**HOW TO WRITE**

**A RESEARCH INTRODUCTION**

The introduction to a research paper can be the most challenging part of the paper to write. The length of the [introduction](http://www.wikihow.com/Write-Introductions) will vary depending on the type of research paper you are writing, but an introduction should always announce your topic and provide a context and a rationale for your work, before stating your research questions and hypothesis. Well-written introductions catch the reader's interest, and communicate the hypothesis or thesis statement.

**1/ What an academic forum\* says on the question**

\*Academia Stack Exchange is a question and answer site for academics and those enrolled in higher education

Q : “How does one write a strong (good) introduction into a research paper? Some introductions make me really curious about the rest of the paper while others do not. Although it is relatively easy to say which introductions are good and which are not, I find it difficult to distill what makes the difference”.

* write the paper first, then tack on a beginning and end. That way you will know what it’s about.

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| |  |  | | --- | --- | |  |  | | * Here's a bit of meta-advice on this point. One major way I've learned how to improve introductions is by thinking hard about negative referee reports. In my experience, when a paper gets a referee report that I disagree with, the explanation is often that the introduction needed to be clearer about something. | | | |
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| * [Previous] advice is spot on (although one might aspire to write a good introduction earlier in the day than this) and really points to the importance of the question: the difference between an average introduction and a good one is often the difference between your paper being grokked or not by some fairly random referee who has sufficient subject-level expertise but is not closely clued in to your particular perspective. | | |
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| * The way I think about introductions (which is not to say they are GOOD introductions) is that they tell the story of the paper in brief. Every paper has a story to tell, starting with * Here's a fascinating question * Here's what people have tried to do (in brief: not a full related work section, but a high level assesment) * here's the key challenge preventing further progress * Voila: here's our complete/partial/intermediate/awesome solution * (additionally) and here's how it works.   The intro is typically the "hook" to read the rest of the paper, so you have to provide a birds-eye view that draws the reader in without drowning them in details.  The thing that separates a good intro from a bad one is knowing where that right level of detail is, so you're not either totally vacuous or mired in details. Getting this right is an art and depends on your field, your results, the problem, and your understanding of the target audience.   * I was recently forwarded (what I think) is a guide full of excellent advice, Writing Tips for Ph. D. Students by John Cochrane. In it, Cochrane has a brief section of advice on the introduction:   § The introduction should start with what you do in this paper, the major contribution. You must explain that contribution so that people can understand it. Don’t just state your conclusion: “My results show that the pecking-order theory is rejected.” Give the fact behind that result. “In a regression of x on y, controlling for z, the coeﬃcient is q.”  § The ﬁrst sentence is the hardest. Do not start with philosophy, “Financial economists have long wondered if markets are eﬃcient.” Do not start with “The ﬁnance literature has long been interested in x.” Your paper must be interesting on its own, and not just because lots of other people wasted space on the subject. Do not start with a long motivation of how important the issue is to public policy. All of this is known to writers as “clearing your throat.” It’s a waste of space. Start with your central contribution.  § Three pages is a good upper limit for the introduction.  This just reiterates the point [two previous contributors] made that the introduction should clearly state what the paper is about, and also some more detailed advice about avoiding generic intro. statements. (Note the upper bound is good for social science articles that may be from 20~40 pages, it should be much lower for briefer articles in different fields or journals.) | | | |
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|  | |  |  |  |  | | --- | --- | --- | --- | | |  |  | | --- | --- | |  |  | | >> Yes, I read something somewhere before about these types of generic introductory phrases, calling the practice "grandfathering" ... which is the idea of writing passages out of a sense of tradition in such a way that they are extremely familiar only to experts and incomprehensible to anyone else. Hence these passages are utterly useless since nobody learns anything. It seems introductions to papers are littered with them. I do it myself I guess. Bad habits. :) | | |  |  | | --- | --- | |  |  | | >>> After I read this advice I went through my current papers and edited such things out. When I first write something I don't care very much about specific sentences, and if writing such things helps get the ball rolling then that is fine - but they should be deleted or copy-edited later on. | |

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|  | * Some points to take into consideration (not an exhaustive list):  1. Correct grammar: for obvious reasons. 2. Proper literature review: many readers find annoying when the authors claim to be the first people attacking the problem of interest, while the reader is well aware of other relevant references. 3. State clearly the aims and main results in the introduction. It is frustrating when you have to read the entire paper to understand its purpose. 4. Not too long, not too short. A long introduction will make the idea of skipping this section really tempting, while a short introduction might compromise clarity or points 2 and 3. 5. Cover points of interest for different audiences. For example, try to explain the impact of the paper or the topic in terms of both theoretical and practical issues. |

**2/ What you are attempting to do, then**

In the introduction, you are attempting to inform the reader about the rationale behind the work, justifying why your work is an essential component of research in the field.

The introduction does not have a strict word limit, unlike the [abstract](https://explorable.com/writing-an-abstract), but it should be as concise as possible. It can be a tricky part of the paper to write, so many scientists and researchers prefer to write it last, ensuring that they miss no major points.

The [Introduction](https://explorable.com/how-to-write-an-introduction) should contain your [thesis statement](https://explorable.com/what-is-a-thesis-statement) or the topic of your research as well as the purpose of your study. You may include here the reason why you chose the particular topic or simply the significance of your research paper's topic. You may also state what type of approach it is that you'll be using in your paper for the entire discussion of your topic.

Generally, your introduction should state briefly all the major points of your topic your readers will be reading about.

The introduction gives an overall [review](https://explorable.com/what-is-a-literature-review) of the paper, but, unlike the abstract, it works upon the principle of introducing the topic of the paper and setting it into a broad context, gradually narrowing down to a [research problem](https://explorable.com/defining-a-research-problem), thesis and [hypothesis](https://explorable.com/how-to-write-a-hypothesis)\*. A good introduction explains how you mean to solve the [research problem](https://explorable.com/research-paper-question), and creates ‘leads’ to make the reader want to delve further into your work.

**\* An Example of How to Write a Hypothesis**

A worker on a fish-farm notices that his trout seem to have more fish lice in the summer, when the water levels are low, and wants to find out why. His research leads him to believe that the amount of oxygen is the reason - fish that are oxygen-stressed tend to be more susceptible to disease and parasites.

He proposes a general hypothesis: ***“Water levels affect the amount of lice suffered by rainbow trout.”*** This is a good general hypothesis, but it gives no guide to how to design the [research](https://explorable.com/what-is-research) or [experiment](https://explorable.com/conducting-an-experiment).

The hypothesis must be refined to give a little direction: ***“Rainbow trout suffer more lice when water levels are low.”*** Now there is some directionality, but the hypothesis is not really [testable](https://explorable.com/testability).

The final stage is to [design an experiment](https://explorable.com/design-of-experiment) around which research can be designed, a testable hypothesis: ***“Rainbow trout suffer more lice in low water conditions because there is less oxygen in the water.”*** This is a testable hypothesis - he has established [variables](https://explorable.com/research-variables), and by measuring the amount of oxygen in the water, eliminating other [controlled variables](https://explorable.com/controlled-variables), such as temperature, he can see if there is a [correlation](https://explorable.com/statistical-correlation) against the number of lice on the fish.

This is an example of how a gradual focusing of research helps to define [how to write a hypothesis](http://www.wikihow.com/Write-a-Hypothesis).

**3/ The right ingredients …**

**Background**

Like in any good Hollywood movie, the first task of the introduction is to set the scene, giving your paper a context and seeing how it fits in with previous research in the field.

Whilst not the only way, this section, comprising the first paragraphs of your introduction, can be based around a historical narrative, from the very first research in the field to the current day.

In many fields, this could make up an entire essay in itself, so you have to stick to relevant information.

**Importance**

This leads into the rationale behind the research, revealing whether it is building upon previous research, looking at something that everybody else has overlooked, or improving upon a previous research project that delivered unclear results.

This section can then flow into how you are going to fill the gap, laying out your objectives and [methodology](https://explorable.com/writing-methodology). You are trying to predict what impact your research will have if everything works as it should, and you ultimately reject the [null hypothesis](https://explorable.com/null-hypothesis).

**Limitations**

The introduction is the place to highlight any weaknesses in the experiment from the start.

For example, an ideal [experiment](https://explorable.com/experimental-research) should have perfectly [randomized samples](https://explorable.com/randomized-controlled-trials), but there are many good reasons why this is not always possible. As long as you warn the reader about this, so that they are aware of the shortcomings, then they can easily judge the [validity](https://explorable.com/validity-and-reliability) of the research.

This is much better than making them wait until you point it out in the [discussion](https://explorable.com/writing-a-discussion-section).

**Assumptions**

You should also point out any assumptions that you make about conditions during the research. You should set out your basic principles before embarking upon the experiment: any research will be built around some assumptions.

For example, if you were performing educational research, you may assume that all students at the same school are from a very similar socio-economic background, with randomization smoothing out any [variables](https://explorable.com/research-variables).

**… and tips**

There are a few tips that can help you write a strong introduction, arousing interest and encouraging the reader to read the rest of your work.

* **Keep it Short**  
  A long and rambling introduction will soon put people off and lose you marks.
* **Define the Problem**  
  The entire introduction should logically end at the research question and thesis statement or hypothesis. The reader, by the end of the introduction, should know exactly what you are trying to achieve with the paper. In addition, your [conclusion](https://explorable.com/writing-a-conclusion) and [discussion](https://explorable.com/writing-a-discussion-section) will refer back to the introduction, and this is easier if you have a clearly defined problem.
* **Organisation**

As you write the paper, you may find that it goes in a slightly different direction than planned. In this case, go with the flow, but make sure that you adjust the introduction accordingly. Some people work entirely from an outline and then write the introduction as the last part of the process.

* **Introduction vs abstract**

The abstract is the only text in a research paper to be written without using paragraphs in order to separate major points.

The following approach can produce an effective introduction:

* Describe the importance (significance) of the study - why was this worth doing in the first place? Provide a broad context.
* Defend the model - why did you use this particular system? What are its advantages? You might comment on its suitability from a theoretical point of view as well as indicate practical reasons for using it.
* Provide a rationale. State your specific hypothesis(es) or objective(s), and describe the reasoning that led you to select them.
* Very briefy describe the experimental design and how it accomplished the stated objectives.

**4 / Assembling the bricks**

**Block 1: Introducing the Topic of the Paper**

**1/1 Announce your research topic.** You can [start](http://www.wikihow.com/Start-a-Research-Paper) your introduction with a few sentences which announce the topic of your paper and give an indication of the kind of research questions you will be asking. This is a good way to introduce your readers to your topic and pique their interest. The first few sentences should act as an indication of a broader problem which you will then focus in on more closely in the rest of your introduction, leading to your specific research questions.

* In scientific papers this is sometimes known as an "inverted triangle", where you start with the broadest material at the start, before zooming in on the specifics.
* It provides the reader with an indication of the content of the essay and encourages him/her to read on.

**1/2 Consider referring to key words.** When you [write a research paper](http://www.wikihow.com/Write-a-Research-Paper) for publication you will be required to submit it along with a series of key words which give a quick indication of the areas of research you are addressing. You may also have certain key words in your title which you want to establish and emphasise in your introduction.

* For example, if you were writing a paper about the behaviour of mice when exposed to a particular substance, you would include the word "mice", and the scientific name of the relevant compound in the first sentences.

**1/3** **Define any key terms or concepts.** It may be necessary for you to clarify any key terms or concepts early on in your [introduction](http://www.wikihow.com/Write-an-Essay-Introduction). You need to express yourself clearly throughout your paper so if you leave an unfamiliar term or concept unexplained you risk your readers not having a clear understanding of your argument.

* This is especially important if you are attempting to develop a new conceptualization that uses language and terminology your readers may be unfamiliar with.

**Block 2: Establishing the Context for Your Paper**

**2/1 Include a brief literature review.** Depending on the overall length of your paper, it will be necessary to include a review of the existing literature already published in the field. This is an important element of your paper which demonstrates that you have a strong knowledge and understanding of the debates and scholarship in your area. You should aim to indicate that you have a broad knowledge, but that you are engaging in the specific debates most relevant to your own research.

* It is important to be concise in the introduction, so provide an overview on recent developments in the primary research rather than a lengthy discussion.
* You can follow the "inverted triangle" principle to focus in from the broader themes to those to which you are making a direct contribution with your paper.

**2/2 Use the literature to focus in on your contribution.** A concise but comprehensive literature review is a very effective way to frame your own research paper. As you develop your introduction, you can move from the literature to focus in on your own work and its position relevant to the broader scholarship.

* By making clear reference to existing work you can demonstrate explicitly the specific contribution you are making to move the field forward.
* You can identify a gap in the existing scholarship and explain how you are addressing it and moving understanding forward.

**2/3 Elaborate on the rationale of your paper.** Once you have framed your work within a broader context you can elaborate more fully on the rationale of your research and its particular strengths and importance. The rationale should clearly and concisely indicate the value of your paper and its contribution to the field. Try to go beyond saying that you are filling a gap in the scholarship and emphasise the positive contribution of your work.

* For example, if you are writing a scientific paper you could stress the merits of the experimental approach or models you have used.
* Stress what is novel in your research and the significance of your new approach, but don't give too much detail in the introduction.
* A stated rationale could be something like: "the study evaluates the previously unknown anti-inflammatory effects of a topical compound in order to evaluate its potential clinical uses".

**Block 3: Specifying Your Research Questions and Hypothesis**

**3/1 State your research questions.** Once you have indicated where your research sits in the field and the general rationale for your paper, you can specify the research questions the paper addresses. The literature review and rationale frames your research and introduces your research question. This question should be developed fluently from the earlier parts of the introduction and shouldn't come as a surprise to the reader.

* The research question or questions generally come towards the end of the introduction, and should be concise and closely focused.
* The research question might recall some of the key words established in the first few sentences and the title of your paper.
* An example of a research question could be "what were the consequences of the North American Free Trade Agreement on the Mexican export economy?"
* This could be honed further to be specific by referring to a particular element of the Free Trade Agreement and the impact on a particular industry in Mexico, such as clothing manufacture.
* A good research question should shape a problem into a testable hypothesis.

**3/2 Indicate your hypothesis.** After you have specified your research questions you need to give a clear and concise articulation of your hypothesis, or your thesis statement. This is a statement which indicates your essay will make a specific contribution and have a clear result rather than just covering a broader topic. You should make it clear briefly how you came to this hypothesis in a way which references your discussion of the existing literature.

* An example of a hypothesis could be "mice deprived of food for the duration of the study were expected to become more lethargic than those fed normally".

**3/3 Outline the structure of your paper.** In some cases the final part of an introduction to a research paper will be a few lines that provide an overview of the structure of the body of the paper. This could simply give an outline of how you have organised the paper and how it is broken down into sections.

**5 / Style …**

* Use past tense except when referring to established facts. After all, the paper will be submitted after all of the work is completed.
* Organize your ideas, making one major point with each paragraph. If you make the four points listed above, you will need a minimum of four paragraphs.
* Present background information only as needed in order support a position. The reader does not want to read everything you know about a subject.
* State the hypothesis/objective precisely - do not oversimplify.
* As always, pay attention to spelling, clarity and appropriateness of sentences and phrases.

**… and a few writing rules (presented facetiously)**

1. Verbs HAS to agree with their subjects.  
2. Prepositions are not words to end sentences with.  
3. And don't start a sentence with a conjunction.  
4. It is wrong to ever split an infinitive.  
5. Avoid cliches like the plague.   
6. Also, always avoid annoying alliteration.  
7. Be more or less specific.  
8. Parenthetical remarks (however relevant) are (usually) unnecessary.  
9. Also too, never, ever use repetitive redundancies.  
10. No sentence fragments.  
11. Contractions aren't necessary and shouldn't be used.  
12. Foreign words and phrases are not apropos.  
13. Do not be redundant; do not use more words than necessary; it's highly superfluous.  
14. Comparisons are as bad as cliches.  
15. Avoid abbreviations, etc.  
16. One-word sentences? Eliminate.  
17. The passive voice is to be ignored.  
18. Eliminate commas, that are, not necessary. Parenthetical words however should be enclosed in commas.  
19. Never use a big word when a diminutive one would suffice.  
20. Use words correctly, irregardless of how others use them.  
21. Understatement is always the absolute best way to put forth earth-shaking ideas.  
22. Eliminate quotations. As Ralph Waldo Emerson said, "I hate quotations. Tell me what you know."  
23. Who needs rhetorical questions?  
24. Exaggeration is a billion times worse than understatement.

And the last one...

25. Proofread carefully to see if you any words out.

**6/ Common Errors in Student Research Papers**

**Quotes**

When you write a paper related to literature, history, current events, and many other fields, direct quotes may be essential to a full discussion of the subject. In science, there is very rarely any call for a direct quote. In student papers, there is no reason at all to include direct quotes, except in the case when the student doesn't understand the concept and uses the quote to avoid having to explain it him/herself. Obviously, this doesn't go over too well with the grader. As a rule, do not use direct quotes in a scholarly technical paper. Your own thoughts must be expressed, not those of someone else.

**Verb tense**

Use of the wrong verb tense reflects poorly on the student's writing skills. At worst, the reader can be confused as to what facts are already known and what was newly discovered in the actual study that is the subject of the paper. As a rule, use past tense to describe events that have happened. Such events include procedures that you have conducted and results that you observed. Use present tense to describe generally accepted facts.

“We **sought** to determine if mating behavior in Xiphophorus helleri **is** related to male tail length by placing combinations of two male fish with different length tails in the same tank with a female fish.”

“We **found** that protein synthesis in sea urchin embryos treated with actinomycin D **was** considerably less than in untreated embryos. This finding agrees with the model stating that protein synthesis in 24 hour sea urchin embryos **is** dependent on synthesis of new messenger RNA.”

Reference to results of a specific study should also be in past tense.

“Abercrombie and Fitch **reported** that 30% of the public is allergic to wool.”

Mixing tenses is awkward and/or difficult to understand.

(from a newspaper article) Two inmates **hide** in trailer to escape South Carolina prison.

[If they know the inmates are in the trailer, why don't they just go in and get them? What the article actually reported was that the two had hidden in a trailer which was driven out of prison, allowing them to escape.]

**Irrelevant information**

* **Anecdotal information**

You might think it appropriate to write "we used Microsoft Excel to produce a graph of x versus y." Such information is anecdotal and is considered to be superfluous. Papers in the older literature tend to be a lot more exciting and often more informative for those not 'in the know,' because the researcher could report how a conclusion was reached, including the reasoning and various sidetracks that led him/her to conclusions. The writer could actually tell the story of the investigation process. Modern papers omit such information because the volume of literature is so great that people doing a search don't have time to wade through more material than they need.

A research paper summarizes a study. It does not identify who did what. Reference to instructors, fellow students, teams, partners, etc. are not appropriate, nor is it appropriate to refer to "the lab."

* **Unnecessary background**

If you state facts or describe mechanisms, do so in order to make a point or to help interpret results, and do refer to the present study.

* **Including material that is inappropriate for the readership**

It isn't necessary to tell fellow scientists that your study is pertinent to the field of biochemistry. Your readers can figure out to what field(s) your work applies. You need not define terms that are well known to the intended readership. For example, is it really necessary to define systolic blood pressure if your readership consists of physicians or cardiovascular physiologists?

* **Subjectivity and use of superlatives**

Technical writing differs from the writing of fiction, opinion pieces etc. in many ways. One way is in the use of superlatives and subjective statements in order to emphasize a point. One does not use such writing styles in science; objectivity is absolutely essential.

Subjectivity refers to feelings, opinions, etc. For example, in your discussion you might write, "We felt that the fixative was bad, because we had difficulty finding flagella on our Chlamydomonas." Another researcher is unlikely to risk time and resources on the basis of your "feeling." On the other hand, you might write, "The percentage of cells with flagella was inversely proportional to the time they spent in fixative, suggesting that the fixative was causing cells to shed flagella." This is information that another scientist can use.

Superlatives include adjectives such as "huge," "incredible," "wonderful," "exciting," etc. For example, "the mitochondria showed an incredibly large increase in oxygen consumption when we added uncoupling agent." Your definition of incredible might be different from that of someone else - perhaps a fivefold increase is incredible to you, but not for the next person. It is much better to use an objective expression, such as "Oxygen consumption was fivefold greater in the presence of uncoupler, which is a greater change than we saw with the addition of any other reagent."

**Grammar and spelling**

Avoid obvious grammatical errors. Clear written communication requires proper sentence structure and use of words. Make sure that your sentences are complete, that they make sense when you proofread, and that you have verb/subject agreement.

**Inaccurate word or phrase**

- “Changing temperature had the following *affect* on the subject”.

'Affect' is a verb. 'Effect' is a noun. What happened to the subject was an effect. The temperature change affected the subject.

- “The data lead to the *assumption* that x has no relationship to y”.

If you base a conclusion on data, then your conclusion is a deduction, not an assumption. In fact, in experimental science assumptions are usually avoided. A purpose of controls is to eliminate the need to assume anything.

The word 'data' is plural. However since investigators usually refer to sets of data, there is a tendency to use the word as though it was singular. Hence a writer will state, 'the data was affected by the phase of the moon,' or 'the data suggests that phase of the moon has no effect on mood.' As awkward as it may seem to you, the proper phrases are, 'the data *were* affected...,' and 'the data *suggest*...' By the way, the singular form is 'datum.'

**Anthropomorphism**

Anthropomorphism is a type of oversimplification that helps the writer avoid a real explanation of a mechanism.

“Sodium wants to move down the chemical gradient toward the compartment with the lower concentration”.

The thought behind the statement is correct, but the statement does not represent the correct mechanism. Sodium has no free will. It tends to move toward the compartment with lower concentration because the probability of a sodium ion moving through a channel on the more concentrated side of the membrane exceeds the probability that an ion will move through a channel on the less concentrated side. If you don't want to explain the principle behind osmosis, you can simply state that osmotic pressure tends to drive sodium from the more highly to less highly concentrated side of a membrane.

**7/ Application #1: a hypothetical example of a research paper based on an experiment.**

Imagine you have just conducted the [Milgram Study](https://explorable.com/stanley-milgram-experiment); now you want to [write the research paper](https://explorable.com/write-a-research-paper-0) for it. Here's an example of a research article that might have been written (a short version).

"Behavioral Study of Obedience"

by [author], [University]

1961

**Abstract**

There are little facts about the role of obedience when doing evil actions up until now (1961). Most theories suggest that only very disturbed people do horrible actions if they are ordered to do so. Our experiment tested people's obedience to authority. The results showed that most obey all orders given by the authority-figure. The conclusion is that when it comes to people harming others, the situation a person's in is more important than previously thought. In contrary to earlier belief, individual characteristics are less important.

**Introduction**

Current theories focus on personal characteristics to explain wrong-doing and how someone can intentionally harm others. In a survey, professionals such as doctors, psychologist and laymen thought that very few out of a population (1-3%) would harm others if ordered to do so.  
    In the recent war trial with Adolph Eichmann, he claims to "only have been following orders". The author wanted to test whether this is true, or just a cheap explanation. Can people harm others because they obey the orders? Are good-hearted people able to do this?  
    The experiment tested whether a person can keep giving electric shocks to another person just because they are told to do so. The expectation was that very few would keep giving shocks, and that most persons would disobey the order.

**Methods**

Participants  
There were male 30 participants participating. They were recruited by advertisement in a newspaper and were paid $4.50.  
Instruments  
A "shock generator" was used to trick the participants into thinking that they gave shock to another person in another room. The shock generator had switches labeled with different voltages, starting at 30 volts and increasing in 15-volt increments all the way up to 450 volts. The switches were also labeled with terms which reminded the participant of how dangerous the shocks were.  
Procedures  
The participant met another "participant" in the waiting room before the experiment. The other "participant" was an actor. Each participant got the role as a "teacher" who would then deliver a shock to the actor ("learner") every time an incorrect answer was produced. The participant believed that he was delivering real shocks to the learner.  
The learner was a confederate who would pretend to be shocked. As the experiment progressed, the teacher would hear the learner plead to be released and complain about a heart condition. Once the 300-volt level had been reached, the learner banged on the wall and demanded to be released. Beyond this point, the learner became completely silent and refused to answer any more questions. The experimenter then instructed the participant to treat this silence as an incorrect response and deliver a further shock.  
When asking the experimenter if they should stop, they were instructed to continue.

**Results**

Of the 40 participants in the study, 26 delivered the maximum shocks. 14 persons did not obey the experimenter and stopped before reaching the highest levels. All 40 participants continued to give shocks up to 300 volts.

**Discussion/Conclusion**

Most of the participants became very agitated, stressed and angry at the experimenter. Many continued to follow orders all the time even though they were clearly uncomfortable. The study shows that people are able to harm others intentionally if ordered to do so. It shows that the situation is far more important than previously believed, and that personal characteristics are less important in such a situation.

**8/ Application #2: example of a published research paper**

**3D analysis of brace treatment in idiopathic scoliosis**

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**Abstract**

*Purpose* We have evaluated the effect of bracing in

scoliosis on coronal alignment in a cohort of patients.

Current literature has not described the specific effect of

bracing on the 3D shape of the scoliotic curves. The purpose

of this study was to analyze the variability of the 3D

effect of bracing on idiopathic scoliosis.

*Materials and methods* The spines of 30 patients with

adolescent idiopathic scoliosis were reconstructed using

biplanar stereoradiography with and without the brace. The

Cobb angle, sagittal and pelvic parameters and transverse

plane parameters were calculated. The variability and the

mean values of each parameter, with and without a brace,

were analyzed and compared using a student t test.

Results The Cobb angle improved in 50 % of patients but

remained unchanged in 50 % cases. In 90 % of the cases

lordosis was decreased. The thoracic kyphosis was

decreased in 26 % cases, unchanged in 57 % of cases and

increased in 17 % cases. The AVR was improved (>5°) in

26 % cases, worsened in 23 % and unchanged in 50 %.

Only the differences of Cobb angle and the lordosis were

statistically significant.

*Conclusions* Global statistics of this study concur with

the literature. The Cobb angle was significantly improved.

It also showed a significant hypolordotic effect. However,

the results showed a high variability of the brace treatment

effect in almost every parameter. Analysis of this variability

by means of 3D reconstructions instead of global

statistics should help characterize the mechanisms of correction

of brace treatment.

Keywords: Scoliosis \_ Brace \_ 3D \_ Variability \_Stereoradiography

**Introduction**

Bracing is the main option in the treatment of scoliosis

before skeletal maturity. Many different types of braces

have been described in the past decades but principles of

correction are very similar. Empirical evidence dictates

that a pressure should be below the apex of the curve with

opposite pressure near the junctions [1]. An area of relief

needs to be preserved so that the trunk may shift. Besides

these basics, in reality one must consider the curve topology

and severity, the experience of the brace manufacturer

and patient compliance.

The effect of bracing in idiopathic scoliosis has been

evaluated in our series and essentially in the AP plane by

means of global statistics [2–8]. However, the different

curve topology and severity, different brace concepts and

designs should not be analyzed together as this could lead

to controversial conclusions. Compared with the natural

history [9] and the prospective study data of Nachemson

et al. [5], most braces are effective in preventing progression

of adolescent idiopathic scoliosis for curves under 35

degrees. But there is a lack of knowledge of the effect of

brace treatment on the sagittal alignment and more particularly

on the 3D transverse plane parameters.

Recent development in 3D imaging using biplanar stereoradiography

has allowed a novel 3D approach to scoliotic

deformity in standing position. These methods of 3D

reconstruction of the spine have been validated in asymptomatic

and scoliotic patients [10–13]. The purpose of the

current study was to analyze the variability of the effect of

brace treatment on the 3D shape of idiopathic scoliosis.

**9/ Application #3: analysis of the structure of an introduction**

**“Running on Empty”: The Effects of Food Deprivation on**

**Concentration and Perseverance**

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**Abstract**

This study examined the effects of short-term food deprivation on two

cognitive abilities—concentration and perseverance. Undergraduate

students were tested on both a concentration task and a

perseverance task after one of three levels of food deprivation: none, 12

hours, or 24 hours. We predicted that food deprivation would impair both

concentration scores and perseverance time. Food deprivation had no

significant effect on concentration scores, which is consistent with recent

research on the effects of food deprivation (Green et al., 1995; Green

et al., 1997). However, participants in the 12-hour deprivation group

spent significantly less time on the perseverance task than those in both

the control and 24-hour deprivation groups, suggesting that short-term

deprivation may affect some aspects of cognition and not others.

**Introduction**

Many things interrupt people’s ability to focus on a task: distractions,

headaches, noisy environments, and even psychological disorders. To

some extent, people can control the environmental factors that make it

difficult to focus. However, what about internal factors, such as an empty

stomach? Can people increase their ability to focus simply by eating

regularly?

* **The introduction states the topic and the main questions to be explored**

One theory that prompted research on how food intake affects the

average person was the glucostatic theory. Several researchers in the

1940s and 1950s suggested that the brain regulates food intake in order

to maintain a blood-glucose set point. The idea was that people become

hungry when their blood-glucose levels drop significantly below their set

point and that they become satisfied after eating, when their blood-glucose

levels return to that set point. This theory seemed logical because glucose

is the brain’s primary fuel (Pinel, 2000). The earliest investigation of the

general effects of food deprivation found that long-term food deprivation

(36 hours and longer) was associated with sluggishness, depression,

irritability, reduced heart rate, and inability to concentrate (Keys, Brozek,

Henschel, Mickelsen, & Taylor, 1950). Another study found that fasting

for several days produced muscular weakness, irritability, and apathy or

depression (Kollar, Slater, Palmer, Docter, & Mandell, 1964). Since that time,

research has focused mainly on how nutrition affects cognition. However, as

Green, Elliman, and Rogers (1995) point out, the effects of food deprivation

on cognition have received comparatively less attention in recent years.

* **The researchers supply background information by discussing past research on the topic**
* **Extensive referencing establishes support for the discussion**

The relatively sparse research on food deprivation has left room for

further research. First, much of the research has focused either on chronic

starvation at one end of the continuum or on missing a single meal at the

other end (Green et al., 1995). Second, some of the findings have been

contradictory. One study found that skipping breakfast impairs certain

aspects of cognition, such as problem-solving abilities (Pollitt, Lewis,

Garza, & Shulman, 1983). However, other research by M. W. Green, N.

A. Elliman, and P. J. Rogers (1995, 1997) has found that food deprivation

ranging from missing a single meal to 24 hours without eating does not

significantly impair cognition. Third, not all groups of people have been

sufficiently studied. Studies have been done on 9–11 year-olds (Pollitt et

al., 1983), obese subjects (Crumpton, Wine, & Drenick, 1966), college-age

men and women (Green et al., 1995, 1996, 1997), and middle-age males

(Kollar et al., 1964). Fourth, not all cognitive aspects have been studied.

In 1995 Green, Elliman, and Rogers studied sustained attention, simple

reaction time, and immediate memory; in 1996 they studied attentional

bias; and in 1997 they studied simple reaction time, two-finger tapping,

recognition memory, and free recall. In 1983, another study focused on

reaction time and accuracy, intelligence quotient, and problem solving

(Pollitt et al.).

* **The researchers explain how their study will add to past research on the topic**
* **Clear transitions guide readers through the researchers’ reasoning.**

According to some researchers, most of the results so far indicate that

cognitive function is not affected significantly by short-term fasting (Green

et al., 1995, p. 246). However, this conclusion seems premature due to the

relative lack of research on cognitive functions such as concentration and

perseverance. To date, no study has tested perseverance, despite its

importance in cognitive functioning. In fact, perseverance may be a better

indicator than achievement tests in assessing growth in learning and

thinking abilities, as perseverance helps in solving complex problems

(Costa, 1984). Another study also recognized that perseverance, better

learning techniques, and effort are cognitions worth studying (D’Agostino,

1996). Testing as many aspects of cognition as possible is key because the

nature of the task is important when interpreting the link between food

deprivation and cognitive performance (Smith & Kendrick, 1992).

* **The researchers support their decision to focus on concentration and perseverance**

Therefore, the current study helps us understand how short-term food

deprivation affects concentration on and perseverance with a difficult task.

Specifically, participants deprived of food for 24 hours were expected to

perform worse on a concentration test and a perseverance task than those

deprived for 12 hours, who in turn were predicted to perform worse than

those who were not deprived of food.

* **The researchers state their initial hypotheses**

