

HOW TO WRITE A GOOD ABSTRACT FOR A BIOMEDICAL PAPER

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A – study design, **B** – data collection, **C** – statistical analysis, **D** – interpretation of data, **E** – manuscript preparation, **F** – literature review, **G** – sourcing of funding

ABSTRACT

Although a relatively short text, the abstract of a paper summarizes the most important issues raised in the main text. The abstract is, at least initially, the key text on which journal editors, reviewers and eventually readers form their initial judgement on the overall quality of the full manuscript. Therefore, it is essential to execute this step of the writing process well. In this article, we discuss the purpose of an abstract, why it is important, and how to write a good abstract. Increasingly, journal abstracts are structured to follow the IMRAD format (Introduction, Methods, Results, and Discussion). We provide examples of well written and badly written abstracts, with explanatory notes, to help readers understand the key points that need to be addressed and mistakes that should be avoided. Since international abstracts are generally written in English, preparing an abstract can be especially challenging for researchers who are not native speakers of English. We close this article with general linguistic advice, paying particular attention to key terms and word choice than can meaningfully express an author's intention in a concise way. The points raised in this article will help authors improve their scientific writing and enable their findings to be expressed with clarity.

KEYWORDS: scientific writing, writing advice, abstract, IMRAD

WHAT IS AN ABSTRACT?

All researchers will have written an abstract for journal submissions or conference proceedings. The abstract is essentially a mini version of the full paper. The slightly unusual origin of the word, abstract, actually sums up its purpose very nicely. Abstract, in the context of academic articles, comes from the Latin *abstractus* – meaning to draw away. In relation to writing, this means that the central points of the paper are extracted into the form of a very short version of the full manuscript. This text, the abstract, is then a self-contained text that can be understood on its own, including all of the key aspects of the study that is being described. The abstract is drawn away from the main text and is presented at the beginning of the paper. Its purpose is to help readers decide whether or not the study is of sufficient interest for them to read the full manuscript.

WHY IS AN ABSTRACT IMPORTANT?

You may think your abstract is of the same importance as the text in the main body of the paper. In fact, as I will show, the abstract and title are the most important part of your written work. This is best understood in terms of who the readers of your work are. As a general rule, a good abstract indicates a good paper, whereas a bad abstract – a weak one.

Potential Readers. The most obvious targets are other scientists. Many scientists may read the abstract but far fewer read the paper. There needs to be enough information so that readers can decide whether or not to read the full paper.

Reviewers. Before your paper is even considered for publication it needs to be reviewed. Typically, 2-3 reviewers will read and evaluate your manuscript for its strengths and weaknesses. Based on this, they will accept or reject the publication or recommend minor/

major revisions. When reviewers are invited to review a text the only information they have to go on is the title and abstract (the full text is usually only accessible if the reviewer agrees). Reviewers are often busy and do not have to review a paper. Indeed, reviewers may be close to making a final decision on the whole paper after having read the abstract alone. Therefore, it is fundamental that your title, and abstract, are well written to even be considered for publication.

Search Engines. Gone are the days when students and researchers searched through library journals to find papers, photocopying, and then continuing their search for more related articles. As a student, it always felt very rewarding to find a long sought-after paper. Nowadays, once a manuscript has been accepted by a journal it is uploaded to various electronic libraries, and all searching can be done with the click of a button. However, in most cases only the title, and abstract, are visible to internet search engines. The main text often remains inaccessible behind paywalls. As such, your published abstract will be readily available on the internet, and the choice of keywords you use influences how easily your abstract can be found.

THE STRUCTURE OF AN ABSTRACT

Early journals often published reports as chapters or letters where the writing style was usually descriptive and often chronological, e.g., “first I did [...] then I did [...]”. Key points of a paper, such as motivations, assumptions, results, and methodologies, were often buried in the text. As techniques became more advanced and the need for research reproducibility grew, the importance of clear scientific writing became a prominent issue. In the 1950s, Sir Austin Bradford Hill, a British epidemiologist and statistician who was increasingly frustrated with the lack of uniformity in scientific writing, stated that there were four central questions:

1. “Why did you start?” – Introduction
2. “What did you do?” – Methods
3. “What answer did you get?” – Results
4. “What does it mean?” – Discussion

These are usually formulated into the IMRAD (Introduction, Methods, Results, and Discussion) format of papers that has been adopted by most journals. In parallel, the IMRAD format is the most widely used approach for writing an abstract. This is known as a structured abstract with the Introduction, Methods, Results, and Discussion forming subheadings within the abstract. Abstracts often follow a wineglass structure with the opening and closing sentences very general and the detailed content in the methods and results sections. Typically, a structured abstract has 1-2 sentences for the Introduction, 1-2 for Methods, 3-4 for Results, and 1-2 for Discussion.

Not all journals have adopted the IMRAD approach, even many high-profile traditional journals, such as *Nature* and *Science*. However, the parallel structure can still be clearly seen despite the lack of subheading. Often in these cases, a series of related studies have been car-

ried out to address a common problem, and therefore combining methods with results is a clear way to express these findings. Below you can find two examples published from high-impact journals, i.e., *Nature* and *Neuron*. In both, the abstracts open and close with broadly understood concepts understandable to non-specialists. The main section provides sufficient detail for specialists to grasp the novelty and sufficient details of the work.

Activation of microglia and inflammation-mediated neurotoxicity are suggested to play a decisive role in the pathogenesis of several neurodegenerative disorders. Activated microglia release pro-inflammatory factors that may be neurotoxic. Here we show that the orderly activation of caspase-8 and caspase-3/7, known executioners of apoptotic cell death, regulate microglia activation through a protein kinase C (PKC)- δ -dependent pathway. We find that stimulation of microglia with various inflammogens activates caspase-8 and caspase-3/7 in microglia without triggering cell death in vitro and in vivo. Knockdown or chemical inhibition of each of these caspases hindered microglia activation and consequently reduced neurotoxicity. We observe that these caspases are activated in microglia in the ventral mesencephalon of Parkinson’s disease (PD) and the frontal cortex of individuals with Alzheimer’s disease (AD). Taken together, we show that caspase-8 and caspase-3/7 are involved in regulating microglia activation. We conclude that inhibition of these caspases could be neuroprotective by targeting the microglia rather than the neurons themselves. (Burguillos et al., 2011)

The olfactory bulbs (OBs) are the first site of odor representation in the mammalian brain, and their unique ultrastructure is considered a necessary substrate for spatiotemporal coding of smell. Given this, we were struck by the serendipitous observation at MRI of two otherwise healthy young left-handed women, yet with no apparent OBs. Standardized tests revealed normal odor awareness, detection, discrimination, identification, and representation. Functional MRI of these women’s brains revealed that odorant-induced activity in piriform cortex, the primary OB target, was similar in its extent to that of intact controls. Finally, review of a public brain-MRI database with 1,113 participants (606 women) also tested for olfactory performance, uncovered olfaction without anatomically defined OBs in ~0.6% of women and ~4.25% of left-handed women. Thus, humans can perform the basic facets of olfaction without canonical OBs, implying extreme plasticity in the functional neuroanatomy of this sensory system. (Weiss et al., 2020)

Introduction

Methods and Results

Discussion

EXAMPLE OF A BADLY STRUCTURED ABSTRACT

Introduction: Huntington's (HD) disease is an autosomal dominant neurodegenerative disease with no known cure. It is caused by progressive nerve cell death primarily affecting the dorsal striatum and leads to motor and cognitive symptoms. The mean age of onset is 35 to 44 years and the median survival time is 15 to 18 years after onset and was first identified by George Huntington in 1872. The HTT mutation that causes Huntington disease involves a DNA segment known as a CAG trinucleotide repeat. Here, we investigated whether creatine treatment would slow the progressive functional decline in HD.

Methods: We conducted a randomized, double-blind, placebo-controlled study of up to 40 g daily of creatine monohydrate in participants with stage I and II HD treated for up to 3 years. Functional decline was assessed using the Unified Huntington's Disease Rating Scale. The study was carried out at the Department of Neurology, Jupiter Hospital, Jupiter Road, Leeds, England. All data were originally collected with appropriate preapproval of human ethics committees and written informed consent at each site in each respective study. Eligible participants were in stage I or II of HD (TFC ≥ 7), were over 18 years old and had a confirmatory family history. Study personnel, participants, caregivers, steering committee members, and NIH program staff were blinded to treatment assignment until study conclusion.

Results: We analyzed all four domains – motor function, cognitive function, behavioral abnormalities, and functional capacity. Next, we examined if the changes in each domain were correlated with each other. Adverse events, mainly gastrointestinal, were significantly more common in participants on creatine. Subgroup analysis suggested that men and women may respond differently to creatine treatment.

Discussion: Comparison between the findings reported here and in other studies are discussed. This study's primary limitation was that the data were gathered only from a small number of patients and therefore, further research is needed to confirm the generalizability of the study's results.

CRITIQUE

These are common problems which can be found in abstract.

Introduction. This is much too long. The only really important sentences are the first and the last one. The sentences in between are all superfluous information for this type of abstract.

Methods. This is also much too long. The only essential sentences are the first two sentences. The rest belong in the Methods section of the paper. It is not necessary to state specifically, with the full address, where the study was carried out. Ethics approval statements and details of methodology do not belong here either. Abbreviations, e.g., TFC, should not be used

unless spelled out in full. Numbers of patients are also not stated.

Results. The important results are not presented at all, just statements that these data can be found in the main text! This is a surprisingly common mistake, and it puts your abstract at an immediate disadvantage when the reader does not see clearly what your results are. The only concrete result is that there were drug side effects. It's perfectly correct to include this information, as it might be an important finding, and negative data as well as positive data do need to be reported.

Discussion. Another common issue is that the authors do not draw out a single message from their paper. Was creatine potentially beneficial or not? Does the data support the use of this drug in the treatment of HD or not? A simple sentence is all that is needed. Limitations, unless specifically requested by an editor, are very rarely included in the main abstract. This belongs in the Discussion section of the main paper.

LINGUISTIC AND STYLISTIC CORRECTNESS IN A GOOD ABSTRACT

An abstract is very short, typically 200-300 words. So, it can be hard to encapsulate the full manuscript, which is typically 4,000-6,000 words into such a short piece of text. Since the main language used in international publication is English, this can put authors whose first language is not English at a disadvantage but not severely so, since scientists are writing scientific, rather than literary, works. Researchers whose second language is not English might consider that scientific language should be complicated, using multiple clauses, and essentially esoteric and only understood by an enlightened few. Nothing could be further from the truth. Good scientific writing is clear and concise. Use of superfluous words, clauses, and certainly metaphors should be avoided. It is important that the terms used are consistent with those used in the existing canon of scientific language but, aside from terminology, the expression should be as simple as possible (refer to the abstract shown in this article).

The language of the abstract should be adjusted to the scientific indicators. Thus, the authors should avoid using any colloquial expressions and those which may be not understood – or even misunderstood. The scientific character of the paper has two sides – one concerns the message, and therefore the essence of the text, and the other, by contrast, is related to the meticulous and appropriate selection of specialist terminology. This is particularly important when the papers are written by non-native speakers of English – as it is the lead language used in international journal publications. It is essential to take care in finding the proper equivalents and to avoid any ambiguous wording that may cause readers' – but firstly, reviewers' and editors' – doubts. Another crucial matter is the aesthetics of the manuscript. Almost every editorial board provides the formal

and editorial requirements that have to be applied in scientific papers. They mainly concern editing the paper according to the common patterns, i.e., font style, its size, line spacing, paragraphs, and highlights. Although these elements do not significantly affect the reception, they play an important part in the manner it is read. Editorial requirements, however, do not only refer to the described elements. There are also those that determine the proper reception of the text and its adequacy, i.e., the length of the abstract, the way thoughts are organized, placement of figures and other secondary elements, as well as creation of bibliographic descriptions.

PHRASES TO USE IN AN ABSTRACT (AND MAIN TEXT)

Below we present some expressions that authors may find useful in the different sections of a structured abstract.

Introduction

- “[...] is a neurodegenerative disease with no known cure.”
- “However, it remains unclear how [...]”
- “We have shown recently that [...]”

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