing his discovery of the double helix shape of DNA has been sold for $5.3m (£3.45m).

An anonymous buyer purchased it at a New York auction on Wednesday.

Related Stories

'Quadruple helix' DNA

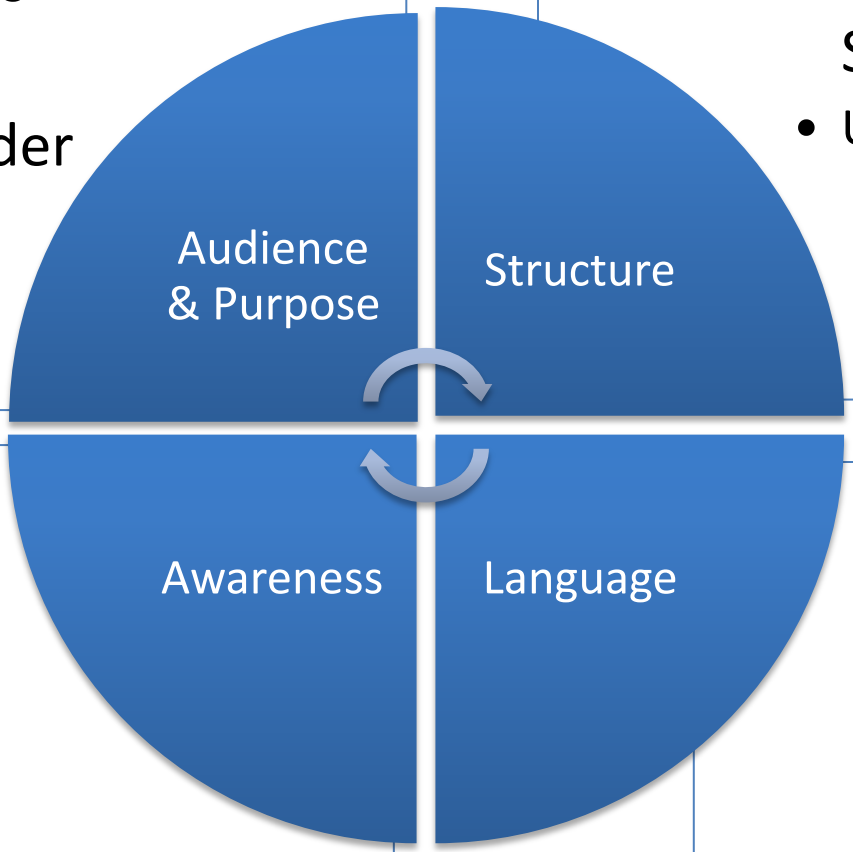
Source: http://www.bbc.co.uk/news/uk-england-22090344

Recommendations for Researchers

Hyland (2007)

- Considerations
- Reader Types
- Motivate Reader

- Genre Structures
- Useful Frameworks



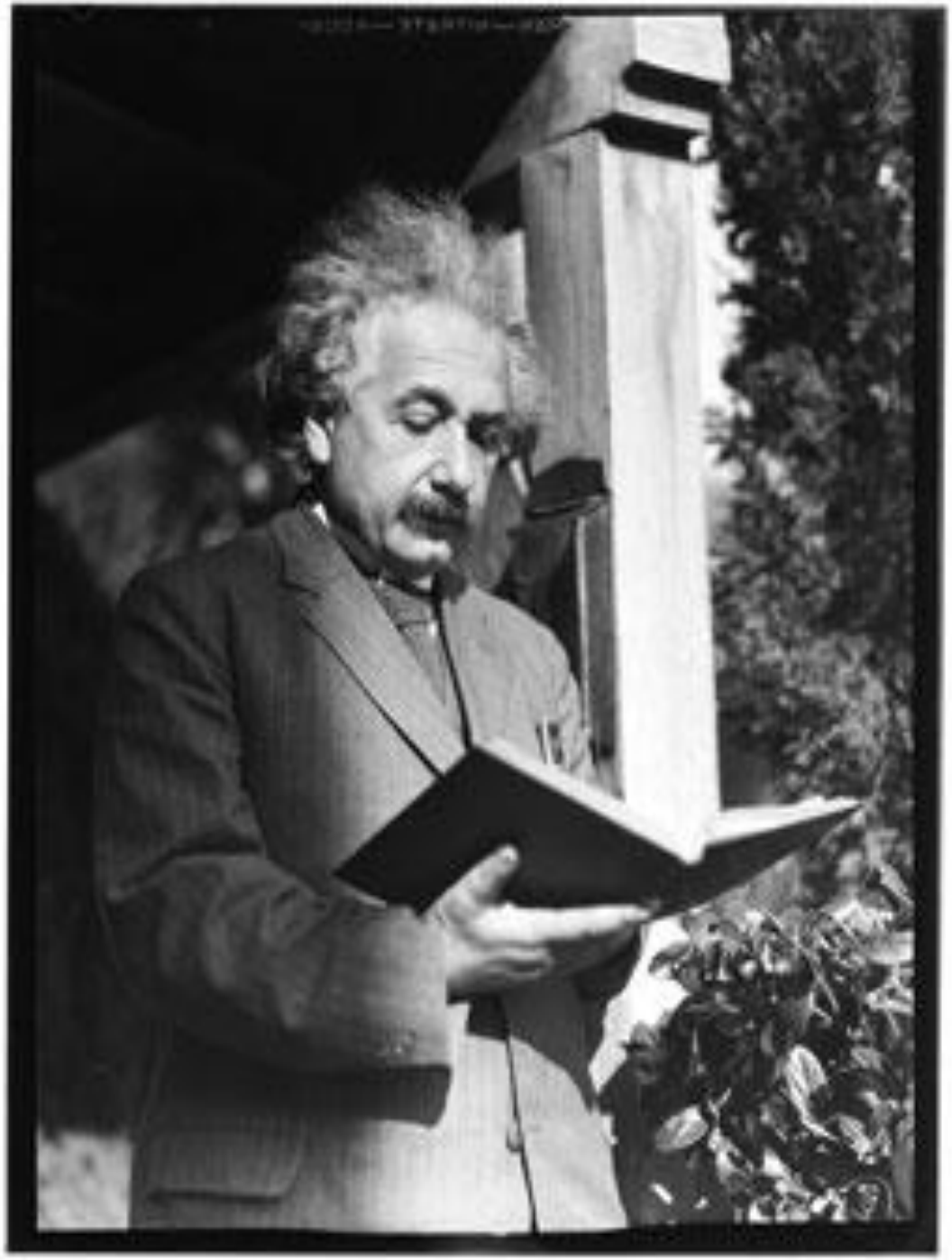
- Self Mention
- Hedges
- Citation

- Clear
- Accurate
- Concise

Characteristics of Scientific Writing

- '**objective**' not '**subjective**',
- '**intellectual**' not '**emotional**',
- '**serious**' not '**conversational**',
- '**impersonal**' not '**personal**',
- '**formal**' rather than '**colloquial**'

Clanchy and Ballard (1992), cited in (Jordan, 1997: 244)



Who?

AUDIENCE

Writing Considerations

AUDIENCE

- who?
- level of knowledge

TONE

- Style,
- manner of expression,
- grammar,
- vocabulary,
- length of sentences

PURPOSE

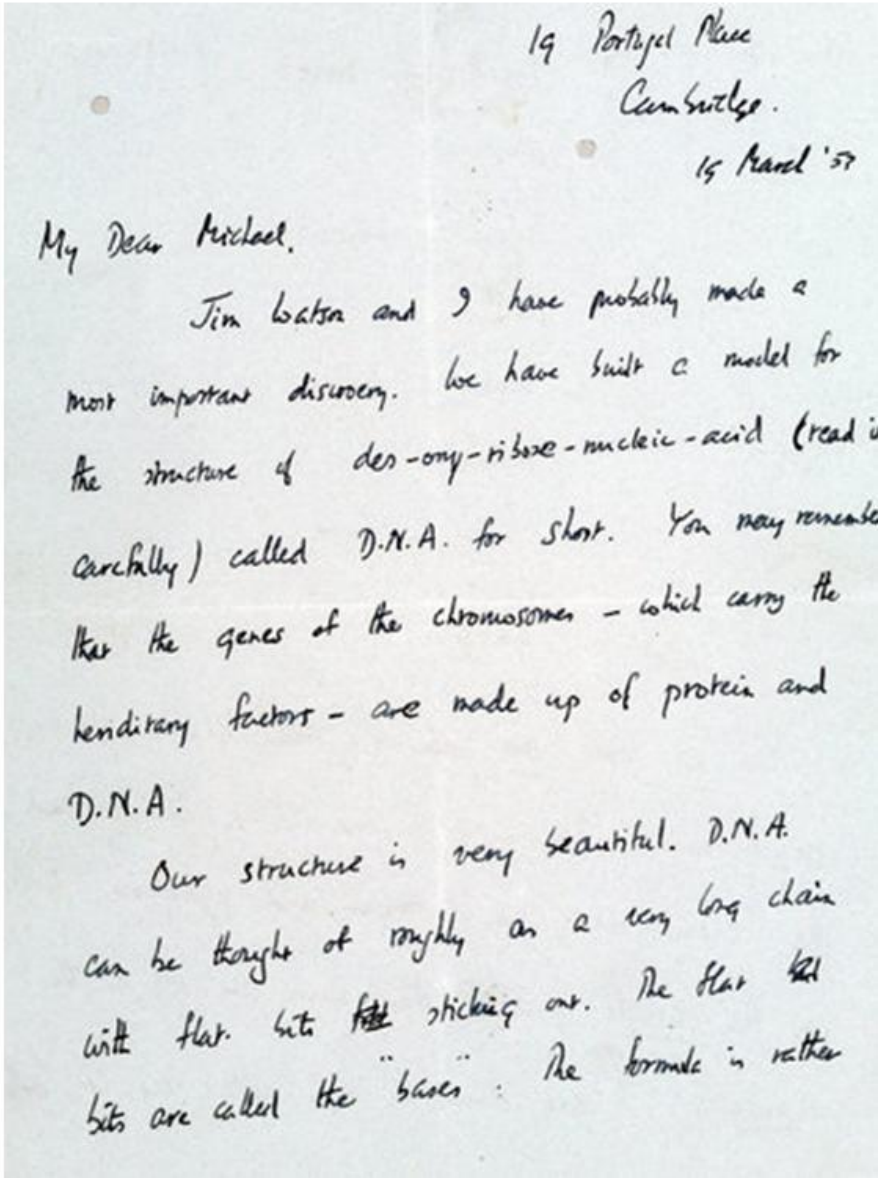
- persuasive,
- expository

Table 1.1 Purposes, types, audiences, and styles of scientific writing

Purpose	Document Types	Intended Readers	Linguistic Style
Recording and archiving	Laboratory notes, with other preservable forms of documentation, such as equipment, printouts, photos, and special artifacts for verifiability	Self; research collaborators; workplace supervisors	Informal to highly formal notations in arcane shorthand; lab jargon
Professional exposition and synthesis	Scholarly articles and books; abstracts; notes and visual media for conference papers and seminars; letters; e-mail	Researchers in same or related field	Highly formal, with heavy use of jargon

Performing job duties	On-the-job communications, including e-mail, letters, memoranda, meeting minutes, and activity or progress reports; internal and external	Research associates, colleagues, and administrators	Informal to highly formal; low to high level of jargon
Seeking research resources	Grant proposals to government agencies, corporations, and philanthropic foundations	Granting agency officials; peer reviewers	Highly formal; moderate to heavy use of jargon

The New York Times February 26, 20



19 Portugal Place
Cambridge.
19 March '53

My Dear Michael.

Jim Watson and I have probably made a most important discovery. We have built a model for the structure of des-oxy-ribose-nucleic-acid (read it carefully) called D.N.A. for short. You may remember that the genes of the chromosomes - which carry the hereditary factors - are made up of protein and D.N.A.

Our structure is very beautiful. D.N.A. can be thought of roughly as a very long chain with flat bits sticking out. The flat bits are called the bases. The formula is rather

" *You can understand that we are very excited. We have to have a letter off to Nature in a day or so.*

Lots of Love
Daddy "

3, 285 (1949).
[3] Von Arx, W. S., Woods Hole Papers in Phys. Oceanog. Meteor., **11** (3) (1950).
[4] Ekman, V. W., *Arkiv. Mat. Astron. Fysik. (Stockholm)*, **2** (11) (1905).

MOLECULAR STRUCTURE OF NUCLEIC ACIDS

A Structure for Deoxyribose Nucleic Acid

WE wish to suggest a structure for the salt of deoxyribose nucleic acid (D.N.A.). This structure has novel features which are of considerable biological interest.

A structure for nucleic acid has already been proposed by Pauling and Corey[1]. They kindly made their manuscript available to us in advance of publication. Their model consists of three intertwined chains, with the phosphates near the fibre axis, and the bases on the outside. In our opinion, this structure is unsatisfactory for two reasons: (1) We believe that the material which gives the X-ray diagrams is the salt, not the free acid. Without the acidic hydrogen atoms it is not clear what forces would hold the structure together, especially as the negatively charged phosphates near the axis will repel each other. (2) Some of the van der Waals distances appear to be too small.

Another three-chain structure has also been suggested by Fraser (in the press). In his model the phosphates are on the outside and the bases on the inside, linked together by hydrogen bonds. This structure as described is rather ill-defined, and for this reason we shall not comment on it.

This figure is purely diagrammatic. The two ribbons symbolize the two phosphate—sugar chains, and the horizontal rods the pairs of bases holding the chains together. The vertical line marks the fibre axis

We wish to put forward a radically different structure for the salt of deoxyribose nucleic acid. This structure has two helical chains each coiled round the same axis (see diagram). We have made the usual chemical assumptions, namely, that each chain consists of phosphate diester groups joining β-D-deoxyribofuranose residues with 3′,5′ linkages. The two chains (but not their bases) are related by a dyad perpendicular to the fibre axis. Both chains follow right-handed helices, but owing to the dyad the sequences of the atoms in the two chains run in opposite directions. Each chain loosely resembles Furberg's[2] model No. 1; that is, the bases are on the inside of the helix and the phosphates on the outside. The configuration of the sugar and the atoms near it is close to Furberg's 'standard configuration', the sugar being roughly perpendicular to the attached base. There is a residue every 3.4 A. in the fibre. The structure is a right-handed helix with an angle of 36° between adjacent residues. The structure repeats after 10 residues on each chain, that is, after 34 A. The distance of a phosphate from the fibre axis is 10 A. As the phosphates are on the outside, cations have easy access to them.

The structure is an open one, and its water content is rather high. At lower water contents we would expect the bases to tilt so that the structure could become more compact.

The novel feature of the structure is the manner in which the two chains are held together by the purine and pyrimidine bases. The planes of the bases are perpendicular to the fibre axis. They are joined together in pairs, a single base from one chain being hydrogen-bonded to a single base from the other chain, so that the two lie side by side with identical z-co-ordinates. One of the pair must be a purine and the other a pyrimidine for bonding to occur. The hydrogen bonds are made as follows: purine position 1 to pyrimidine position 1; purine position 6 to pyrimidine position 6.

If it is assumed that the bases only occur in the structure in the most plausible tautomeric forms (that is, with the keto rather than the enol configurations) it is found that only specific pairs of bases can bond together. These pairs are: adenine (purine) with thymine (pyrimidine), and guanine (purine) with cytosine (pyrimidine).

In other words, if an adenine forms one member of a pair, on either chain, then on these assumptions the other member must be thymine; similarly for guanine and cytosine. The sequence of bases on a single chain does not appear to be restricted in any way. However, if only specific pairs of bases can be formed, it follows that if the sequence of bases on one chain is given, then the sequence on the other chain is automatically determined.

It has been found experimentally[3,4] that the ratio of the amounts of adenine to thymine, and the ratio of guanine to cytosine, are always very close to unity for deoxyribose nucleic acid.

It is probably impossible to build this structure with a ribose sugar in place of the deoxyribose, as the extra oxygen atom would make too close a van der Waals contact.

The previously published X-ray data[5,6] on deoxyribose nucleic acid are insufficient for a rigorous test of our structure. So far as we can tell, it is roughly compatible with the experimental data, but it must be regarded as unproved until it has been checked against more exact results. Some of these are given in the following communications. We were not aware of the details of the results presented there when we devised our structure, which rests mainly though not entirely on published experimental data and stereochemical arguments.

It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material.

Full details of the structure, including the conditions assumed in building it, together with a set of co-ordinates for the atoms, will be published elsewhere.

We are much indebted to Dr. Jerry Donohue for constant advice and criticism, especially on interatomic distances. We have also been stimulated by a knowledge of the general nature of the unpublished experimental results and ideas of Dr. M. H. F. Wilkins, Dr. R. E. Franklin and their co-workers at

.....

In other words we think we have found the basic copying mechanism by which life comes from life. The beauty of our model is that the shape of it is such that only these pairs can go together, though they could pair up in other ways if they were floating about freely. You can understand that we are very excited. We have to have a letter off to Nature in a day or so. Read this carefully so that you understand it. When you come home we will show you the model.

Lots of love,

Daddy

Know your Readers

- How much does *your audience* know about the subject?
- Is the document for a research supervisor, a journal, a public official?
- How should a document's technical formality and style be adjusted for its reader(s)?
- Do the writer's intentions match the reader's expectations?

#1 The Field Intelligence Gatherer

The field intelligence gatherer

Hi! I am a scientist working in the same area as you. I may not be doing the exact same research, but I am a regular reader of the journal you read and attend the conferences you attend. I was the guy sitting on the fifth row facing you when you presented your paper in Korea last year. I read most of the abstracts to keep up to date with what's happening.

#2 The Competitor

The competitor

Hi! You know me and I know you, although we have never met face to face. We reference each other in our papers. By the way, thanks for the citation. I am trying to find a niche where you are not playing, or maybe I'll fix some of your problems in my next paper. Hey, who knows, maybe you are onto something I could benefit from. I'd love to chat or work on a common paper one of these days. Interested?

#3 The Seeker of a Problem to Solve

The seeker of a problem to solve

Hi! You don't know me. I am a senior researcher. I just completed a major project, and I am looking for something new to do. I am not quite familiar with your field, but it looks interesting, and it seems as though I could apply some of my skills and methods to your problems and get better results than you. I am reading your paper to find out.

#4 The Solution Seeker

The solution seeker

Help! I'm stuck. My results are average. I am pressured to find a better solution. I need to look at other ways of solving my problem. I started looking outside my own technology field to see if I could get fresh ideas and methods. I'm not too familiar with what you're doing, but as I was browsing my list of titles, I discovered that you are working in the same application domain as I am.

#5 The Young Researcher

The young researcher

Hello! I'm fresh out of university, and quite new to this field. Your paper looks like a review paper. That's exactly what I need right now. Nothing too complicated; just enough for me to understand the field, its problems, and the solutions advocated by researchers. That will do just fine!

#6 The Serendipitous Reader

The serendipitous reader

Hi! Cute title you've got there. I had to read your paper. Such a title could only come from an interesting writer. I thought I would learn a few things, a paradigm shift maybe. I'm not sure that I will understand any of it, but it's worth a try. Last time I did that, I learned quite a lot. The paper had won the Best Paper Award in an IEEE competition. I studied the paper. Although I did not understand much, I got quite a few hints on how to improve my scientific writing skills!

MOTIVATION

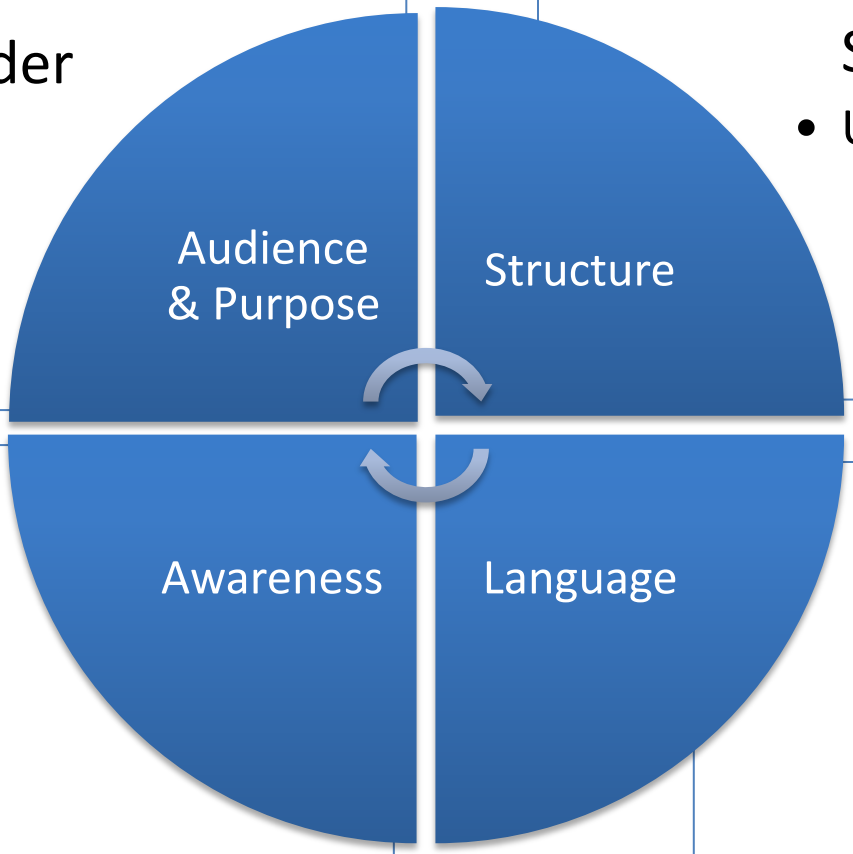
Meet the goals of your readers to motivate them (Lebrun, 2007)

Recommendations for Researchers

Hyland (2007)

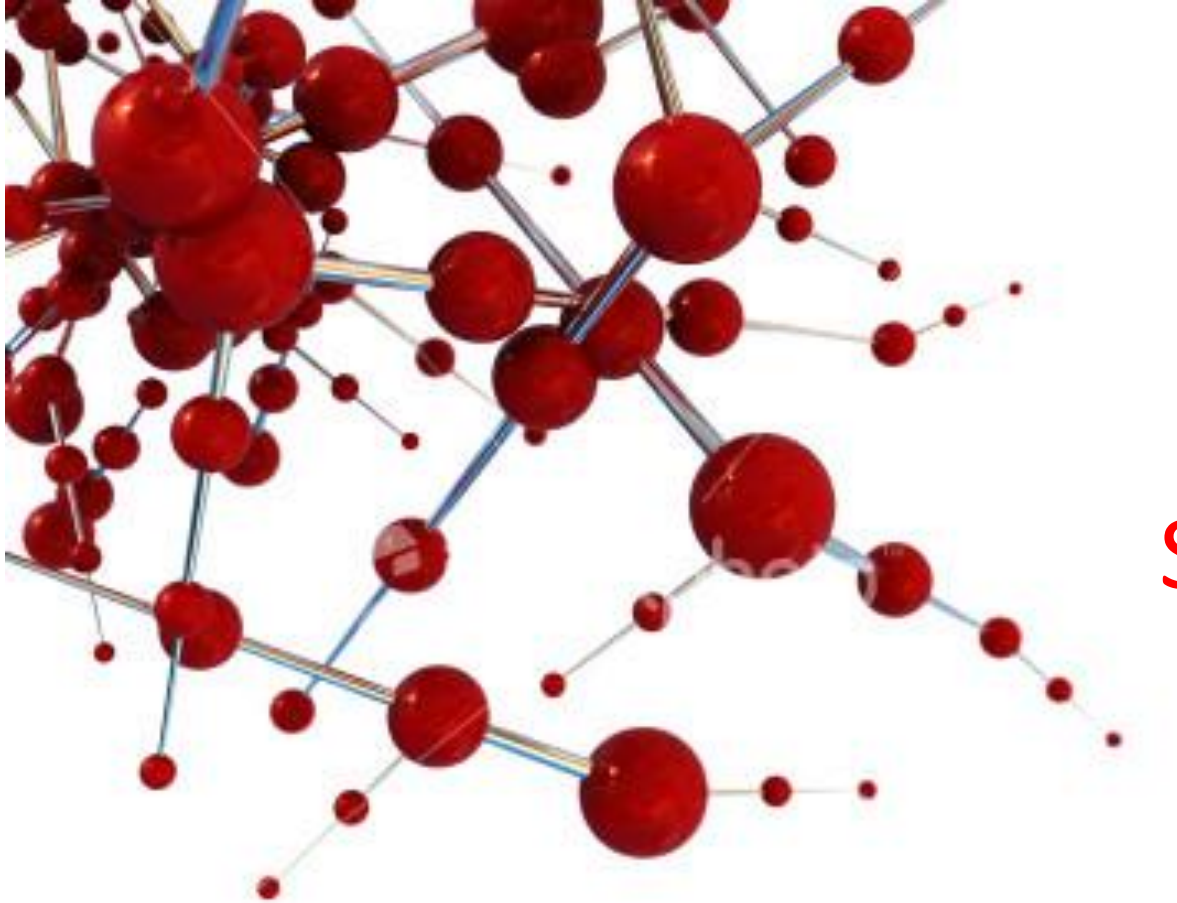
- Reader Types
- Motivate Reader

- Genre Structures
- Useful Frameworks



- Self Mention
- Hedges
- Citation

- Clear
- Accurate
- Concise



STRUCTURE?

Scientific Discourse Community

Schematic Structures

Introductions - Swales (1990)

Methods – Peacock (2007)

Results Brett (1994)

Discussion (Lewin et al. 2001)

Abstracts (Hyland, 200/2004)

Research Proposals

MOVES in INTRODUCTION

- MOVE 1: Establishing a Territory
  - Claiming Centrality
  - Making Topic Generalizations
  - Reviewing Previous Research

This move can describe the current situation, features and characteristics of that area of study, as well as why it is an important field and who has already been working in it.

- MOVE 2: Establishing a Niche
  - Counter-Claiming
  - Indicating a Gap
  - Question-Raising
  - Continuing a Tradition

The most common way of achieving this is to present a ***negative evaluation*** of some feature of the research "territory" described in **Move 1**. This is often signalled by words expressing a ***contrast*** or *negative evaluation*

- MOVE 3: Occupying the Niche
  - Outlining Purposes
  - Announcing Present Research
  - Announcing Main Findings
  - Indicating Structure of the Article
  - Evaluation of Findings

Here, the writer states how s/he intends to fill the gap, answer the specific question or continue the research tradition that was described in **Move 2**.

MOVE 1: Establishing a Territory

*The effect of...**has been studied extensively** in recent years.*
*The effects of... **have received considerable attention***
***Many investigators** have recently turned to...*
***A large body of data** concerning...has been reported.*
*In recent years, there have been **many papers** describing...*
*Recently, there has been **wide interest in**...*
*In recent years, researchers **have become increasingly interested in**...*
*Knowledge of...has **great importance for**...*
*The study of...has become **an important aspect** of...*
*The theory that...has led to **the hope that**…*
***A long-standing problem** has been to obtain more information on…*
***A central issue in**...is the validity of...*

*The general features of... **are well known**.*
*Plumage coloration **is known to influence** mate selection in mallards.*
*An increase of Mallards in eastern North America **has been well documented**.*
*Trout **are believed to be** relatively immobile.*
***It is generally accepted** that...*

***Smith** (1989) **found** a clear relationship between...*
***Smith** (1989) **argued** that...*
***Smith** (1989) **concluded** that...*
*It **has been suggested** that...(**Smith** 1989)*
***Data have been presented** in the literature which show that...(**Smith** 1989)*
*Observations by **Smith** (1989) **suggest** that...*

MOVE 2: Establishing a Niche

CONTRAST:	QUANTIFIERS:	VERBS:	ADJECTIVES:
however, but, yet, although, despite, nevertheless, unfortunately	few, less, little, no, none, not	fail, ignore, lack, neglect, overlook, question, prevent, hinder, deter, restrict, limit	unsatisfactory, elusive, inconclusive, ineffective, limited, restricted, scarce, uncertain, unclear, unreliable

However, *this view* ***is challenged*** *by recent data showing...*
However, *these studies have* ***failed to*** *recognize the...*

A considerable amount of research has been... ***but little research****...*
...has been extensively studied. ***However, less attention*** *has been paid to...*
As a result, ***no comprehensive theory*** *appears to exist.*
Despite *the importance of...,* ***few researchers*** *have studied...*
*Research has tended to focus on...****rather than****...*
The only reported study to date of...covered ***a limited range*** *of...*
...studies have appeared previously in the literature, ***but*** *measurements* ***were restricted to****...*

These differences ***need to*** *be analyzed...*
Hence, *additional studies of...****are needed****.*

MOVE 3: Occupying the Niche – **Outlining Purpose**

HUMAN AGENT:

*In this study, **we suggest** a 3-step process...*
*In this letter, **we propose** a ...algorithm.*
*In this paper, **we attempt** to develop a...*
*In this article, **we provide** a novel approach to...*
*In this paper, **we describe** novel algorithms for...*
*In this paper, **we present** a system for...*
*Here, **we will analyze** the performance of...*
*In this letter, **we present** an efficient routing protocol that...*

INANIMATE AGENT:

***This paper evaluates** the effect on...*
***This paper presents** data on...*
***This study focuses on** a strategy for...*
***The present study tested**...*
***This thesis proposes** a formal procedure for...*
***This paper introduces** a novel architecture for...*
***This research aims to develop** a methodology for...*

MOVE 3: Occupying the Niche - **Indicating article structure**

Author as actor:
In Section II, **we** describe the framework used to...
In Section IV, **I** present the model used to...

Text as actor:
Section II describes the framework used to...
Section IV presents the model used to...

Content as subject:
In Section II, **the framework** is described that was used to...
In Section IV, **the model** is presented...

MOVES

- MOVE 1: Establishing a Territory
  - Claiming Centrality
  - Making Topic Generalizations
  - Reviewing Previous Research

This move can describe the current situation, features and characteristics of that area of study, as well as why it is an important field and who has already been working in it.

- MOVE 2: Establishing a Niche
  - Counter-Claiming
  - Indicating a Gap
  - Question-Raising
  - Continuing a Tradition

STRONGER ↓ **WEAKER**

The most common way of achieving this is to present a ***negative evaluation*** of some feature of the research "territory" described in **Move 1**. This is often signalled by words expressing a ***contrast*** or ***negative evaluation***

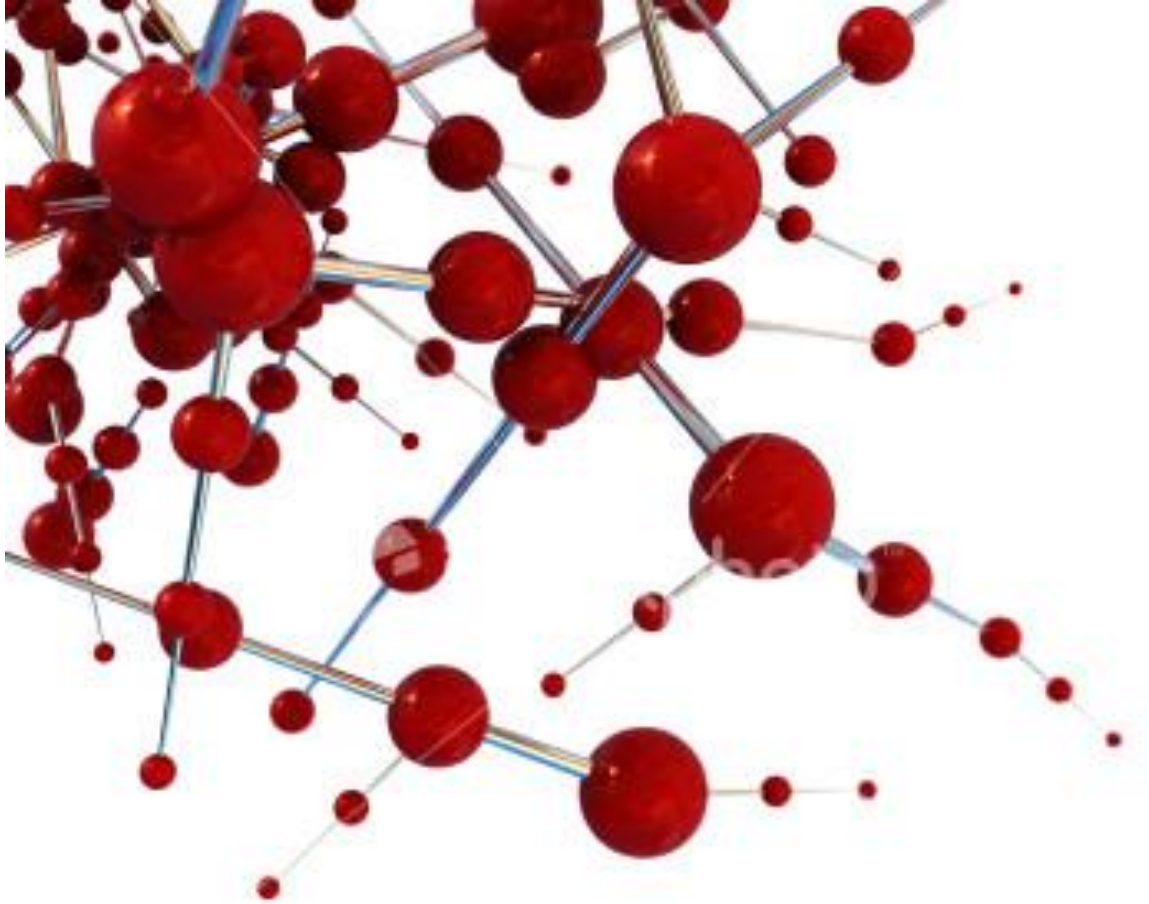
- MOVE 3: Occupying the Niche
  - Outlining Purposes
  - Announcing Present Research
  - Announcing Main Findings
  - Indicating Structure of the Article
  - Evaluation of Findings

Here, the writer states how s/he intends to fill the gap, answer the specific question or continue the research tradition that was described in **Move 2**.

Introduction task

Obesity is the strongest risk factor for knee osteoarthritis (OA), but evidence from cross-sectional surveys for a link between obesity and hand OA is inconsistent. Findings from the longitudinal Tecumseh Community Health Study suggest that adult obesity is associated with incident hand OA in men and women ages 50–74 years. The mechanism underlying the association between increased body weight and OA probably involves mechanical loading across joints.

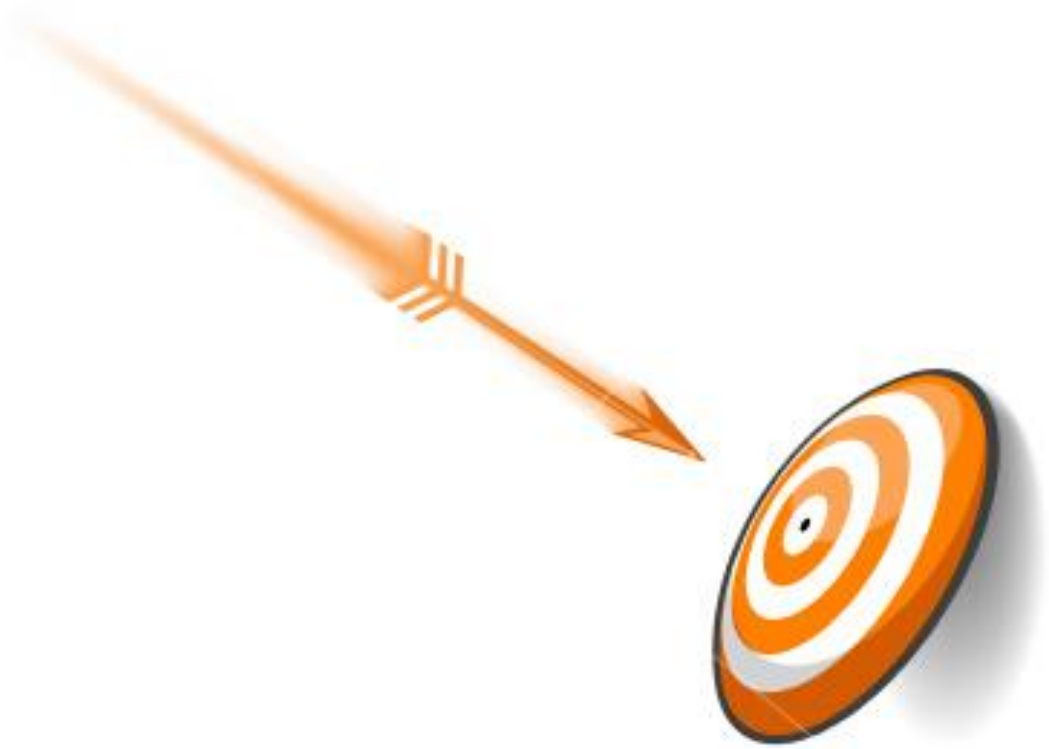
However, the force across hand joints is not necessarily greater in persons who are overweight, and metabolic factors associated with obesity have been implicated; some of these, such as impaired glucose tolerance, are also linked to low weight at birth. The relationship between OA and body weight in early life is not known. Using prospectively collected data from a large, population-based birth cohort, we examined the relationship between birth weight, childhood growth, adult weight, and hand OA.



LANGUAGE?

Objective
Precise
Clear

OBJECTIVITY & PRECISION



Objectivity: any claims that you make need to be based on facts, not intuition or emotion

Precision: ambiguities in writing cause confusion and may prevent a reader from grasping crucial aspects of the methodology and synthesis

Objectivity : Don’t Fear Pronouns

….. when they are appropriate.

Passives

The story of the passive lover

Imagine yourself at the doorstep of your loved one. You are clutching, somewhat nervously, a beautiful bouquet of fragrant roses behind your back. You ring the doorbell. As your loved one opens the door and gives you a beaming smile, you hand out the bouquet of flowers and utter these immortal words:

"*You are loved by me.*"

What do you think happens next?

(a) You eat the flowers; or

(b) You ring the doorbell again and say the same thing using the active voice.

Abstract

"The GCB and ABC DLBCL subgroups identified in this data set had ***significantly different 5-yr survival rates after multiagent chemotherapy (62% vs. 26%; P ≤ 0.0051), in accord with analyses of other DLBCL cohorts****. These results demonstrate the ability of* ***this gene expression-based predictor*** *to classify DLBCLs into biologically and clinically distinct subgroups irrespective of the method used to measure gene expression."*[j]

Introduction

*"****We*** *demonstrate that this method is capable of classifying a tumor irrespective of which experimental platform is used to measure gene expression. The GCB and ABC DLBCL subgroups defined by using* ***this predictor*** *have* ***significantly different survival rates after chemotherapy.***[k]

[j] Wright G, Tan B, Rosenwald A, Hurt E, Wiestner A, and Staudt LM, "A gene expression-based meth to diagnose clinically distinct subgroups of diffuse large B cell lymphoma", *Proc Natl Acad Sci U S* **100**(17): 9991–9996, 2003. © 2003 National Academy of Sciences, USA.

Words that indicate a lack of precision in scientific writing

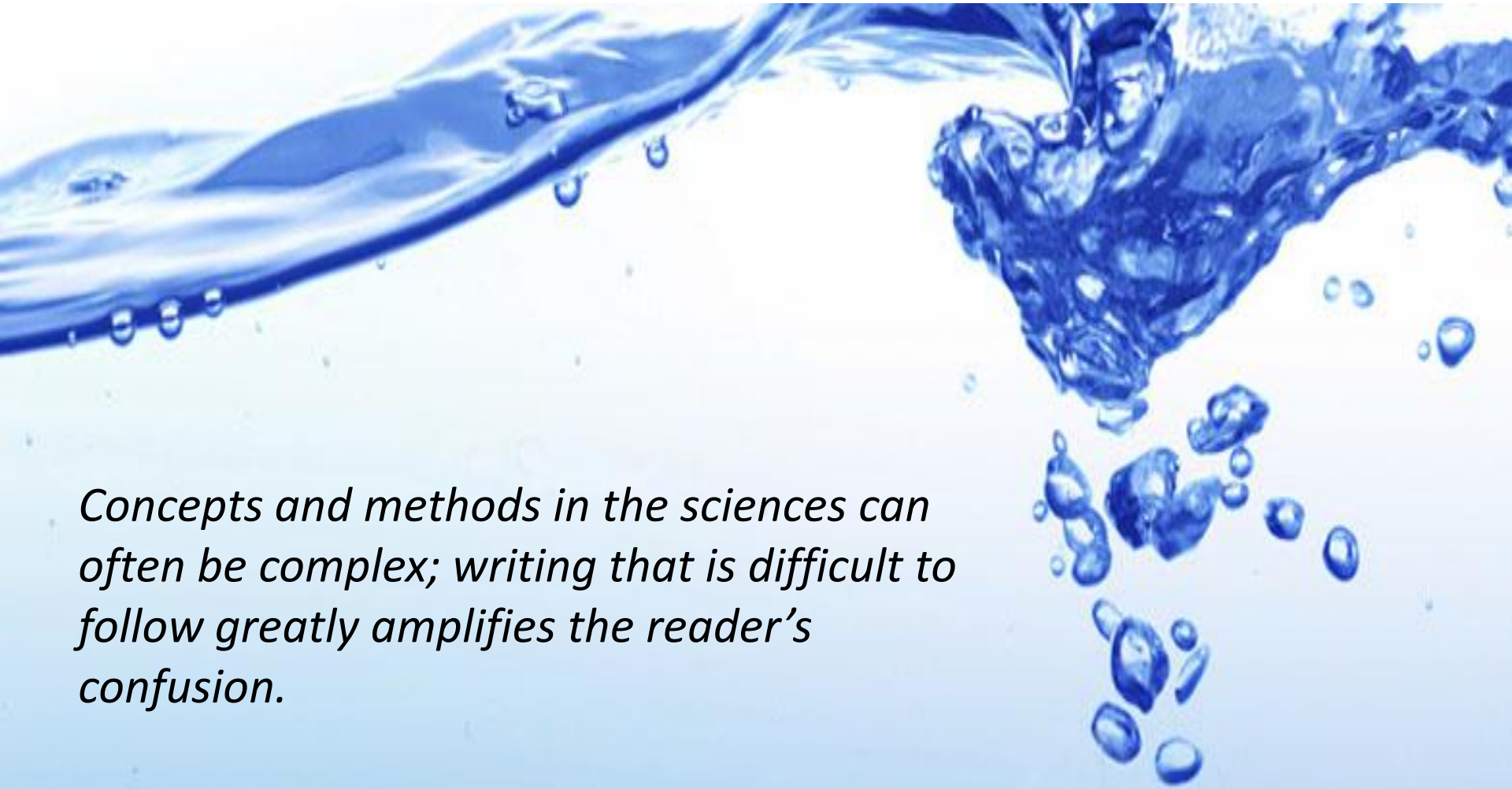
Typically	*A number of*	*Several*	*Many*	*Most*
Generally	*The majority of*	*Less*	*Others*	*A few*
Commonly	*Substantial*	*Various*	*More*	*The main*
Can /May	*Probably*	*frequent*	*Often*	…

Precision

1. Researchers have found that experiments with crops under reduced lighting require a considerable amount of time because the seeds germinate so slowly.

2. Johnson and Brown (2003) have found that experiments with tomatoes and carrots in 50% and 75% light-deprived environments require 12–16 weeks instead of 7–8 weeks because the seeds take twice as long to germinate.

CLARITY



Concepts and methods in the sciences can often be complex; writing that is difficult to follow greatly amplifies the reader's confusion.

DETACHED PRONOUNS

This, it, they, them and their

Example

The cellular automaton (CA) cell, a natural candidate to model the electrical activity of a cell, is an ideal component to use in the simulation of ***intercellular communications****, such as those occurring between cardiac cells, and to model* ***abnormal asyn- chronous propagations****, such as* ***ectopic beats****, initiated and propagated cell-to-cell, regardless of the complexity of THEIR patterns.*

Keep these Happily Married Couples Together

• An unfamiliar word and its definition • An acronym and its definition • A noun/phrase and its pronoun	• A verb and its object • Background information and the text it clarifies • A visual and its complete caption • A verb and its subject

Take home message

Minimize the time, memory, and energy needed for reading while keeping your readers attention and motivation high.

Sources

Alley Michael. (1996). The craft of scientific writing, 3rd edition. New York: Springer-Verlag.

Barrass, Robert. (2002). Scientists must write, 2nd edition. New York: Routledge.

Council of Biology Editors. (1994). Scientific style and format: the CBE manual for authors, editors, and publishers (6th ed.). New York: Cambridge University Press.

Day, R. A. (1998). How to write and publish a scientific paper (5th ed.). Phoenix, AZ: Oryx Press.

Day, R. A. (1995). Scientific English: a guide for scientists and other professionals. (2nd ed.) Phoenix, AZ: Oryx Press.

Gartland, J. J. (1993). Medical writing and communicating. Frederick, MD: University Publishing Group.

Hyland, K. (2007). English for Professional Academic Purposes: writing for scholarly publication. New York: Cambridge University Press