Scientific reading and writing, and creativity

Simon Davis

1. READING

Read well!

“Any man[/woman] who reads too much and uses his[/her] own brain too little falls into lazy habits of thinking.”

Albert Einstein (1879–1955)

“Don’t try to carry too many ‘facts’ around in your head - many of them will be wrong!”

James D. Watson (?; 1928-)

How to read well

Approaching the task

- You'll need to become expert in your area of research during your DPhil
- You can't read everything, so you need to be selective (aim for >50 papers a year)
- Read papers from very high-ranking journals but be careful
- Old established journals care about their reputations and data quality is paramount

  e.g. Biophysical Journal or J Biol Chem or, ideally, PNAS

- Don't read papers from journals you've never heard of (and don't publish there!)
- Set aside time to read papers; it can take me a whole afternoon to fully grasp a paper
- Be willing to do extra work, e.g. translating words you don't understand using Wikipedia
- As you get more experience, consider "SNACKING ON A PAPER" during breaks
- **Above all, try to get a feel for whose papers are worth reading: <u>ASK YOUR SUPERVISOR</u>**

How to read well

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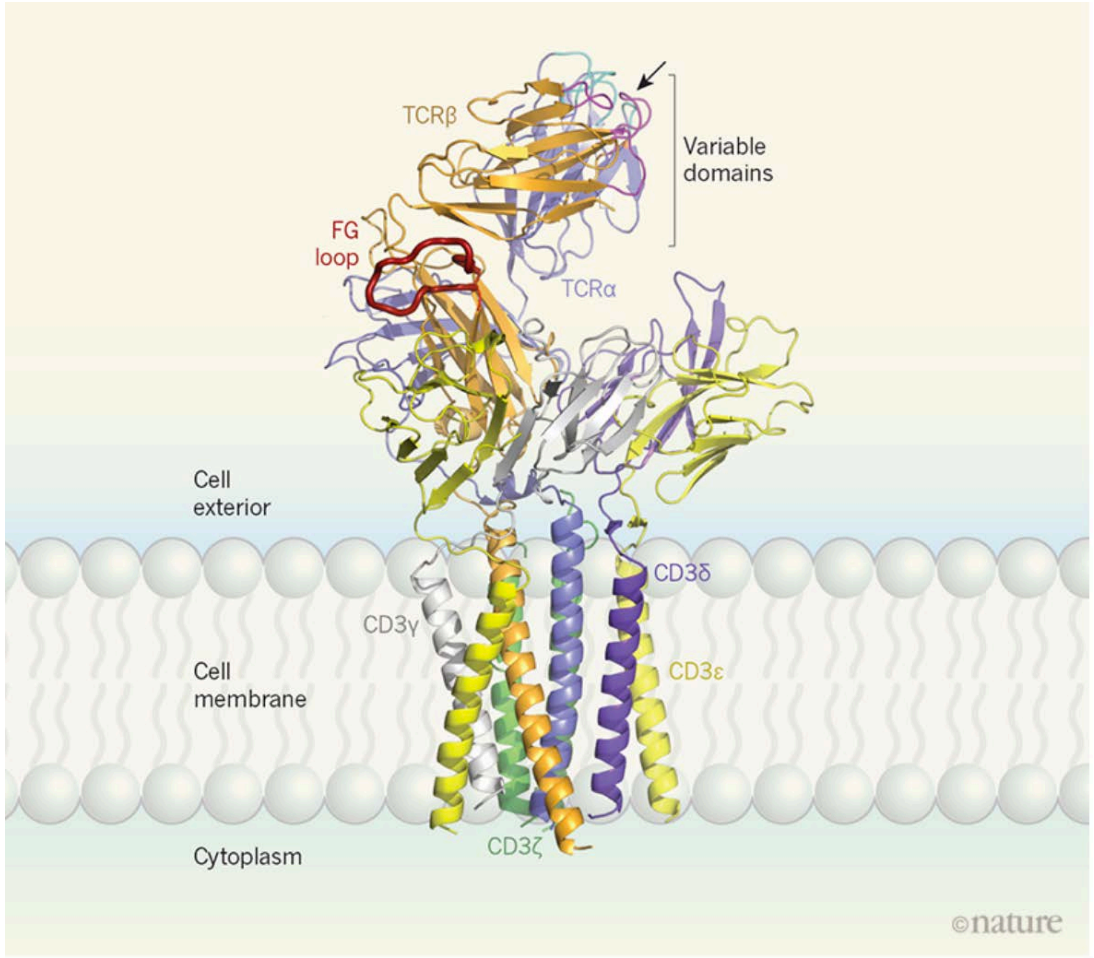


A commentary on a Nature paper…

IMMUNOLOGY

The structure of a T–cell mechanosensor

T–cell receptors orchestrate immune–system responses against infection and cancer. A structure of an entire T–cell receptor complex clarifies its assembly and signalling, and sheds light on its dynamic ligand recognition. **SEE ARTICLE P.546**

[redacted]

technique called single-particle cryogenic electron microscopy (cryoEM). Such a high-

How to assess a scientific paper **quickly**

1. Read the title
2. Then read the Abstract
3. Read the last paragraph of the Introduction (the “set up”)
4. Read the first paragraph of the Discussion (main conclusions)
5. Look at the figures and tables
6. Find the figure/table that supports the main point
7. DECIDE IF THE DATA STRONGLY SUPPORT THE CONCLUSION

Finding the **key** figure

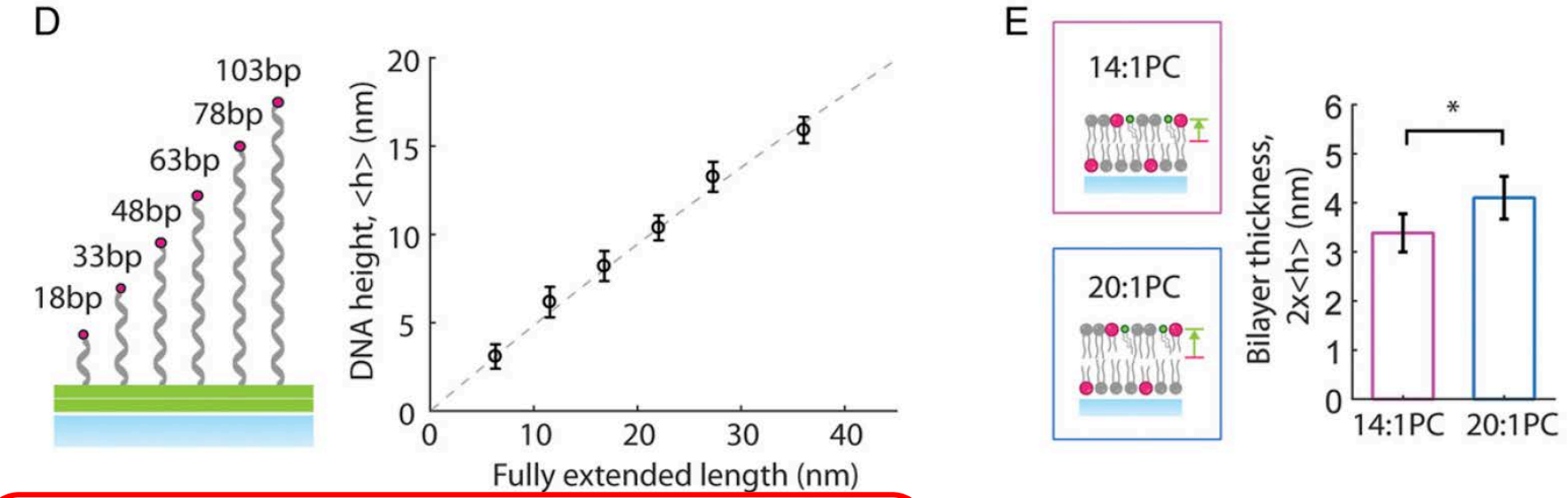
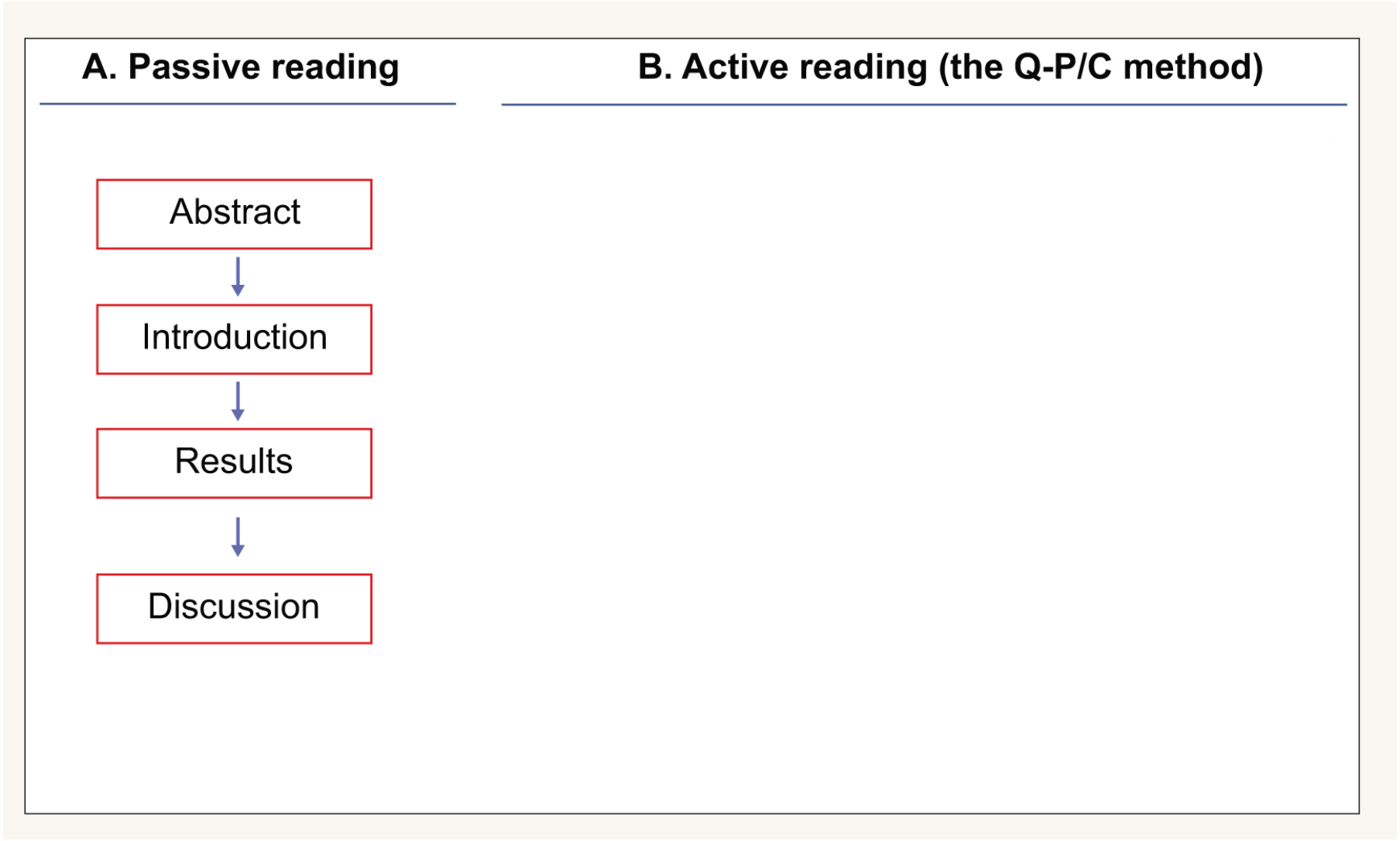


Fig. 1. CSOP measures cell surface molecular heights using two-point localization. (*A*) In an example CSOP measurement, a lipid-coated glass bead (6.8-μm diameter) with multidomain proteins bound to the membrane is imaged using confocal microscopy with a high-NA objective while a z-piezo stage scans the bead through a confocal plane. *Inset* shows a bilayer labeled with green fluorescent dyes and multidomain proteins labeled with red fluorescent dyes at their tip. Protein height, <h>, is measured by localizing the centroids of the green and red fluorescent peaks averaged axisymmetrically. The fluorescence intensities of the protein or lipid channels (red and green circles) and their corresponding Gaussian fits (red and green lines) are shown below. (*B*) A representative fluorescent profile of a protein on a lipid-coated bead (*Insets*) along a single line *r* (*Top*) or by radial averaging $\bar{r}$ of fluorescence signal (*Bottom*), showing the improved SNR with radial averaging. The dashed gray box in *Bottom* line scan is zoomed in *A*. (Scale bar, 2 μm.) (*C*) Comparison of CSOP's resolution (circles) to other single-molecule localization methods (gray dashed line) based on Thompson et al. (29). The open circles were obtained from simulated data, and the closed circles were obtained from experimental data. (*D*) CSOP measurement of surface-tethered dsDNAs of varying length. Dashed line indicates the predicted WLC height when the persistence length is 50 nm, showing good agreement; $n > 40$ for all measurements. The error bar indicates SD. (*E*) Quantification of lipid bilayer thickness with CSOP. *Inset* illustrates the location of a green (TopFluor-Cholesterol) and red (Liss Rhod B) label within a bilayer. The magenta and blue bars show the measurement of a bilayer containing either 14:1PC or 20:1PC lipids, respectively ($n = 99$ or 103). Error bars indicate the 95% CIs. *P* value is 0.015 based on two-sample Student's *t* test (*$P < 0.05$).

An advanced method for reading a paper **carefully**



Natl Sci Rev, Volume 7, Issue 9, September 2020, Pages 1422–1427, https://doi.org/10.1093/nsr/nwaa130

An advanced method for reading a paper **carefully**

The FOUR questions you need to ask:

1. **What is the question** that the authors are trying to address, and why is it important?
2. If this were *my* DPhil project, **what kind of experimental approach** would *I* use to tackle the problem?
3. **What kind of data** would *I* need to generate in order to support the conclusions of this paper?
4. How **would this conclusion fit** into *my* previous understanding of this subject (does it make biological sense)?

Natl Sci Rev, Volume 7, Issue 9, September 2020, Pages 1422–1427, https://doi.org/10.1093/nsr/nwaa130

Passive versus active reading

Passive reading	Active reading (Q-P/C)
* Obedient purposelessness	▪ Reading with **q**uestions in mind
* Uncritical; blind trust in authorities	* Regard authors as respected but not infallible source of information
▪ 'Finish a job' mentality	▪ Intellectually interested & engaged
▪ Read every sentence/word; inefficient	* Focused, highly selective & more efficient
* Unengaged; boring & tiresome	▪ Critical evaluation via **p**redictions & **c**omparisons
▪ Little understanding of the rationale & experimental design	* Deep understanding of the rationale & experimental design
* Shallow impression	▪ Deep impression

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2. WRITING

How to **write** a scientific paper

WHEN do I start?

a. When you know your conclusions and have proven them to the best of your abilities
b. **More usefully, start fairly early to establish the narrative (i.e. structure) and identify what experiments are missing ("writing is concentrated thinking")**

Don't 'over-cook' your paper…

Consider the idea that *"every paper is just a **progress report** in the development of your field"* – this attitude will help fend off perfectionism that might keep your paper from ever seeing the light of day

Don't 'under-cook' it either

You don't want reviewers to tell you that you've missed an obvious control

How to **write** a scientific paper

Where should I consider sending it?

- Do need a journal to target: sets the format and the style
- Critically self-assess your results and conclusions – is the study of interest to a general or more specialist audience?
- Not all papers should go to CNS – value is ultimately judged by the citation record of the paper, not the impact factor of the journal

Most-cited papers of all time

Lowry, O. H., Rosebrough, N. J., Farr, A. L. & Randall, R. J.	Protein measurement with the folin phenol reagent.	J. Biol. Chem.
Laemmli, U. K.	Cleavage of structural proteins during the assembly of the head of bacteriophage T4.	Nature
Bradford, M. M.	A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding.	Anal. Biochem.
Sanger. F., Nicklen, S. & Couslon, A. R.	DNA sequencing with chain-terminating inhibitors.	Proc. Natl Acad. Sci. USA
Chomczynski, P. & Sacchi, N.	Single-step method of RNA isolation by acid guanidinium thiocyanate-phenol-chloroform extraction.	Anal. Biochem.

How to **write** a scientific paper

What are the important considerations for choosing a journal?

1. Type of journal – general or specialist
2. Try not to be overly concerned about impact factor
3. Reputation in the field
4. Format of the article

BUT also consider depositing on an on-line preprint server: *bioRxiv.org*

Likely the future of biological publishing if *arXiv.org* (physics) is anything to go by

- Advantages: citable doi, early distribution/feedback, **establishes priority of discovery**, help with editors!
- Disadvantages: can compromise submission of patents; “scoop-ability”

Some general advice on compiling the paper

Half of all papers are never cited – make sure yours don't join them!

Ask yourself the following questions:

1. Have you told a story?
2. Is your paper well structured?
3. Have you made things too complicated?
4. Is your title as good as it can be?

Instead of: 'The influence of cadmium, zinc and copper pollution on algal and invertebrate populations living in the River Thames, UK, between 2010 and 2018: a comprehensive analysis', say instead:

'The impact of metal pollution on the ecology of a river'

8. **Have you taken on critical reviews to improve your paper?**

https://www.brunel.ac.uk/news-and-events/news/articles/How-to-write-a-good-scientific-paper

How to **structure** a scientific paper

The Introduction: the most important part according to editors of major journals

1. Provide **Context**
   - Orient the reader but NO UNNECESSARY INFORMATION
   - Works like a funnel – general to specific
   - Implicitly establishes the importance of your work
   - *Example: "…since the early 1990s…"*
2. Explain the **need** for your work
   - Provide an idea of the existing situation in your field
   - State the desired situation (where the field needs to get to)
   - *Example: "but/however/unfortunately we still don't understand…"*
3. Explain what you've **done** in the paper in response to the situation
   - How you addressed this need (in the last paragraph)
   - *Example: "Here, we investigated the behaviour of . . ."* PAST TENSE
4. Finish by grandly stating the **object** of the paper (in the last sentence)
   - What the paper actually achieves (or tries to)
   - *Example: "This paper provides a framework for . . ."* PRESENT TENSE

The writing itself: **the effort**

It's all about revision…

- Writing is an iterative process
- Do not hope to write a perfect paper in one pass
- Work in several (or many) passes
- Focus on progressively smaller parts of the text

My special writing tips

- Use well marked and structured paragraphs to help frame your argument
- Take care of the typos – show how careful a scientist you are
- Try to be as compact, i.e. elegant with your language as possible

  e.g. (1) "An increase in the temperature was observed" should be "the temperature increased"

  e.g. (2) Instead of "serves to positively regulate" just use "activates"
- Be **honest**; if you didn't do something next, don't start "Next, we tested…"
- ***Above all - polish, polish, polish!***

The **key** to good writing

In a word: what all good writing seeks to capture…

“essence”

A great resource for scientific writing (and presentations):
https://www.nature.com/scitable/ebooks/english-communication-for-scientists-14053993/118519859/

In pursuit of the **perfect** sentence

12 Saturday 7 December 2019 *The Daily Telegraph*

In pursuit of the perfect sentence

Every story Lydia Davis writes begins in a notebook, but how does she know when they are ready to let out?

This morning I walk around the house feeling happy and I'm struck by what I'm doing. Actually, I'm struck by only one gesture I happen to make, but that one gesture inspires me to write a sentence describing what I have just been doing. This is usually an effective approach in writing because one striking element can be the culmination of a series of more familiar elements that would not stand on their own.

So I go to my notebook, which is lying open beside my "official" work – a typed and nearly finished story that needs three or four changes. My notebook always lies beside my "official" work because I write in it most when I am supposed to be doing something else. So today I write down a sentence about what I have just been doing. I write it in the third person. I write about myself sometimes in the third person and sometimes in the first. Thinking about it now, I realise what determines this: If it matters that I'm the one doing something, if I am truly the subject, then I write in the first person. If it does not matter who is doing it but I'm simply interested that a person is doing this, then I write in the third person – that is, I'm using myself as a source of material and I'm more comfortable writing in the third person because then I (the writing I) don't get in the way of the character that may evolve from this action. (Sometimes, the "I" has tended to become a "he" in the stories – the "he" being a slightly overweight, feminine sort of man, gentle, androgynous. More recently, the "I" usually becomes a "she.")

So I write it down and then immediately revise it. In revised form it reads: "She walks around the house balancing on the balls of her feet, sometimes whistling and singing, sometimes talking to herself, sometimes stopping dead in a fencing position." Today I have revised this sentence immediately; sometimes I do and sometimes I don't. Maybe it depends on how interested I am in what I write down, or maybe I don't revise it if the writing is so simple or brief that it comes out exactly right the first time. Today it isn't quite right and I must be interested because I revise it: I want it to be exactly right. I will work on it until it is exactly right, whether or not the observation is important and whether or not I think I'll ever "use" it. In fact, I don't often use notebook entries in a story unless the entry turns into the story.

I don't generally use these entries because my stories tend to be written in one uninterrupted "breath" and they usually don't work if I start piecing them together. Then why do I revise the notebook entries? I'm not sure, but I will guess. For one thing, it is hard for me to let a sentence stand if I see something wrong with it. Even when I'm writing a grocery list it is hard for me not to correct a misspelling.

For another, I tend to follow my instinct in writing – I don't question my impulses. So if I want to revise, I don't tell myself there is no point in revising. I follow my instinct: there may be a reason for my doing something, a reason that I don't understand at the moment but that will become clear later on. There may come a day when I will use one or more of these separate notebook entries in a larger written work. I may turn back a few years in the notebook, read an entry, and see how it could become something larger. And if it is poorly written, if it is left unrevised, I will have more trouble seeing what it wants to be.

There is also the constant practice I get from revising notebook entries. And it may be that what I have worked out in the final version of one notebook entry will inspire another sentence in a new story without my even realising it. Or maybe the notebook is a place to practise not only writing but also thinking. After all, when you revise a sentence, you are revising not only the words of the sentence but also the thought in the sentence. And more generally, by getting a certain description exactly right, I am sharpening the acuteness of my observation as well as my ability to handle the language. So there are many ways to justify working hard on one sentence in a notebook, a sentence that you may never use. But most of all, as I said, I follow my impulses in writing (in the notebook) without asking whether what I am doing is sensible, efficient, even moral, etc. I do it because I like to or want to – which is where everything in writing should begin anyway. (As for the question of morality – I won't publish something if it seems to me morally wrong to publish it, but the act of exploration that is writing is very different from the finality and publicness of publishing. Writing is still private until it is made public.)

The notebook is also where I write stories. Every story I write begins in the notebook and in fact is usually written entirely in the notebook. There is a good reason for that, though it took me a while to realise it: in the notebook nothing has to be permanent or good. Here I have complete freedom and so I am not afraid. You can't write well – you probably can't do anything well – if you feel cornered. I am not

Even when I'm writing a grocery list it is hard for me not to correct a misspelling

The tribulations of a professional writer…

https://www.dropbox.com/s/4l1pda0fdu3te8s/perfect_sentence.docx?dl=0

We're all professional writers!

The **problem** with scientific publishing

WORLD VIEW *A personal take on events*

William G. Kaelin Jr
Nobel Prize 2019

Publish houses of brick, not mansions of straw

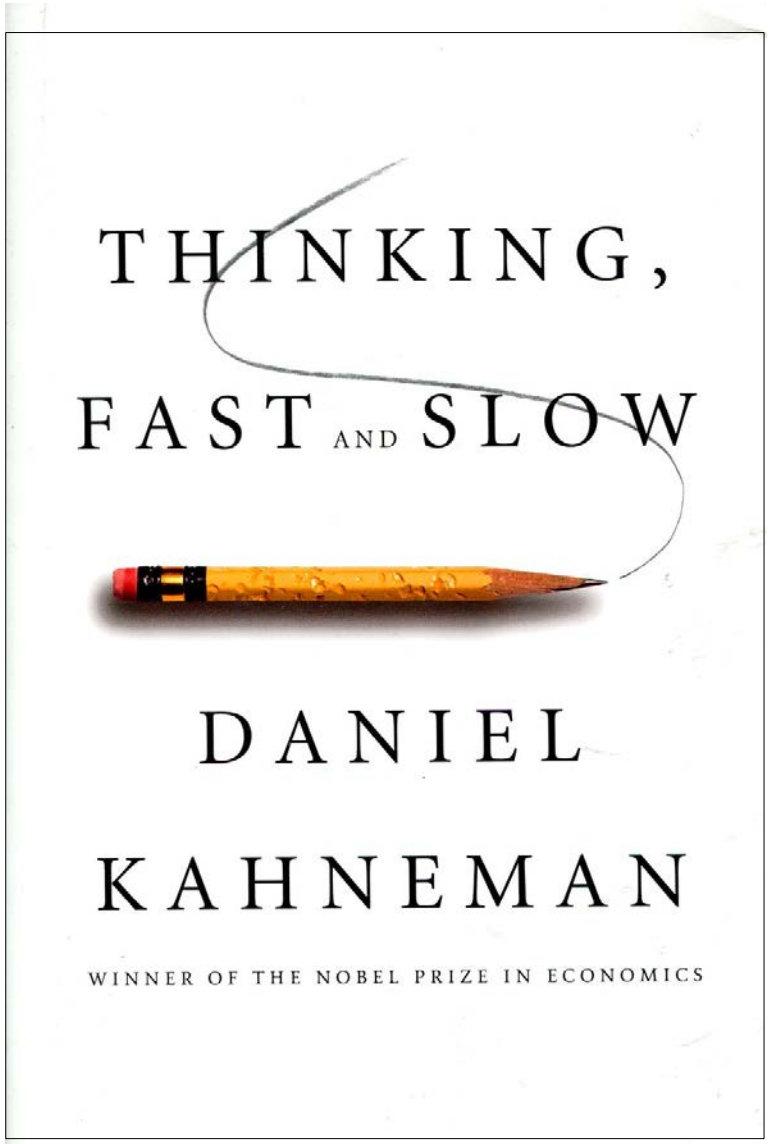
Papers need to include fewer claims and more proof to make the scientific literature more reliable, warns **William G. Kaelin Jr**.

*"We must return to more careful examination of research papers for **originality, experimental design and data quality**, and adopt more humility about predicting impact…"*

https://www.nature.com/news/publish-houses-of-brick-not-mansions-of-straw-1.22029

3. CREATIVITY

Thinking, fast and slow

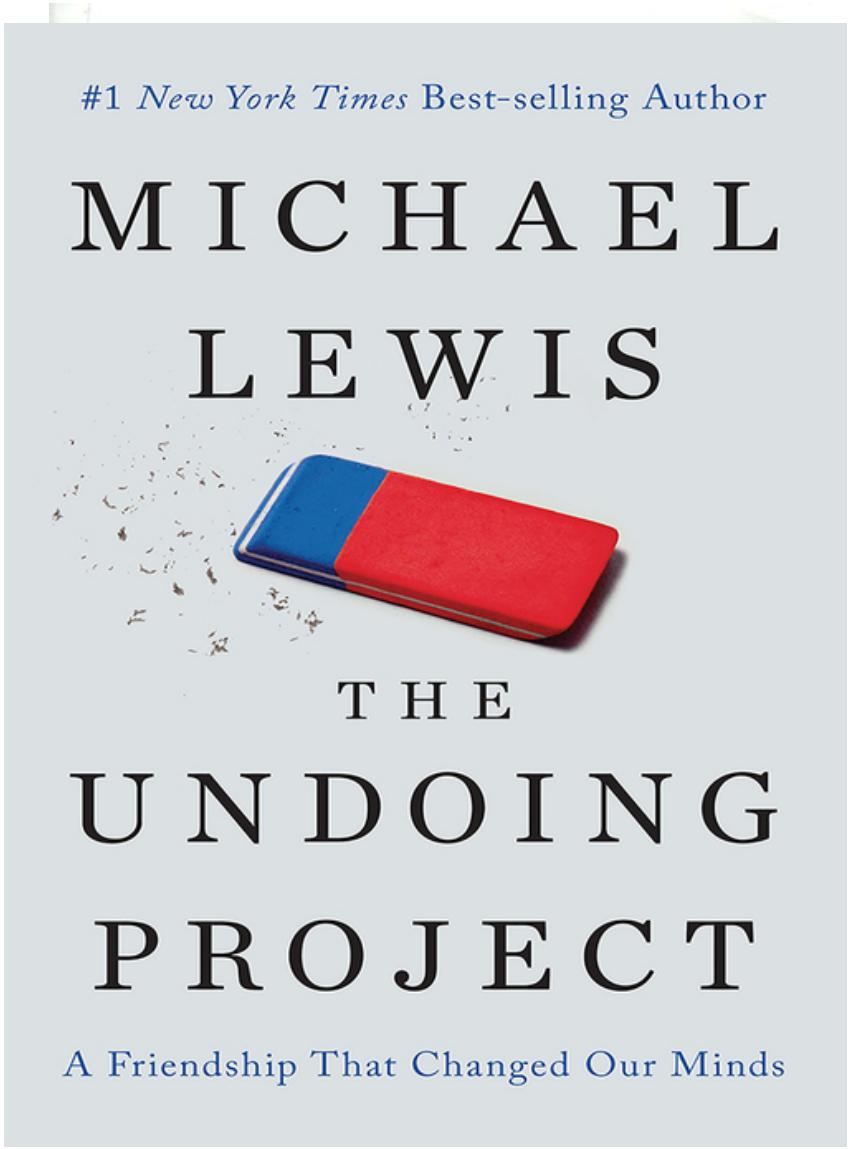


Daniel Kahneman

"How humans make decisions"

e.g. 1/2 chance of £100 vs 1/10 chance of £1000

Thinking, fast and slow



Daniel Kahneman

Nobel Prize (Economics) 2002

Two “thinking systems”

System 1

- fast
- automatic
- intuitive
- subconscious
- effortless

BIASED

e.g. allows us to drive a car whilst listening to a passenger

System 2

- slow
- deliberate
- voluntary
- effortful

LAZY

e.g. allows us to solve a quadratic equation

But what about **creativity**?

Two types of discoveries:

a. Those solved by **observation + inference**
   e.g. the cryo-structure of a receptor

b. Those requiring the **creation** of a new theoretical construct, *e.g.* a counter-intuitive theory of receptor signaling

My (rare) experience of creative episodes

Two features

a. New idea “comes from nowhere”

b. Only when my system 2 is engaged with my work

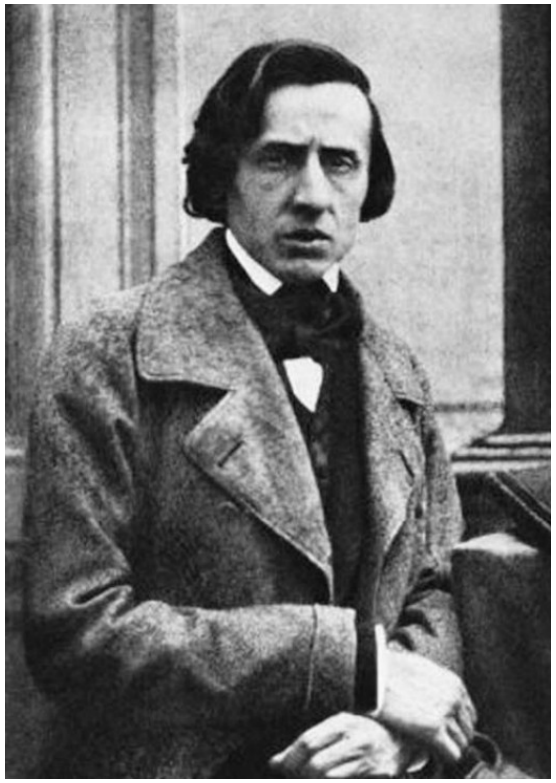
⇨ Conscious thinking opens up a portal to System 1

Time spent thinking*§

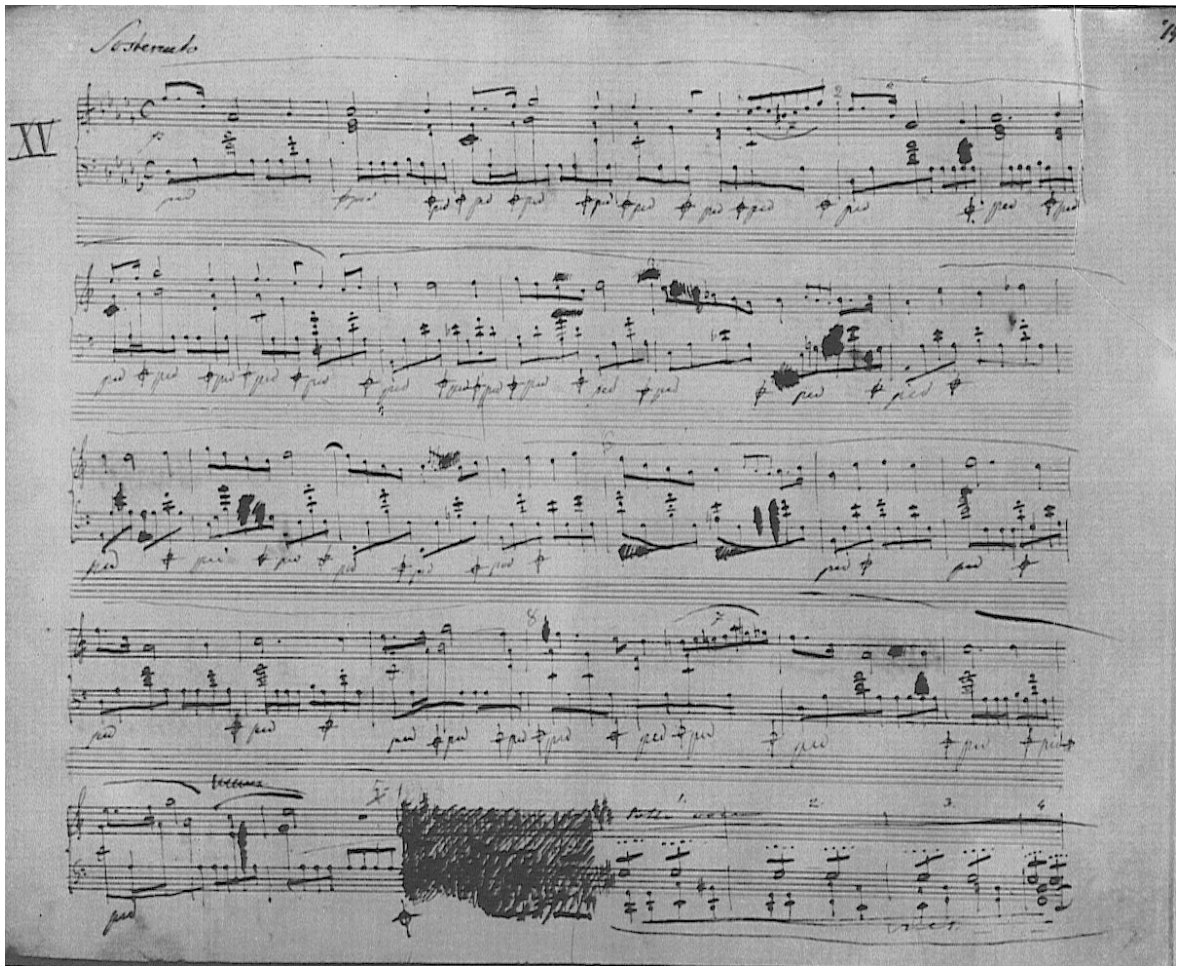
* Not alone in thinking this: Sir Isaac Newton was once asked how he discovered the law of gravity. He replied,
"By thinking about it all the time."

§ Includes talking with (scientific) friends, reading, writing

GENIUS takes time and effort!



Frédéric Chopin



“Raindrop” Prelude Op. 28 no. 15