Designing Science Presentations

A Visual Guide to Figures, Papers, Slides, Posters, and More

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Matt Carter

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kindness and show clean, simple, well-designed slides. After all, that's what I want from a presenter if I'm the one sitting in the lecture hall.

One warning: the only downside to following Carter's advice is that it's going to eat up some time. Alas, this is unavoidable—clean design and clear structure require careful, detail-oriented work, and both benefit from feedback and revision. But the good news is that by spending this time, you'll be making an excellent investment in your scientific future. People who give great talks get invited to speak at meetings, which means we get to feel popular (a welcome change from the science-geekitude that many of us suffered from in high school), and reviewers of manuscripts are kinder to authors who've taken the time to construct compelling figures and tables. And, best of all, the process of creating well-designed presentations and papers is now much easier with the advent of Matt Carter's excellent book.

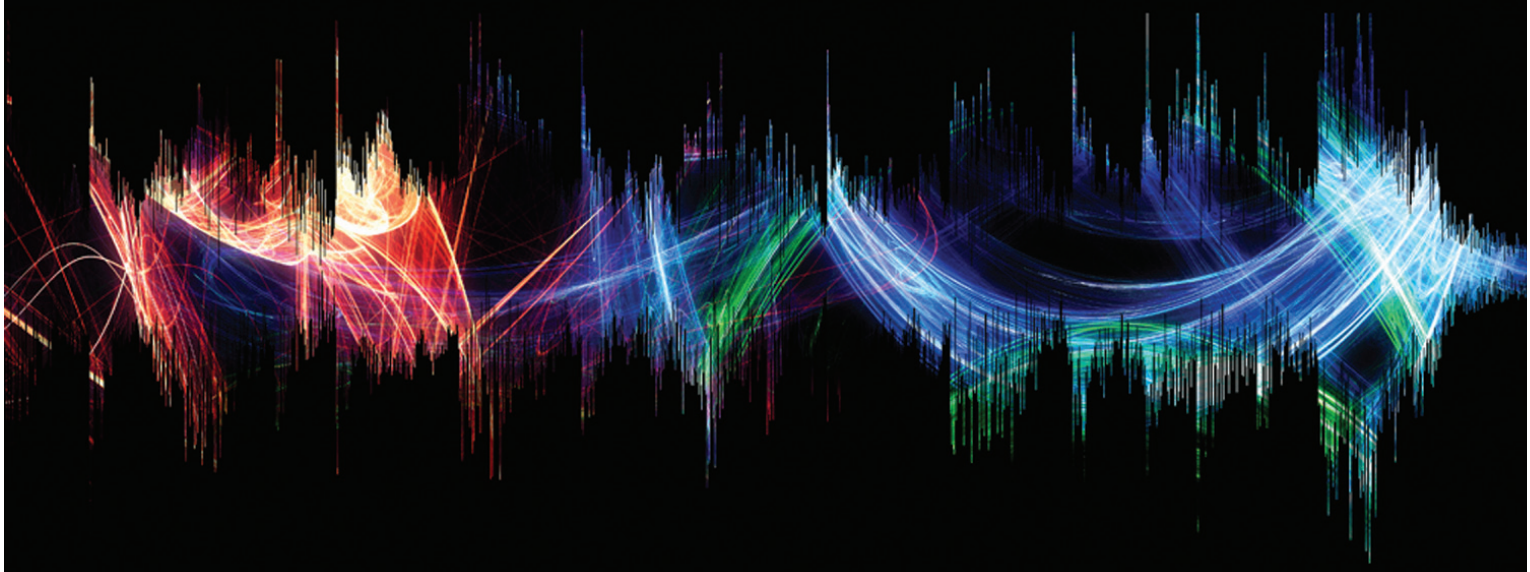
Susan K. McConnell, PhD

Susan B. Ford Professor, Department of Biology, Stanford University

1

Scientists as Designers

As scientists, we don't normally think of ourselves as designers. If anything, we think of design in terms of designing the best scientific experiments. Yet when it comes to scientific presentations, all scientists should embrace design. If a scientific idea matters, then the design and delivery of a presentation necessary to communicate that idea matters. And as we shall see, you don't need a special degree or certificate to think like a designer. You just need to care.



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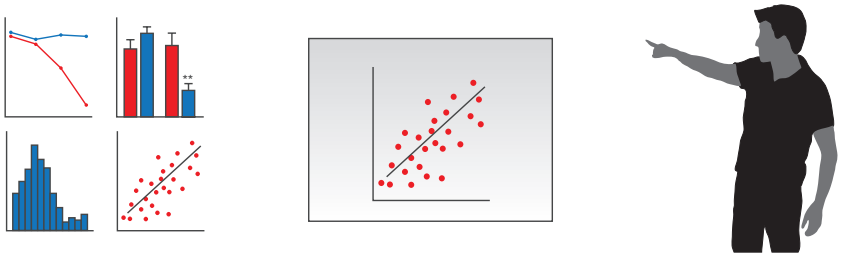
Necessary Ingredients in any Science Presentation

All science presentations are essentially composed of three ingredients:



Scientific Content	+	Visual Information	+	Delivery
Your ideas, experiments, results, discussion, etc. Anything you want to communicate to an audience.		All of the visual aids you use to communicate information. In a paper, these are your figures; in a slide presentation, these are your slides; and in a poster presentation, this is your poster.		Your narrative that leads the presentation of your visual information. In a paper, your narrative is written on the page. In a slide and poster presentation, you deliver your narrative orally and with nonverbal communication (body language).

In this book, we will not discuss methods of improving scientific content. That part is up to you. This book is principally concerned with the other two ingredients: the design and delivery of a world class science presentation.

Great design will not sell an inferior product, but it will enable a great product to achieve its maximum potential.

Thomas J. Watson Jr.

Doesn't Good Scientific Content Speak for Itself?

Experienced scientists know that good content does *not* speak for itself. When scientists fail to appreciate the importance of designing effective presentations, good studies are rejected by scientific journals, good ideas are denied by grant agencies, good stories are ignored by audiences, and good projects are passed by at poster sessions. Without a well-designed presentation, good science is essentially speechless.

The goal of designing a great presentation is not to take bad scientific content and disguise it as great. The goal is to communicate great content in a clear, succinct, and inspiring way…to value and respect your content by presenting it in the best possible light.

If you have spent time and effort pursuing a scientific goal, you owe it to yourself and your work to design and deliver a great presentation. Design matters because your content matters.

Any Scientist Can Be a Designer

Some people are intimidated by the concept of design because they "aren't designers." Indeed, the term "designer" seems to imply attendance at some sort of professional design program and/or an advanced skill set. However, design can be thought of as more than just a skill set—design is also a *process*, a way of thinking about creating a finished product for an audience.

All you need to do to practice design is to *choose* design as a process. By choosing to design, you choose to actively communicate information and provide the best possible experience for your audience. You reject lazy default presentation choices, old habits, dogma, and quick fixes for an active, deliberate approach.

Artistic tricks come with time and experience, but they are ultimately not what good design is all about. Good design is about considering the needs of your audience and choosing to care.

Design is not the narrow application of formal skills, it is a way of thinking.

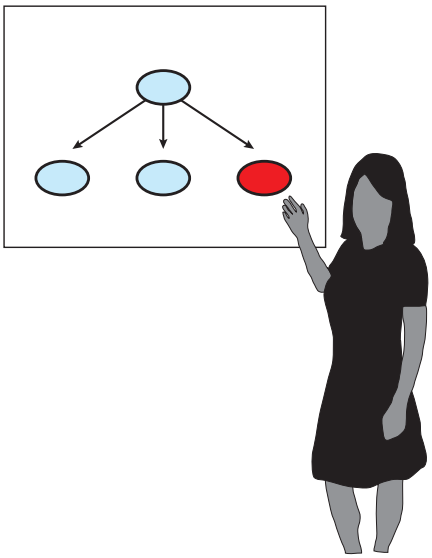
Chris Pullman

What is Design?

Design is surprisingly hard to define. Most people think of design as the way something looks. While it is true that good design ultimately causes something to "look better," there is much more to design than just aesthetics.

Design is ultimately about determining what impact you want to have on an audience and then establishing the best way to achieve that objective.

One of the hallmarks of good design is that it is often invisible. The final product seems obvious, inevitable, and natural—like it could not have existed in any other way. In truth, well-designed science presentations indicate hard work on the part of the presenter, someone who intentionally chose what to add and what to take away to provide a deliberate experience to an audience.

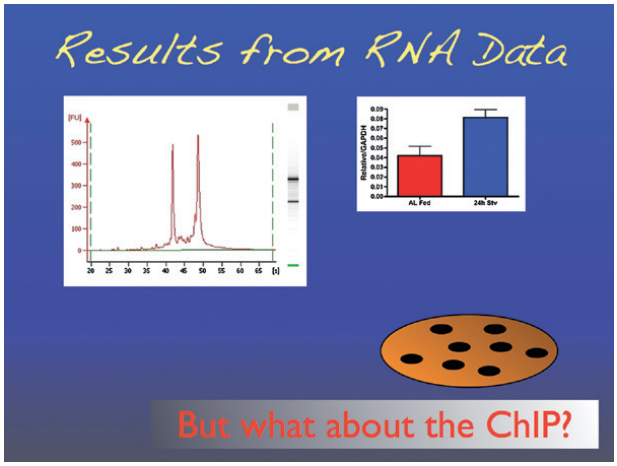


Good design is a lot like clear thinking made visual.

Edward Tufte

What Design Is *Not*

Design is not decoration. Design is not showing off the cute clip-art you found or the fancy tricks your presentation software can do. Design is not adding a random graphic to your poster or making text sparkle when it appears on a presentation slide. Design is not adding anything meaningless that lacks information or purpose.



Good design is hard to define...but it's definitely not *this*.

Design does not call too much attention to itself. Design is not a way for the author to show off how clever or brilliant he or she can be. Design is not about how many graphs can be placed on a slide, how many figures can be placed on a poster, or how many supplementary figures can be added to a research article.

Design is not laziness. Design is not accepting the default settings on presentation software, using pre-made templates, or blindly copying someone else's visual style.

Design is not anything that gets in the way of your communication with an audience.

Design should never say, "Look at me."
It should always say, "Look at this."

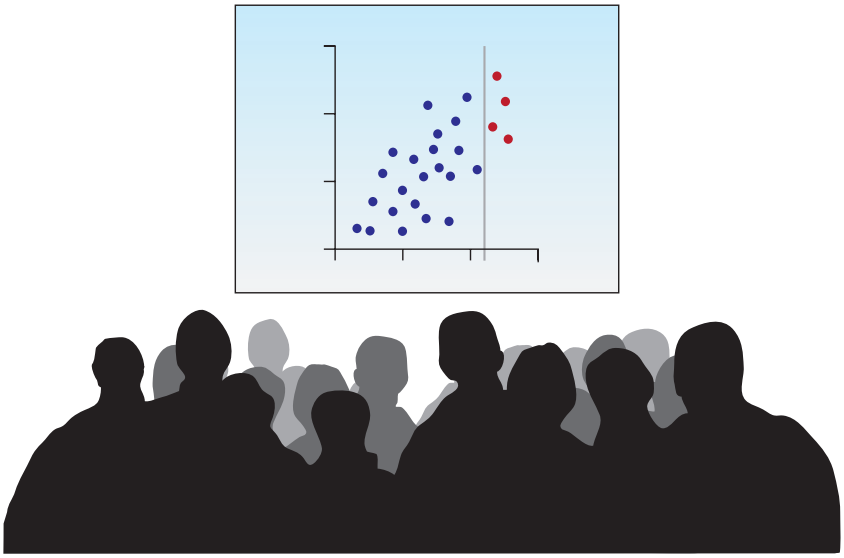
David Craib

Design Is Ultimately about the Audience

What does it mean to design an effective presentation? Ultimately, the quality of a presentation is measured by its ability to impact an audience. Therefore, the best way to ensure that your presentation will succeed is to design a presentation not for you, not for your data, but for the people who you want to impact.

You can design presentations for your audience in multiple ways:

- Determine who your audience will be and what they are likely to already know and not know. Design an introduction that quickly conveys necessary information while avoiding obvious background material.
- Consider the strengths and limitations of your presentation format. Design a presentation that plays to the strengths and, whenever possible, makes up for the limitations.
- Design tables, figures, diagrams, and photographs that quickly convey information to an audience. Discard all elements that do not convey information or enhance a message.
- When appropriate, design strategies to emotionally engage your audience. Take advantage of presentation elements likely to appeal to emotion, enthusiasm, passion, or concern.



Embrace Simplicity

One of the key tenets of good design is simplicity. To design a simple presentation means to distinguish between what is meaningful and what is unnecessary, presenting the former and avoiding the latter. It is about filtering out all of the obvious, distracting, and unimportant elements in a presentation and focusing on what is truly important.

Simplicity doesn't tend to come naturally for us scientists. We are trained to think about and analyze complex datasets, keeping track of multiple details, numbers, and experiments throughout the day. How we process information in our own minds, however, is different from the best way to communicate this information to others.

The genius of a good presentation is often about what you leave out rather than what you put in. It is easy to add more and more facts, visual elements, and discussion to a presentation. It is much harder to subtract, deliberately taking away elements that don't add much value.

A simple presentation is not synonymous with a boring presentation. In fact, many of the most memorable, effective presentations are also the most simple. They resonate with audiences, sometimes long after they are presented, because everything in them is important and impactful.

Simplicity is about subtracting the obvious and adding the meaningful.

John Maeda

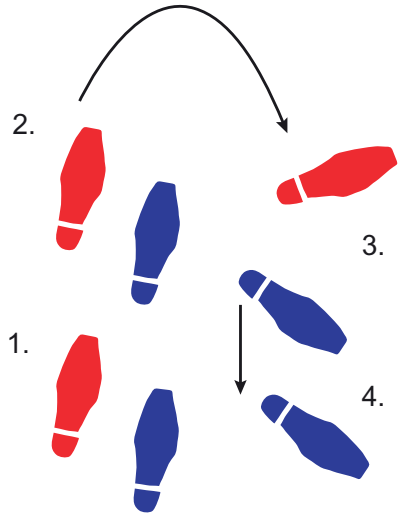
A designer knows he has achieved perfection not when there is nothing left to add, but when there is nothing left to take away.

Antoine de Saint-Exupery

About "The Rules"

The principles of good design can sometimes come across like a list of rules. This book is filled with many guidelines that might seem to limit freedom rather than inspire creativity. Interestingly, the opposite is true. These guidelines promote good design rather than limit it.

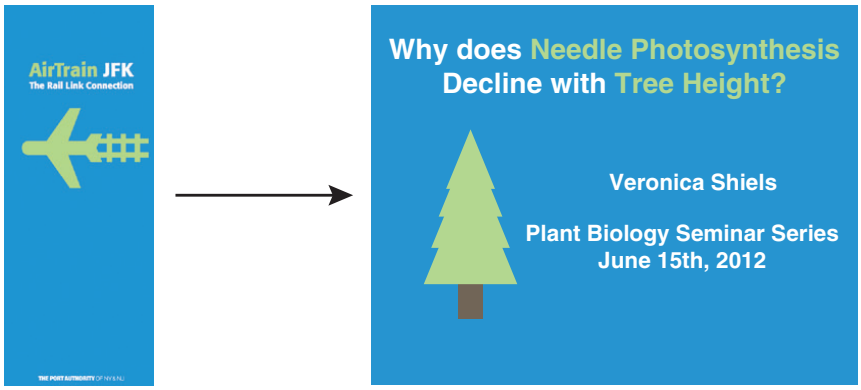
Think of the rules of design like a dance routine. Without learning the right moves, you look like a fool on the dance floor. But once you know the proper steps, your freedom and creativity increases and you can express yourself in new and inventive ways.



Also like dancing, it is occasionally okay to break a rule. Good dancers occasionally break from prescribed dance moves, adding a stylistic flourish while keeping within their traditional routine. Likewise, it is sometimes beneficial to break from tradition and ignore a design guideline. The key is to be aware of *why* you are breaking a rule and what benefit it adds to your presentation.

Appreciate the Design around You

Thinking like a designer includes appreciating the design you encounter throughout your day. Consider all the materials around you as potential inspiration for your presentation design. Sometimes the best inspiration for a slide or poster comes from outside the laboratory.



Inspiration for the design of a plant biology slide show from an AirTrain brochure at JFK airport.

Appreciate the Presentations of Other Scientists

Deliberately seek out great science presentations and identify what makes them so great. There is nothing like experiencing something outstanding to make you want to produce something outstanding; likewise, there is nothing like experiencing a lazy, lackluster presentation to make you want to accomplish much more. Anyone in a scientific institution has access to numerous examples of papers, talks, and posters ranging from the very bad to the truly excellent:

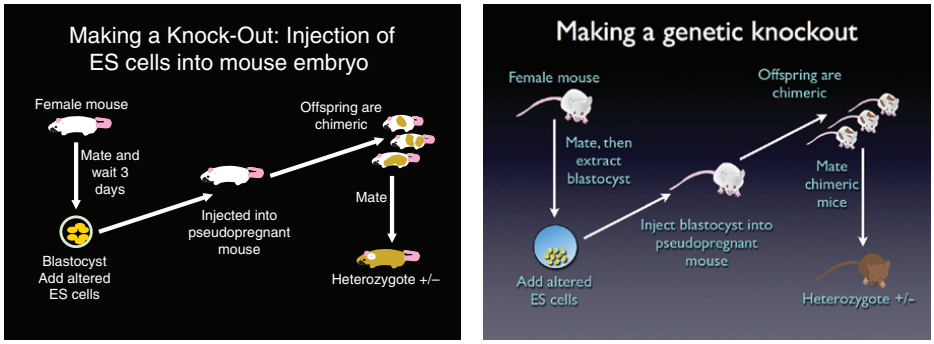
- Keep a file of research articles that are well written or that contain well-designed figures, regardless of their content.
- In your institution, learn who gives the best talks and always try to attend their presentations.
- At a poster session, spend time walking around the venue just to find and appreciate well-designed posters.
- Go online and watch a TED talk. Watch Steve Jobs introduce the iPhone (even if you don't like Apple products) or rent Al Gore's *An Inconvenient Truth* (even if you are a Republican). Watch Carl Sagan's *Cosmos* or James Burke's *Connections*. In an age of YouTube, Netflix, and iTunes University, there are literally thousands of amazing talks at your fingertips.

As Pablo Picasso famously said, "Good artists copy, great artists steal." Identify the design characteristics you see in outstanding science presentations and continually adopt them as your own.

Design Is a Continuous Process

One of the most fun aspects about practicing design in science is that your attitude and vision continuously evolve. Not only do your abilities grow over time, you also start to see the same concept in different ways. For example, some scientists teach the same college course over many years. Each time the class is offered, they rediscover old presentation slides and realize that there is room for improvement, that the slides can be simpler and more effective, and that there are better and more efficient ways of communicating their messages to students.

Design is like biological evolution—it never culminates in something that is finished or perfect, but the results are usually great for their time.



Evolution in the design process. These two slides were designed by the same instructor for the same molecular biology course, but the slide on the left preceded the slide on the right by four years.

Obviously, at some point, you must decide that it is time to finish a presentation. An old saying at Apple Computer in the 1980s (attributed to Steve Jobs) was that "Real Artists Ship," meaning that while it is important to continuously design, innovate, and invent, it is even more important to finish a product and deliver it to users on time. Likewise, Real Scientists Publish. To succeed, scientists must regularly submit manuscripts and present their work. But declaring something ready for publication is not the same as declaring it perfect. Each presentation is another evolution in your development as a designer, and another experience to learn from for the future.

Summary: Don’ts and Dos

Don’t assume that great science speaks for itself.
Do complement great content with a well-designed and well-delivered presentation.

Don’t confuse design with decoration or meaningless visual elements.
Do eliminate unimportant visual elements and anything that distracts from your message.

Don’t be intimidated by the concept of design.
Do embrace design as a process, a way for you to improve communication with your audience.

Don’t confuse a simple scientific presentation with one that is easy, mediocre, or boring.
Do appreciate the benefits of subtracting meaningless elements from presentations so that only important details remain.

Don’t consider design principles as rules that limit freedom or creativity.
Do learn the value of design guidelines and realize that it is okay to break them when it benefits your presentation.

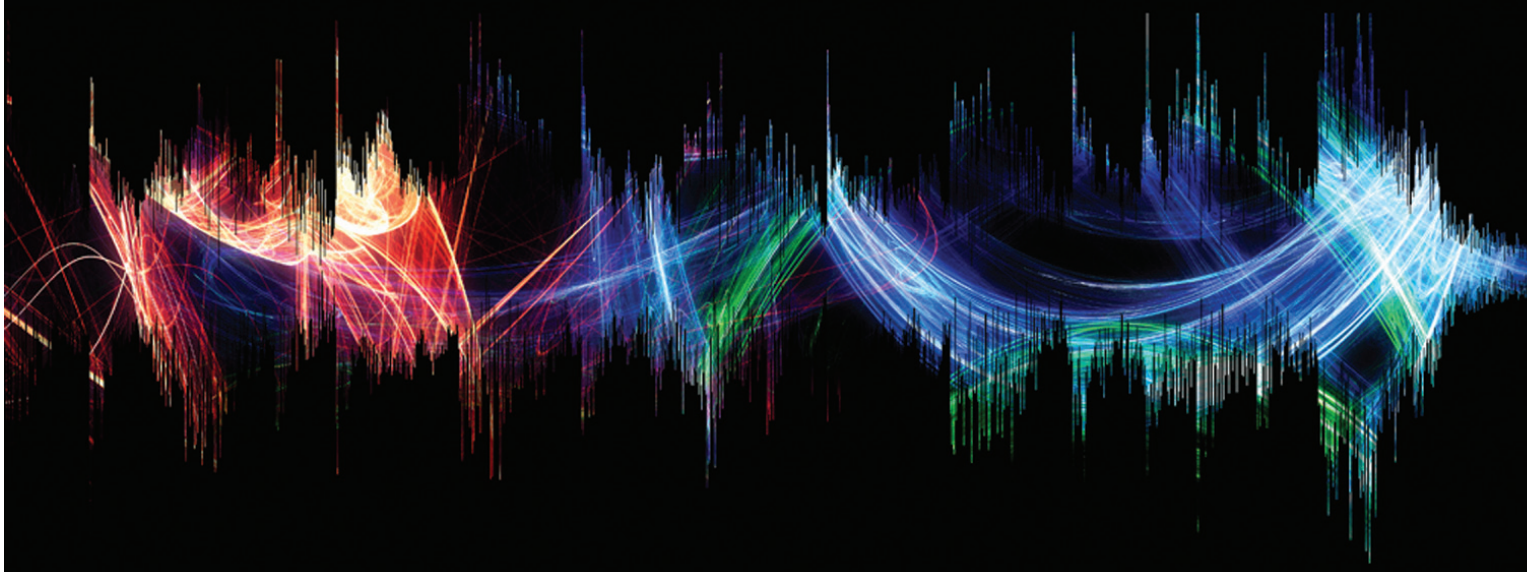
Don’t ignore the design around you, inside and out of your scientific institution.
Do incorporate the good design of others into your own practice of design.

Don’t consider the design of a presentation something that will be perfect when finished.
Do regard design as a continuous process from which you and your presentations consistently grow.

2

Design Goals for Different Presentation Formats

The ways in which scientists share their work and ideas with others have changed dramatically over time, even in just the past 20 years. The ubiquity of fast, personal computers, in combination with easy-to-use software applications like Word, PowerPoint, Keynote, Photoshop, and Illustrator, have made any scientist capable of designing presentations in a variety of formats. In the modern scientific era, most scientists communicate via written presentations, oral presentations with slides, oral presentations without slides, and poster presentations. When we design a presentation, we must consider the specific goals, strengths, and limitations of the format we choose.



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Defining the Goals of Presentation Formats

Every science presentation shares the ultimate goal of communicating information to an audience. However, there are additional goals you can strive to achieve depending on your presentation format.

The Written Presentation

The goal of most written presentations is to permanently add detailed information or discussion to the scientific record. Other written presentations include grant and fellowship proposals, in which the goal is to justify funding, or class assignments, in which the goal is to practice writing research articles, review articles, and grant proposals. Although feedback is possible, written presentations are usually a one-way flow of information from writer to reader.

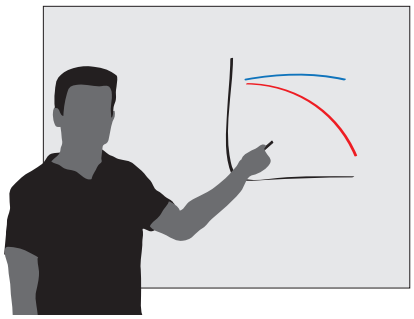
Major subcategories of written presentations: primary research articles, review articles, grant/fellowship proposals.

The Slide Presentation

The goal of a slide presentation is to connect and communicate directly with your audience while using a powerful visual aid. Unlike other presentation formats, slides allow you to show anything you want, *whenever* you want. Depending on the format, two-way communication is often possible during the presentation or immediately following your talk.

Major subcategories of slide presentations: research seminars, symposium talks, data blitzes, course lectures, lab meetings, journal clubs

The Oral Presentation (Without Slides)



An oral presentation is an opportunity to present information but without prepared visual aids. Usually the presentation is for a smaller group, so you can adjust your presentation depending on the real-time questions and comments from the audience. The goal is to lead a conversation while demonstrating your mastery of the subject matter and your ability to think on your feet.

Major subcategories of oral presentations: chalk talks, round table presentations, elevator speeches, speaker introductions

The Poster Presentation

A scientific poster is a large visual document with figures and text that you present at an allotted time and space at a poster session. The goal of a poster is to briefly (5–10 min) communicate a scientific story to an audience, and more importantly to foster discussion, solicit feedback, and network with other scientists.

Major subcategories of poster presentations: departmental/institutional poster sessions, scientific meeting poster sessions.

Advantages and Disadvantages of Presentation Formats

No presentation format is perfect. Each has its own implicit benefits and drawbacks that affect your ability to communicate with an audience. Designing a good science presentation requires an appreciation of these advantages and disadvantages, playing to the strengths of each format while making up for its limitations.

	Advantages	Disadvantages
Written	• The only format that is truly "published" • Considered a permanent entry into the scientific record • Reaches a global audience • Can present details of your methods and data • Editorial and review process can make a submitted manuscript much stronger	• You don't get to meet and network with your audience • No direct or immediate feedback on your work • Journal guidelines can limit your freedom • Difficult or impossible to convey emotion or enthusiasm • Peer reviewers can insert content or design choices with which you disagree
Slide	• Allows for emotion, enthusiasm, personality • More freedom to design with visual elements • Can use movies, animations, visual effects to enhance the meaning of data • Can interact with your audience and answer questions	• Not permanent or published • Only viewed by those present • Cannot go into detail about methods • Can cause presentation anxiety
Oral (without slides)	• Allows for emotion, enthusiasm, personality • Can interact with your audience and answer questions • Can adapt your presentation throughout depending on how your audience responds • No preparation of professional visuals is necessary	• Not permanent or published • Only viewed by those present • Cannot go into detail about methods • Cannot show photographs, animations, etc. • Can cause presentation anxiety
Poster	• Quickly communicates information • Conference/meeting attendees can provide immediate feedback • Facilitates meeting and interacting with other scientists	• Not permanent or published (but can be referenced) • Only viewed by conference/meeting attendees • Cannot present a large volume of information • Hard to show movies/sounds without accessory devices

Reasons for Success and Failure

Science presentations can succeed or fail to communicate and resonate with audiences regardless of their scientific content. Although content certainly matters, design and delivery of your presentation are what will ultimately make it a success.

Different categories of presentations succeed or fail for different reasons. When designing a presentation for a specific format, be mindful about the best ways to succeed in that format. At the same time, be cautious about common pitfalls that might cause a failure to communicate with your audience.

	Common Reasons for Success	Common Reasons for Failure
Written	• The writing is clear and articulate • Excellent transitions provide a steady narrative and a natural flow of information to the reader • Detailed figures and tables stand on their own but are well-integrated into the text	• Poor writing prevents the reader from understanding the message • Poor flow of information causes the paper to seem jumbled and without direction • A lack of rationale or motivation makes the content seem trivial or unimportant • Typos and grammatical errors cause annoying distractions and suggest incompetence
Slide	• Visual information complements oral delivery so that the audience clearly understands the message • Visual information instantly conveys data, concepts, and emotion to the audience • The audience perceives the enthusiasm and excitement of the speaker • The talk is easy to follow • The subject matter comes across as important and interesting	• No sense of goal or purpose • No sense of narrative or story • Slides are poorly designed • Slides distract from the main message • Poor oral delivery • Too many words or figures per slide • No consideration for the needs of the audience • No enthusiasm in the speaker
Oral (without slides)	• Presenter dynamically conveys information and interest through verbal delivery and body language • The personality of the speaker enhances the message • Audience perceives a clear message	• The presenter is unable to communicate without visual aids • The presenter fails to engage the audience
Poster	• Visual information complements concise text • Oral presentation to visitors is succinct and informative • The presenter fosters discussion and solicits feedback	• Too much text • Too many figures that take too much time to comprehend • Awkward presentation of poster with visitors (or complete absence of the presenter) during poster session • No solicitation of discussion or feedback

Design a Presentation with Your Format in Mind

Although your scientific content may remain consistent from one presentation to another, the design guidelines change depending on your presentation format. This change is due to the inherent differences in the goals, advantages, and disadvantages of each.

All too often, many scientists focus on their content with no regard to the design considerations of their presentation medium. For example, they reuse figures from papers in slides with no consideration for the differences between the two formats. Likewise, many scientists copy paragraphs of text from papers to sections of a poster. In these cases and others, the presenters don't design for their intended presentation format, ultimately weakening their message.

Avoid the lazy habit of presenting your content in the same way. An important aspect of designing a presentation is to determine the best ways to communicate within your specific format.

Summary: Don'ts and Dos

Don't assume that the only goal of a science presentation is to communicate science.
Do consider the additional goals of various presentation formats, such as meeting collaborators, inspiring discussion, soliciting feedback, motivating audiences, and networking.

Don't ignore the specific advantages and disadvantages of each presentation format.
Do design to the strengths of a specific format while doing your best to make up for the limitations.

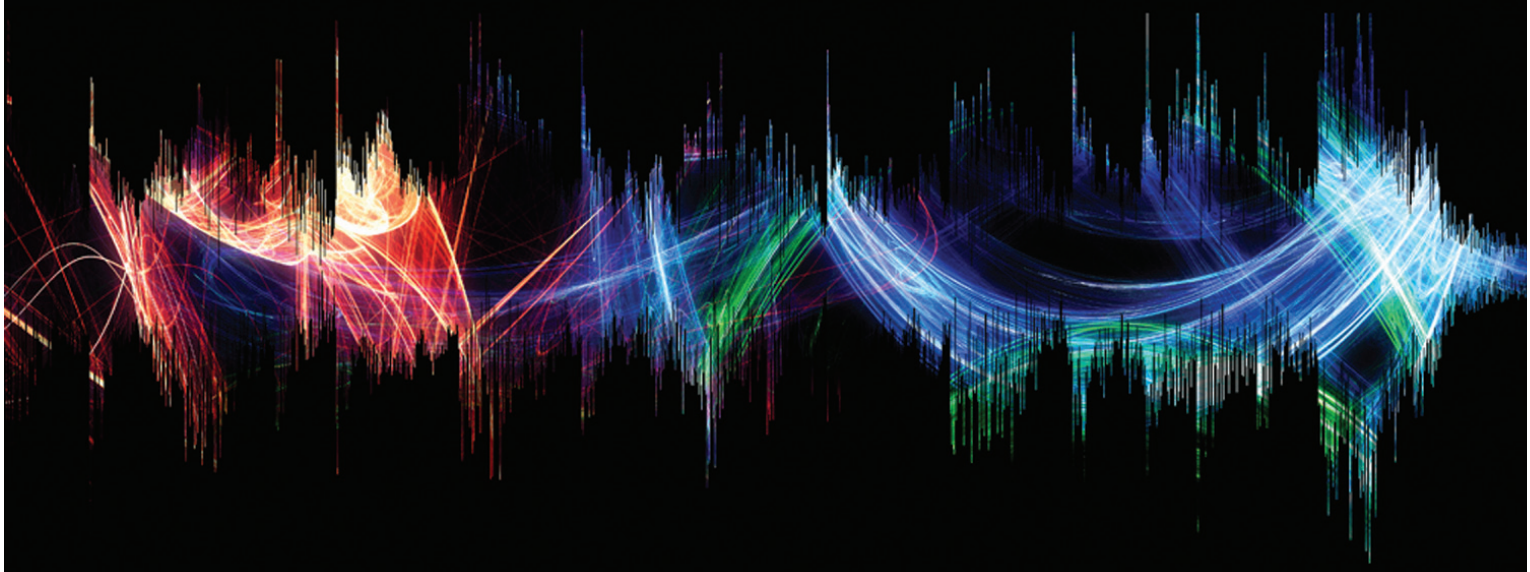
Don't assume your presentation will succeed because you have great content.
Do consider the best ways of succeeding in your specific format while deliberately avoiding common pitfalls that afflict other presenters.

Don't design a science presentation for one format as you would for another.
Do be mindful of the design considerations of each.

3

Twenty-One Characteristics Shared by Exceptional Presenters

Out of all the journal articles, scientific talks, and professional posters you have seen, only a handful stand out as being truly sensational. Their authors designed and delivered presentations that were clear, exciting, and memorable. Although different scientists each have their own style of presentation design and delivery, the most outstanding presenters share common traits that any scientist can and should adopt.



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1 Choose to *Design* a Presentation

Many scientists make figures or create presentation slides without thinking about what they are trying to communicate. Designing a good presentation requires determining what you want to communicate with others and then carefully establishing the best way to accomplish that goal.

Exceptional presenters don't just make figures, tables, reports, slides, or posters, they *design* them, with full consideration of the needs and desires of their audiences in mind.

Instead of just "making" or "putting a presentation together," choose to design. Think about your audience, anticipate their needs, and guide them through your scientific story as clearly and succinctly as possible.

2 Present to Communicate a Message

The purpose of designing and delivering a science presentation is to communicate a message to an audience. This may seem obvious, but often scientists design presentations as if they were goals in and of themselves:

> "It's my turn to present at lab meeting."
> "I'm going to a conference and I need to make a poster."
> "I need to give a public talk as part of my thesis defense."
> "The review article I was invited to write is due soon so I should put something together."

For many scientists, the only goal of a presentation is to do it for its own sake. They seem like the only reason they are presenting is because they have to do so.

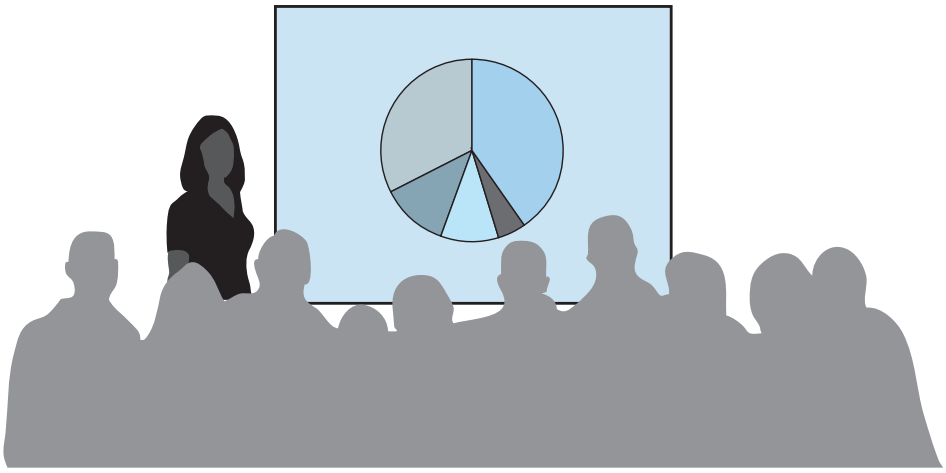
Exceptional presenters are deliberate about their presentations and choose to communicate a message. They always come across as if they sought out the opportunity to share a message, even if their presentation was invited or required.

3 Know Your Target Audience

One of the first questions you should ask before designing a presentation is: Who will be in the audience and what will they be expecting? Your scientific content may be exactly the same from presentation to presentation, but the format and delivery you choose can and should change from one audience to another.

Exceptional presenters know that each audience is unique and that every presentation must be tailored to a specific group at a specific time.

Presenting your scientific results to senior undergraduates in a packed lecture hall at 11:00 am will require a different style and delivery than an invited seminar talk at a symposium attended by other scientists in your field at 3:00 pm. Likewise, a poster presentation delivered during a happy hour at a departmental retreat should be different from a poster delivered at a professional scientific meeting. There are multiple variables to consider about your target audience, including their background and interest in your subject, the number of people in attendance, the time of day you are presenting, and even the day of the week.



These people who have come to attend your presentation... Who are they? What do they need to know to understand your science? Do they have preconceptions or biases about your topic? Are they likely to be tired? Hungry? An exceptional presenter will answer these questions long before a presentation begins.

4 Demonstrate Care and Respect for Your Audience

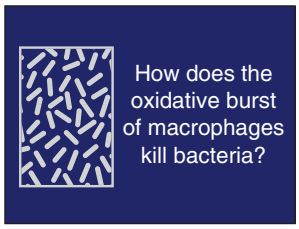
You wouldn't invite someone to dinner if you weren't going to put some effort into serving a good meal. Likewise, delivering a hastily designed presentation without care or forethought not only comes across as lazy, it also shows your audience that you don't respect their attention or time.

Exceptional presenters know that a lack of effort is synonymous with a lack of respect. If someone offers to attend and concentrate on your presentation, you must demonstrate an earnest attempt to provide them with a good experience.

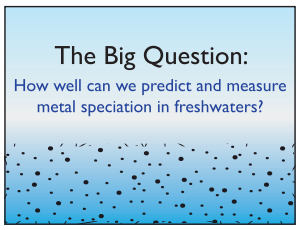
Demonstrating respect is necessary whether or not your audience is required to attend. For example, don't assume that just because your lab-mates are required to attend your lab meeting presentation that it is okay not to design a presentation worth their time.

5 Declare the Question or Goal that Drives Your Science

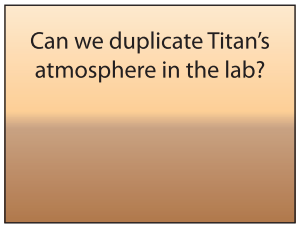
Your scientific question or goal is what inspires your audience to pay attention to your scientific story. Without a clear rationale, a research study seems to have no reason to exist.



Exceptional presenters clearly state their questions/goals in the beginning of their presentations, causing their audiences to care about their work.



Without a clearly stated question/goal, your presentation won't seem to have a purpose and your audience will be less invested in your results. Why spend time clearly explaining your experiments to an audience who has no idea why you're doing them?



6 Inspire Interest in Your Subject

"Who cares?" is the worst possible reaction someone could have about your presentation. Your audience might think you are smart, hard working, and even that you conducted a thorough research study—but if they don't see any value in what you have accomplished, they will think you wasted your time (and theirs).

Exceptional presenters inspire interest by appealing to an audience's concern, imagination, or emotions.

Explain how your research may inform the treatment or etiology of a medical disorder that thousands of people suffer from each year. Describe how your research topic fascinated you as a kid and now you continue to feel like a kid because you get to study this topic as an adult. Convey the applicability of your research to real-world challenges. Whatever you do, don't let your audience wonder why you spend time studying something that they otherwise find uninteresting.

7 Demonstrate Expertise

Audiences don't like the sensation that presenters are not comfortable with their subject matter. They like presenters who are credible, who can think on their feet, and who can answer questions on the fly.

Exceptional presenters demonstrate confidence in their knowledge of the material.

Part of planning a presentation (especially a live presentation) is learning as much about your subject matter as possible. Know more about a topic than you actually present, and anticipate potential questions from your audience.

8 Introduce Your Background and Methods with Clarity

Perhaps the top reason why audiences stop paying attention to a scientific presentation is because they become confused. Sometimes they don't understand the background necessary to understand the subject matter, other times they don't understand the techniques used to perform experiments. A lack of comprehension has nothing to do with intelligence or maturity. Even a Nobel laureate will be unfamiliar with a topic outside his or her field.

Exceptional presenters appreciate the degree to which their audiences are unfamiliar with their background and methods, carefully walking them through details they might not understand.

9 Balance Details with the Big Picture

Scientific audiences like to see a careful balance between important details and the larger scientific story. If a presenter is too preoccupied with experimental results, the audience won't understand why they are meaningful or how they fit into a larger story. In contrast, if a presenter only discusses larger concepts and shows relatively few results, the presentation may come across as glib and without muscle.

Exceptional presenters balance details with the big picture, highlighting detailed experiments while explaining their context within a larger scientific story.

10 Highlight One to Three Take-Home Points

No matter how great your presentation, your audience isn't likely to remember most details in the subsequent hours or days. This is especially true if your presentation is grouped with many other presentations, such as at a symposium or poster session. However, a clear goal of any presentation is to be memorable and resonate with audiences for as long as possible.

Exceptional presenters select one to three key items in their presentation that they hope their audience will remember hours, days, and even weeks later. They dramatically highlight these items in written and/or oral delivery, sometimes even directly telling the audience that they are the key points to remember.

11 Follow Time Restrictions

Scientists attend a talk or browse a poster with a preconceived notion of how much time each will take. Even an enthused, attentive audience will notice when these rules are broken, and nobody likes to watch someone break the rules.

Following time restrictions is important. Violating time constraints is distracting at best, annoying at worst, and can even make your audience feel trapped.

Exceptional presenters design their presentations with time restrictions in mind, rehearsing to practice length requirements and devising methods of real-time feedback to ensure they stay within the allotted timeframe.

For slide or poster presentations, make sure you have a method of keeping track of time during your delivery. The best option is a digital clock displayed somewhere in the room. Don't check your watch or you may give off the impression that you are bored. And never trust someone else to monitor the time for you.

12 Radiate Enthusiasm

Presenting with enthusiasm means exuding sincere passion and interest for your subject. Enthusiasm is difficult to define in terms of specific body movements or gestures, but audiences know it when they see it. And they love it. People are drawn to enthusiastic presenters because they can't help but feel caught up in the excitement. In contrast, unenthusiastic presenters seem like they don't care. And if they don't care, the audience won't feel like they should care either.

Enthusiasm cannot be faked. You can't simply talk louder or vary your movements to seem more energetic. Enthusiasm is an emotional state that comes from within.

Exceptional presenters either already care deeply about their subject or they find a way to care. They focus on the most exciting aspects of their topic and convey their enthusiasm to an audience.

13 Demonstrate Accessibility and Friendliness

During presentations in which it is possible to interact with an audience, presenters who are hostile or unfriendly toward others don't just come across as threatening or mean, they also add unnecessary barriers to communication. If someone is afraid of being verbally attacked or embarrassed by a speaker, they naturally become defensive and stop paying attention to content.

Exceptional presenters emanate warmth, friendliness, and a desire to help an audience understand content. Instead of making an audience feel defensive, they openly invite an audience to ask questions.

14 Read and Respond to Your Audience

During oral and poster presentations, audiences can cycle through periods of excitement, interest, boredom, confusion, and fatigue. They can be thinking about what you are saying, about their own to-do lists, or about a movie they would like to see later that night.

Exceptional presenters stay in tune with their audience, reading emotional states and responding as needed.

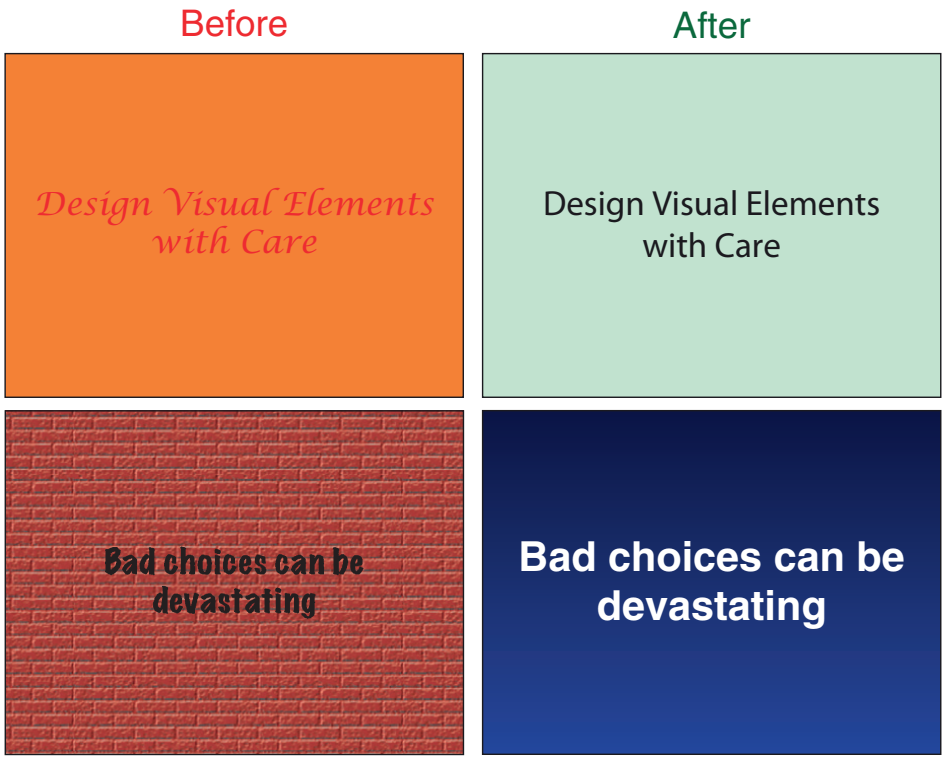
The ability to read and respond to an audience is the major reason why, in today's age of recorded lectures and YouTube videos, live presentations are still beneficial. If you come across in person the same way you would as a recorded movie file, you miss an opportunity to better interact with an audience and solicit questions and feedback.

15 Design Visual Elements with Care

A presentation's visual elements consist of color, text, tables, charts, diagrams, and photographs. Poor choices in the selection of these visual elements can have a devastating effect on a presentation, sometimes even making it incomprehensible.

Exceptional presenters carefully design visual elements so that each aspect of a presentation is clear, legible, and easy to read.

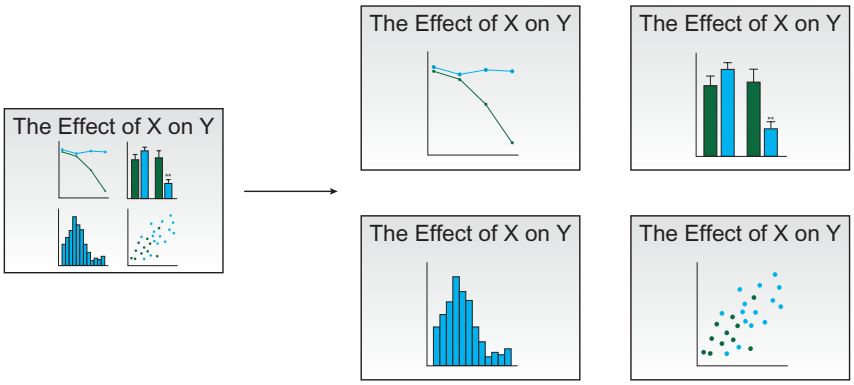
It is also a good idea to go one step further and preview a presentation in its actual form. For example, it is a good idea to project a slide show on a screen to determine if the visual elements appear different from how they look on a computer screen.



16 Present Information One Piece at a Time

Most people cannot perceive, analyze, and digest more than one piece of meaningful information at the same time. Unfortunately, many scientists try to present multiple graphs, lists, and diagrams at once, effectively making them all unintelligible. For example, in slide show presentations, some scientists will show four to eight graphs in the same slide. Likewise, during poster presentations, some scientists talk to their visitors while pointing to multiple graphs at once. There is no way that audience members unacquainted with your material could possibly absorb and consider so much information at the same moment.

Exceptional presenters sequentially focus on one piece of information at a time. They ensure that enough time has passed for their audience to comprehend and reflect on their ideas and results before proceeding to another item.



17 Let Your Narrative Lead Your Visuals

All too often, scientists treat their presentation materials as lecture notes. In slide shows, they have no idea what slides will come next and, when they appear on the screen, they react to them rather than refer to them. In posters, they use the text as a script rather than relying on their own speech. Even in written presentations, many authors focus on describing their figures instead of their results.

Exceptional presenters are always in the driver's seat of a presentation. Their figures support their narrative, not the other way around.

18 Master Your Presentation Technology

An unfortunate number of presentations (especially slide presentations) include awkward moments when a presenter cannot properly connect a computer to a projector, when a movie or graphics file fails to display, when a laser pointer runs out of batteries, or when colors appear too dark or dim in their final form. Sometimes a speaker doesn't even know how to adjust the lights of the room to make their content look optimal.

Scientists are not off the hook when it comes to mastering presentation technology. Exceptional presenters know that a flawless delivery includes the coordinated use of computer display settings, projectors, laser pointers, remote slide advancers, color output settings, and room lighting.

Mastering these tools will improve your delivery and make you come across as a *professional*. Even if your audience never consciously realizes your skill with technology, they will appreciate a fluid and dynamic presentation.

19 Master the Written English Language

It is sometimes said that science is a language that unites all mankind. This is profound, but unfortunately untrue when it comes to science presentations. If you are publishing in an English journal, talking in front of an English-speaking audience, or presenting a poster at an English-speaking meeting, then you must use English well, especially in its written form.

Whether it is fair or not, good English is associated with effort, organized thinking, and forethought. Exceptional presenters may not speak English as a first language, but they always proofread written English until it is free of errors and practice speaking as well as possible.

If English is your first (or only) language, you have no excuse for misspelled words, poorly worded sentences, or lazy writing. If English is your second or third language, you still have no excuse for not seeking proofreading help from someone who is fluent and skilled in English. A foreign advertiser would never display an ad in an English-speaking country without ensuring proper use of language and grammar. If they did, their product would be ridiculed and associated with inadequacy. Likewise, your scientific product must use English properly if it is to be taken seriously.

20 Be Yourself

During oral and poster presentations, a speaker sometimes feels the need to put on a performance. Indeed, sometimes speakers think they should suppress their own personality during a presentation, acting more serious, trying to be funny, or acting more dynamic than they are in everyday life. However, more often than not, this strategy can backfire. Audiences want to see a presentation, not a performance, and they don't like the sensation that a speaker is putting on a show.

Exceptional presenters come across as natural and unrehearsed. They are certainly more serious when they have to be, or more informal when appropriate, but the audience always feels the speaker is genuine.

While it is advantageous to incorporate good delivery techniques into a presentation, one of the worst mistakes a presenter can make is pretending to be someone else. Being yourself is about being honest with your audience.

21 Transform Anxiety into Positive Energy

Just about everyone experiences anxiety when presenting in front of an audience. It's normal for scientists to feel nervous before delivering a talk or presenting a poster.

Unfortunately, uncontrolled nerves can reduce your ability to deliver a fluid presentation. Anxiety cause you to talk too slow or too fast, develop dry mouth, shake your arms, hide behind a lectern, exhibit bad posture, and forget key items to mention to your audience. All of these habits ultimately distract from the main message and prevent you from engaging an audience.

Exceptional presenters can be just as anxious in front of an audience as anyone else, but they practice techniques that prevent anxiety from getting in the way of a fluid delivery.

Rehearse what will happen in the 5 minutes *before* your presentation so you can practice dealing with anxiety. Drink water. Figure out ways to translate the anxiety you feel into a good delivery.

Summary: Don’ts and Dos

Don’t create a presentation without making deliberate decisions about your message, design elements, and delivery.
Do *design* a presentation, making the best choices to communicate with your audience.

Don’t come across as presenting only because it is your turn.
Do present to communicate a specific message to your audience.

Don’t design a presentation without determining and considering the needs of your audience.
Do design a presentation with your audience’s needs and interests in mind.

Don’t show your audience disrespect by failing to take your presentation seriously.
Do show your audience respect by designing a presentation worth their time.

Don’t present any methods, results, or data without clearly stating your main question/goal.
Do clearly state your question/goal as close to the beginning of your presentation as possible.

Don’t assume your audience will automatically care about your presentation topic.
Do inspire interest in your presentation topic by appealing to their interests and emotions.

Don’t show discomfort with your own presentation topic.
Do learn enough about your topic to exude credibility and show confidence.

Don’t assume your audience will automatically understand your background and methods.
Do carefully describe your background and methodology, making sure your audience can follow the rest of your story.

Don’t focus on the details of your presentation topic at the expense of the bigger picture.
Do balance the forest with the trees and let your data inform your larger interests.

Don’t assume your audience will remember everything about your presentation.
Do clearly highlight one to three points for your audience to remember.

Don’t ignore time and space restrictions.
Do plan a presentation that follows the guidelines so your audience won’t be irritated.

Don’t seem uninterested in your own presentation.
Do radiate enthusiasm and passion for your work.

Don't give the impression of being hostile to your audience.
Do deliberately demonstrate accessibility and friendliness.

Don't ignore your audience and present like a robot.
Do continually read and respond to the non-verbal signals your audience demonstrates.

Don't make random choices about visual elements.
Do design visual elements with consideration for what will enhance communication between you and your audience.

Don't show your audience more than one figure at a time.
Do let your audience perceive, analyze, and digest one piece of information before presenting the next.

Don't use your visuals as your own personal presentation guides.
Do use your narrative to lead you through your presentation, stopping to view visuals along the way.

Don't assume that because you are a scientist that you don't have to demonstrate skill with presentation technology.
Do present like a pro by mastering a few presentation devices.

Don't assume that you don't need to have a command of the English language.
Do take every step possible to make sure your language is clear, fluid, and free of mistakes/typos.

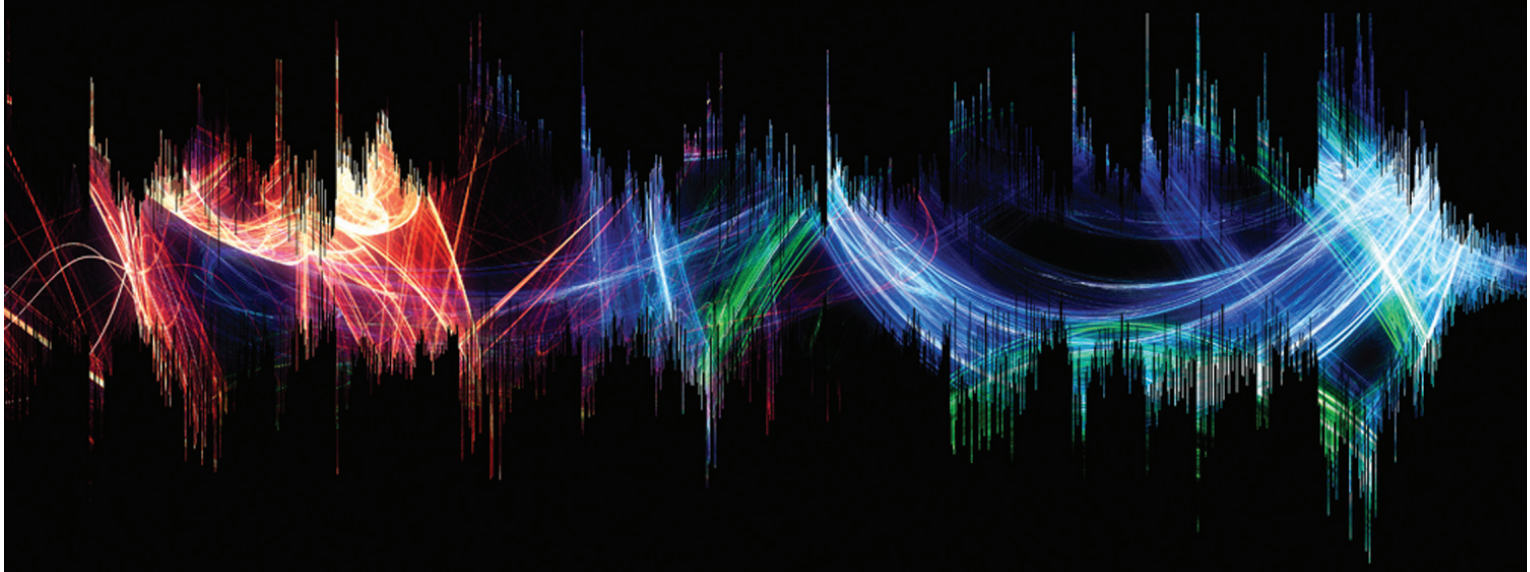
Don't be wooden, stiff, or try to present as someone you're not.
Do be yourself and infuse some personality into your presentation.

Don't let your anxiety distract you from a great presentation delivery.
Do channel your anxiety into energy that will make your presentation better.

4

Color

Color is a powerful communication tool. It can group information into categories and show meaningful relationships between data. It can seize an audience's attention and direct people's eyes to a specific point in space. It can also create a mood or tone that evokes emotions in your audience. Poorly chosen colors distract from your presentation and can make your content unreadable. In contrast, well-chosen colors help illuminate and emphasize your message and make your presentation more compelling and memorable.



Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00004-0

Why We Use Color

Presentation applications like PowerPoint and Keynote make it easy to select from millions of colors for text, backgrounds, foregrounds, graphics, etc. Most of us like to use color in presentations, but we should not use it simply to decorate. Instead, we should use color as a design tool.

We use color to better communicate with our audiences. Color is a wonderful tool to highlight information, to enhance a message, or to convey an atmosphere or emotion.

When a scientist chooses colors poorly, the message conveyed in a figure, slide, or poster can be obscured. At worst, presentations become unreadable. However, good decisions about color can make the main points of a presentation memorable. Color can emphasize specific data, highlight specific conclusions, and convey messages to audiences faster than words alone. It can also create a striking visual aesthetic that enhances the tone of your presentation and conveys emotion to your audience.

By changing nothing else but color settings, you can greatly affect the tone of your presentation and influence which visual elements your audience members pay attention to the most.

Color Gone Wild

Yikes! Many scientists choose to communicate with colors in a way that makes their slides and posters look like a trip to the circus. They probably choose these colors thinking that they would excite their audience or create a playful atmosphere. In reality, poor color choices are distracting, overwhelming, and in the worst cases make presentations unintelligible.

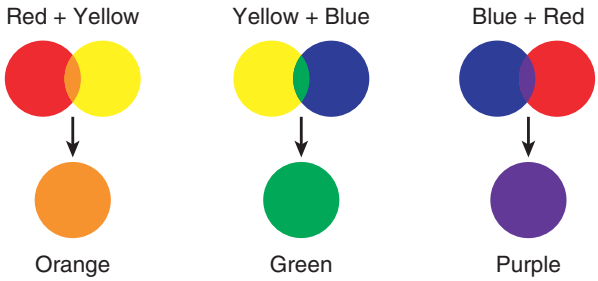
Describing Color

Most computer applications assume that you already know the vocabulary of color. Understanding these terms will help you make informed decisions when choosing colors for your presentations.

Hue is a color's purest identity, independent of other values such as lightness, darkness, and saturation. Hues are what come to mind when you think of colors in their purest, most basic form.

Primary colors, red, yellow, and blue, are the three colors that cannot be created by mixing any other colors.

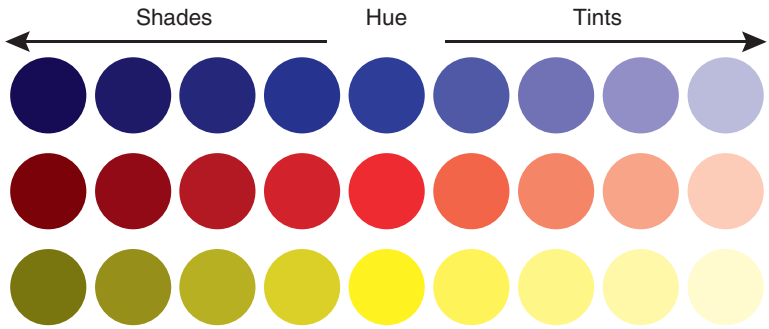
Secondary colors result from the mixing of two of the primary colors.



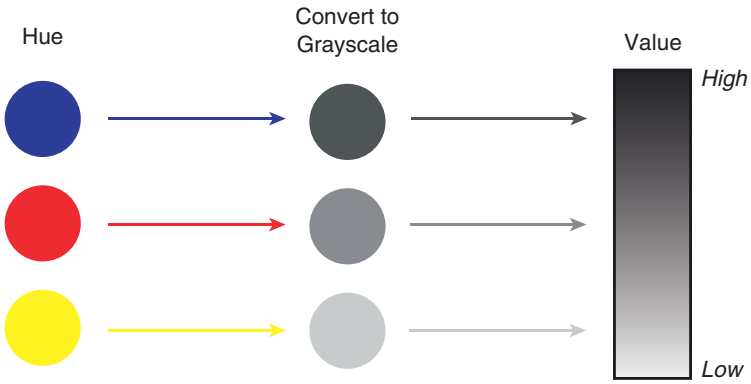
Intermediate colors result from mixing a primary and secondary color, or multiple secondary colors.

Shade is the amount of black added to a hue.

Tint is the amount of white added to a hue.



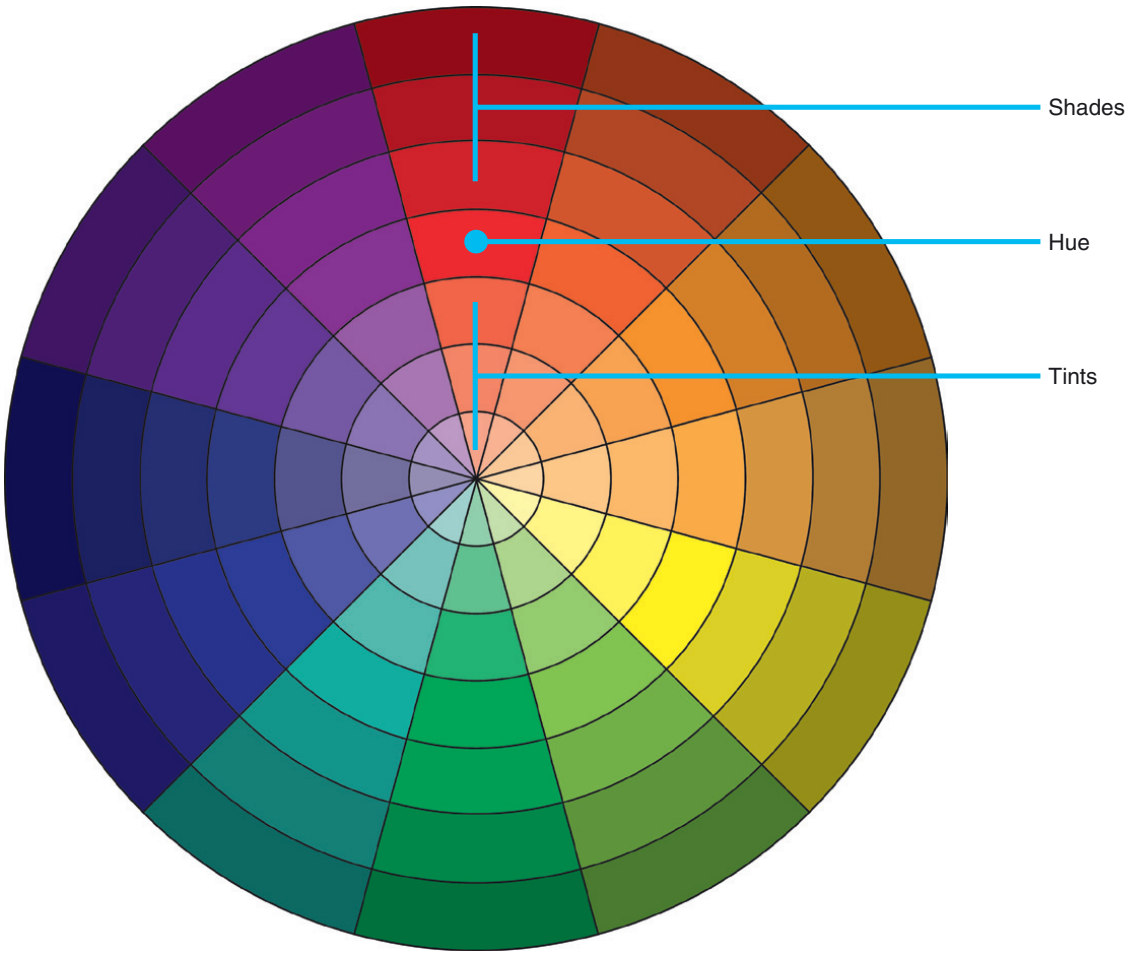
Value refers to the inherent lightness or darkness of a color. The value of different colors can be compared relative to a black-and-white gradient. Black has the highest value and white has the lowest value. The values of colors become important when choosing color combinations that contrast well with each other.



Saturation refers to the degree of hue in a color. A fully saturated color is a true hue, while colors with less saturation look more and more gray. When you convert colors to grayscale, the colors are completely de-saturated.

The Color Wheel

A color wheel depicts the full color spectrum and helps show how different colors relate to each other. The three primary hues (red, yellow, and blue) are spaced evenly apart. Secondary and intermediate colors are spaced in between the primary colors. The center of the wheel has increasing tints while the outside of the wheel has increasing shades.



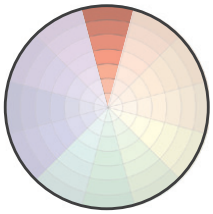
Presentation applications feature their own versions of color wheels:

Microsoft Color Picker

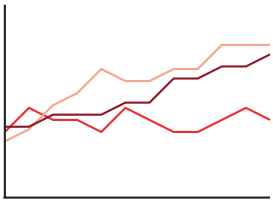
Apple Color Picker

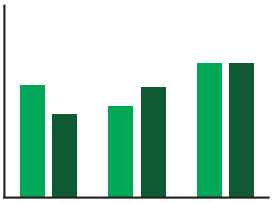
Choosing Color Combinations Using a Color Wheel

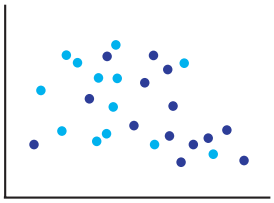
When you need to use multiple colors for graphs or diagrams, a color wheel can help you choose combinations that visually emphasize your message.

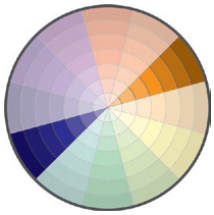


Monochromatic: Only one hue in various shades or tints. The advantage to this strategy is that it creates a consistent, unified look. Even though data may be categorized differently (as in different bars on a chart), it seems representative of a uniform, larger category.

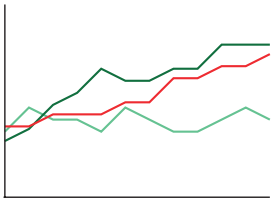


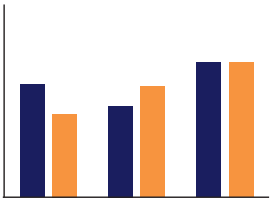


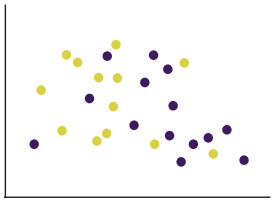




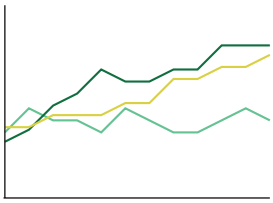
Complementary: Two hues on opposite sides of a color wheel. This strategy enhances the difference between two categories and makes them seem like opposites.

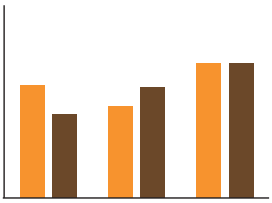


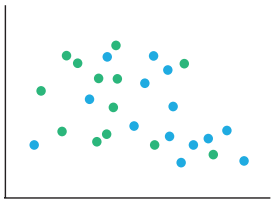




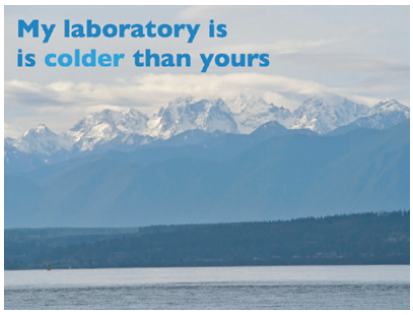
Analogous: Two or three hues that are relatively close together on the color wheel. This strategy combines elements of both the monochromatic and complementary strategies, using multiple colors while also achieving a consistent, harmonious look.



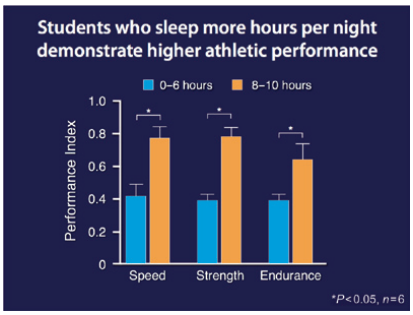




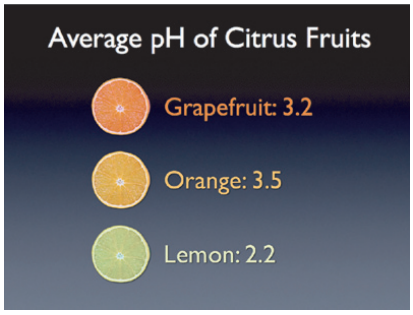
Monochromatic



Complementary



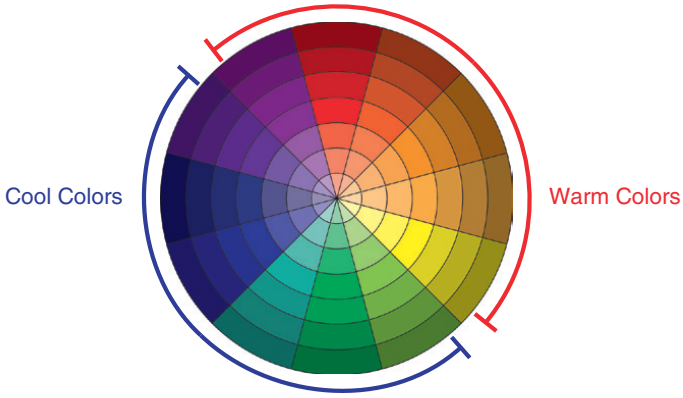
Analogous



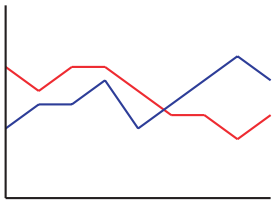
The colors you choose to represent your data and ideas will affect the tone of your presentation and how your audience perceives relationships.

Warm and Cool Colors

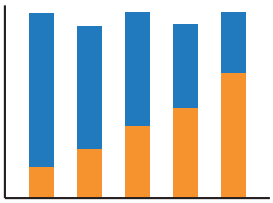
Colors on opposite sides of the color wheel are often described as "warm" or "cool." Warm colors consist of pinks, reds, oranges, yellows, and browns, and are associated with energy, vitality, excitement, and fun. Cool colors are made up of greens, blues, and purples, and are associated with peace, serenity, and nature.



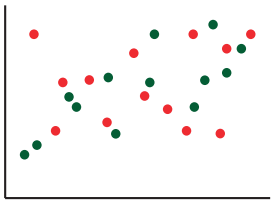
Warm colors can overpower cool colors. People perceive warm colors as being in the foreground and cool colors as being in the background. Therefore, choose warm colors to highlight the data that you really want to emphasize.



The red line appears in the foreground even though it is placed behind the blue line.



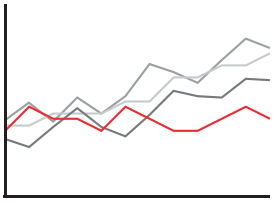
It is easier to notice the orange bars' increasing value from left to right than the blue bars' decreasing value.

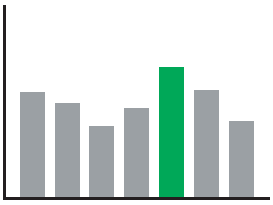


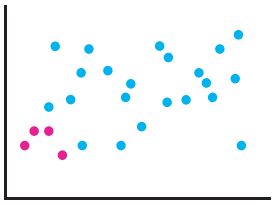
The red data points stand out even though the green data points show more of a trend.

Using Color to Highlight

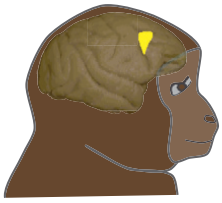
Color is an excellent tool to highlight data in any kind of figure. In order for color to be effective in attracting an audience's attention, it should ideally be used in isolation. When multiple colors are present, the audience will tend to view warm colors first.







	X	Y	Z
A	15.4	12.3	11.1
B	14.8	15.8	19.9
C	10.4	10.6	14.7
D	10.9	41.2	14.1
E	14.2	16.3	12.1



ATTTGACGATGAGCGCTAGCATGGACCGAT
TAAACTGCTACTCGCGATCGTACCTGGCTA

Emotional Associations of Different Colors

Hues are not emotionally neutral. Because of our cultural experiences and the colors of items found in nature, each hue can express a different personality. Design your presentations with an appreciation for these emotional associations, considering that the colors you choose for your backgrounds and object fills, and even the colors you wear, can all affect your audience's mood.

White: purity, simplicity, innocence, clean, spacious, milk, cotton, clouds

Red: love, hate, passion, hot, stop signal, blood, berries, heart

Yellow: light, cheerful, sunny, optimistic, summer, dry, wheatfield, cornfield

Green: natural, environmental, healthy, go signal, grass, vegetables, trees

Orange: autumn, fruity, fun, sporty, pumpkin, Halloween, caution sign, oranges

Blue: peaceful, natural, tranquil, calm, positive, melancholy, cold, sky, air, water, ocean, ice

Brown: rustic, earthy, woody, cozy, dirt, wilderness, cabin, outdoors

Purple: exotic, creative, sweet, artistic, flowers, candy

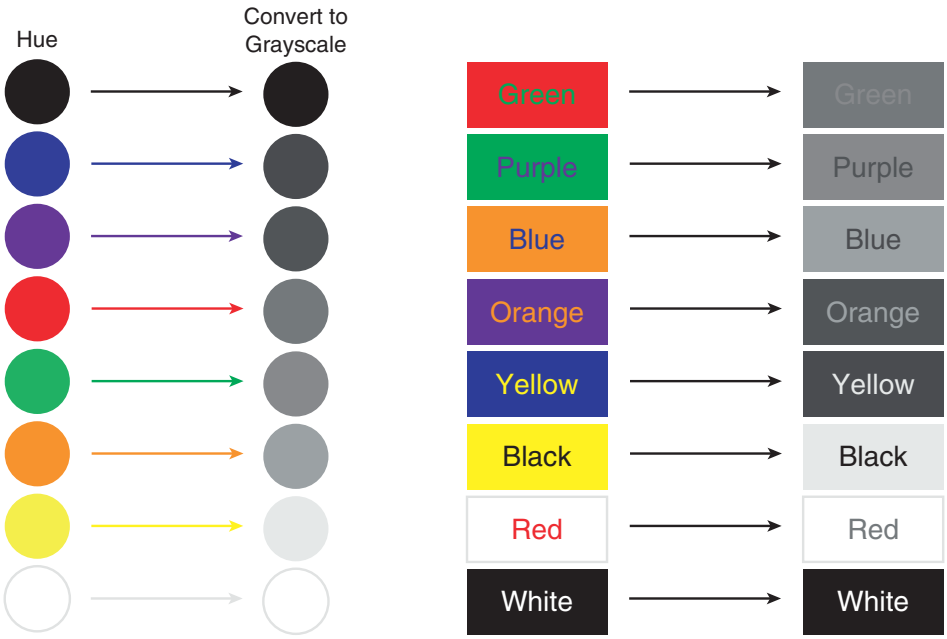
Pink: soft, delicate, young, sweet, feminine, flowers, baby, candy

Black: powerful, formal, corporate, classy, night, suit, briefcase, judge

Background Colors and Contrast

In written presentations, backgrounds are almost always white. In slide and poster presentations, you have more freedom to choose different colors for background and foreground combinations. Considerations for choosing colors when using each kind of presentation format are described in other chapters, but no matter which format you use, you must choose background and foreground colors with optimal contrast. Ideally, the colors you choose for your foreground and background should be as far apart in value as possible to maximize visibility.

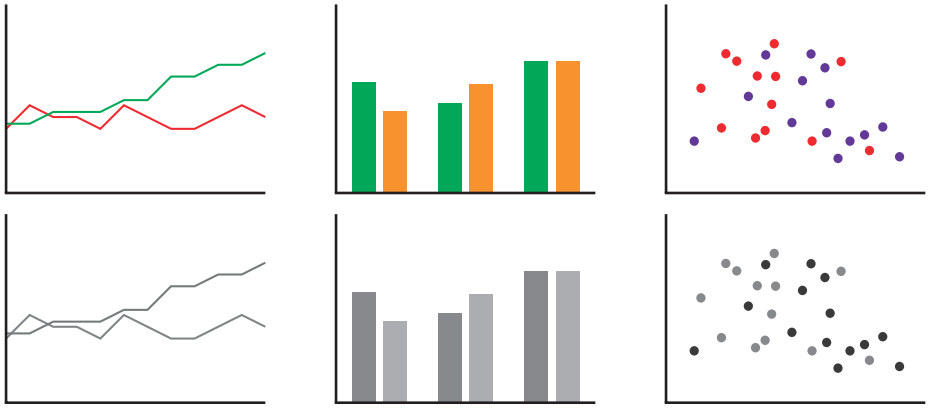
To test various foreground/background combinations, convert your colors to grayscale. Red and green colors are terrible together because they are so close in value. Yellow and blue combinations are much better together because they are relatively far apart in value. The more your two colors approach the values of black and white, the greater the contrast and the clearer your message.



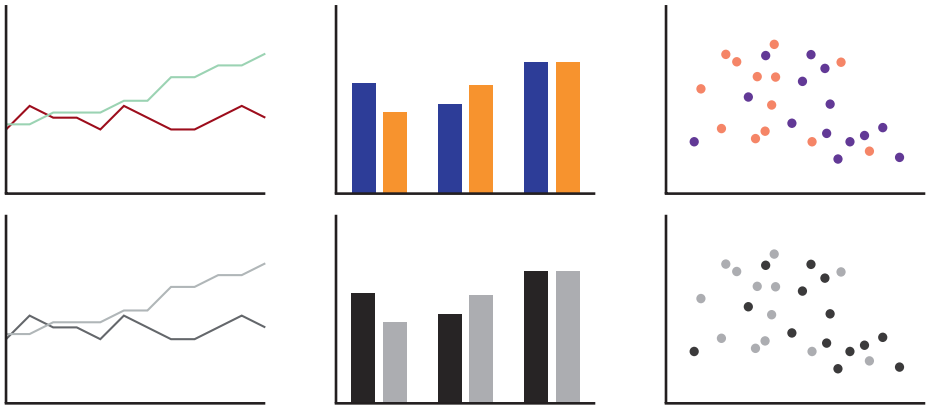
Color in a Colorless Environment

It is important to consider that approximately 10% of men and 1% of women have some form of color vision deficiency. In addition, many people print documents in black and white instead of color to save money on relatively expensive color ink cartridges. Therefore, it is wise to consider how your color choices will be perceived in black and white conditions.

Fortunately, even if someone isn't able to distinguish among different hues, anyone should be able to distinguish among differences in color value. No matter which colors you choose, test your color combinations in grayscale to ensure maximum contrast for audiences unable to perceive color.



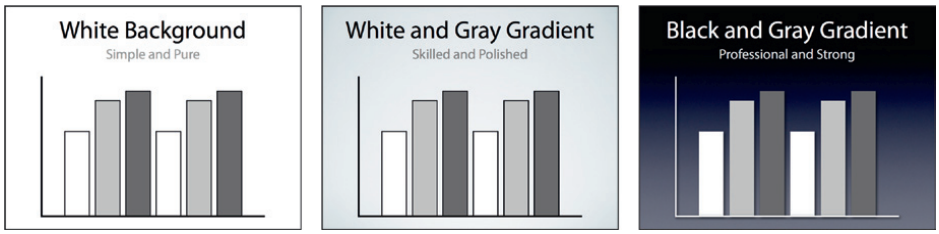
To see how your data will be perceived in a black and white environment, convert your colors to grayscale. Colors that are close in value, like red and green, become indistinguishable.



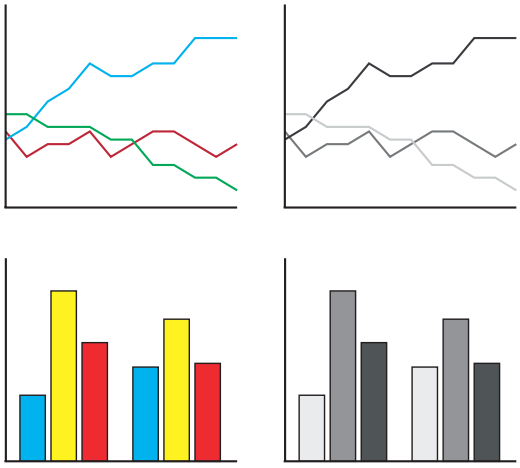
To make your data accessible in a colorless environment, choose colors that are far apart in value. If you want to use two colors that are close in value (for example, you want to use red and green because you are comparing red and green tomatoes), try using a tint of one color and a shade of the other to increase the contrast.

Black and White Are Colors, Too

Don't ignore black, white, and shades of gray when choosing colors for a presentation. White and light grays convey a sense of purity and simplicity while black and dark grays can convey strength and power.



Furthermore, in written presentations, color figures can be unnecessary. Some journals charge large amounts for color figures that could easily be made in black and white. Well-chosen shades of gray can be used in place of multiple colors.



Is the color in these figures really necessary?

Replacing the color with shades of gray reduces printing costs and improves the contrast between data sets.

How Computers Specify Color

Computers specify color in different formats. The optimal format to choose depends on whether your presentation will be printed (e.g., papers, handouts, and posters) or displayed digitally (e.g., slide presentations and web documents).

CMYK

The CMYK format is used to specify color for printed documents. Color printers use a combination of cyan (C), magenta (M), yellow (Y), and black (K) inks to produce all hues of the color spectrum. Each hue is specified as combinations of each ink source. A particular color is specified by a value for C, M, Y, and K ranging from 0 to 100. Use this color specification system for written and poster presentations so that your presentation will be consistent from printer to printer.

Red = CMYK(0,100,100,0)
Blue = CMYK(100,100,0,0)

RGB

The RGB format is used to specify how color will appear on computer displays, television screens, and digital projectors. Each pixel is composed of a combination of red (R), green (G), and blue (B) hues. When all three hues are combined equally, the result is white light. A particular color is specified by a value for R, G, and B, each with a range of 0 to 255. Use this color specification system for slide presentations.

Red = RGB(255,0,0)
Blue = RGB(0,255,0)

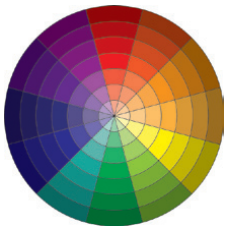
Hexvalue

Website colors also use combinations of red, green, and blue, but utilize a six-digit number instead of the RGB specification system. Colors are specified in the format "#RRGGBB" in which RR, GG, and BB are the values for the red, green, and blue values of each color, respectively. The degree of each color ranges from #00 to #FF. Use this color specification system when designing websites.

Red = ##FF0000
Blue = ##00FF00

What You See Might Not Be What You Get

Most science presentations are designed on a computer, where all visual elements are backlit by the computer screen. In contrast, printed documents are not backlit, nor are slides projected onto a screen. Perhaps the most important reason to preview your presentation in its final form *before* showing it to others is to make sure your colors show as you intended. Otherwise, you might be surprised that your blues turn into purples, your reds turn into browns, and your yellows disappear altogether!



The beautiful color wheel that appears throughout this chapter. On a glossy computer display, the colors appear even more brilliant than they do in print.

A photograph of the color wheel when digitally projected onto a white screen in a dark seminar room. The darkest shades appear almost black and some of the inner tints are too white.

A photograph of the same digitally projected wheel after adjusting the settings on both the computer and projector.

Most laptops have projector calibration settings integrated into their operating systems. If you don't know how to open and adjust these settings, it is worth the brief amount of time it will take to learn.

Summary: Don’ts and Dos

Don’t use color to decorate your slides.
Do use color as a tool to better communicate with your audience.

Don’t pick colors randomly.
Do choose colors deliberately depending on the relationships between data and the tone you wish to convey.

Don’t choose combinations of colors that are hard for audiences to differentiate.
Do choose colors that contrast well with each other.

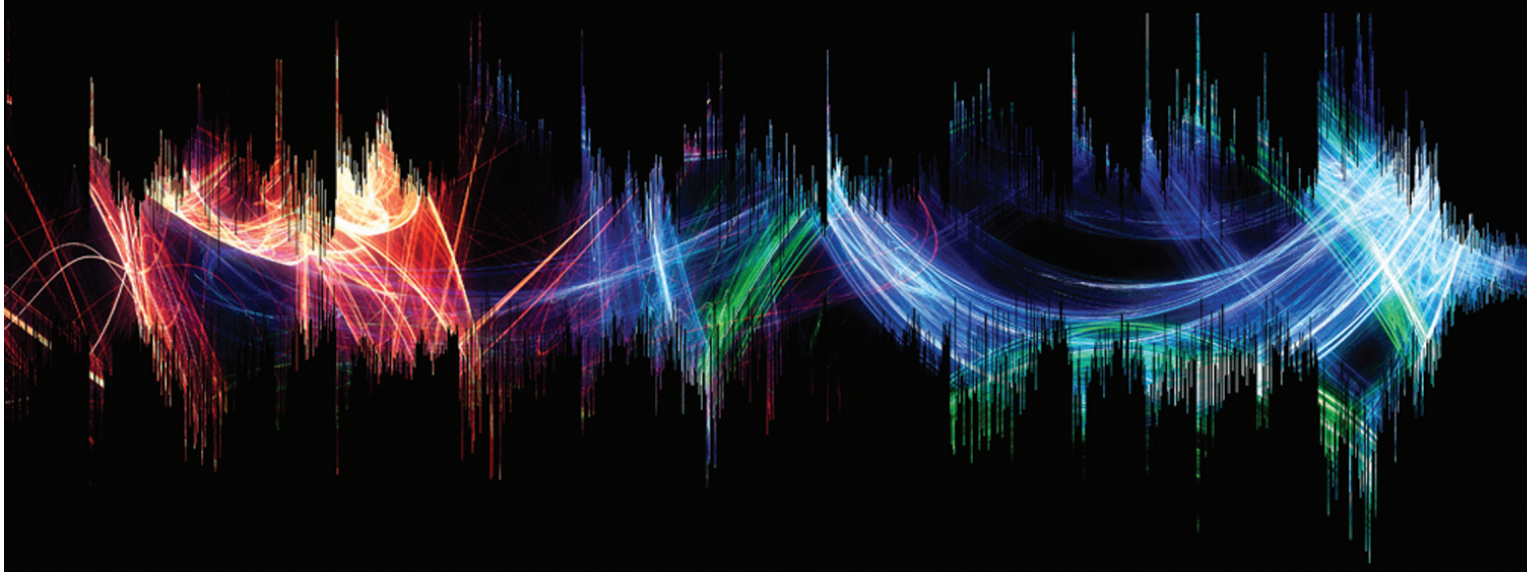
Don’t misuse color such that it doesn’t help to communicate information.
Do use color wisely so that it can highlight pertinent information, emphasize relationships among data, and set a tone for your audience.

Don’t assume the colors you see on your computer screen will be the same as in the final presentation format.
Do choose the right color specification settings on your computer and try as hard as possible to preview your colors in their final form.

5

Typography

Typography is the art of selecting and arranging characters to make language visible. It is hard to remember that before the 1980s, most people were limited to using one or two fonts on typewriters for all of their decisions about type. After the debut of the first Apple Macintosh, anyone could select from dozens of fonts, each with their own characteristics and personality, and make decisions about font size, line spacing, and alignment. The design decisions we make about type are tremendously important—so much so that they can ultimately affect the meaning of the words themselves.

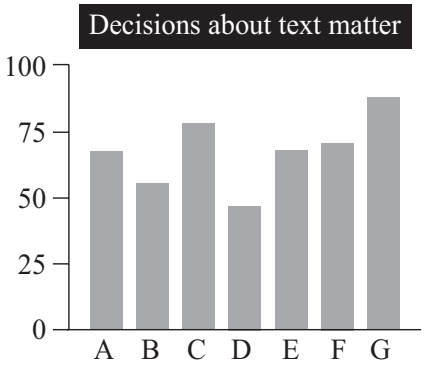


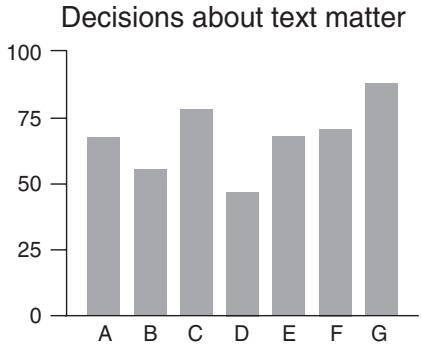
Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00005-2

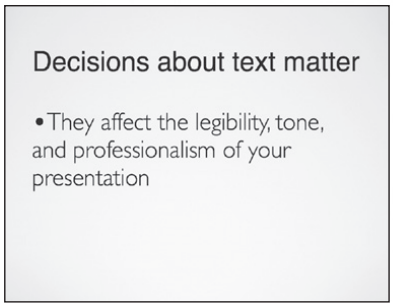
Decisions about Text Matter

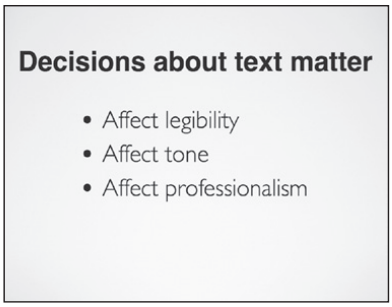
We see text so often in our everyday lives that we forget that every instance of text involves choices: choices about font, character size, casing, typesetting, etc. Decisions about typography matter because they affect the legibility, meaning, and tone of the language we use.

Just as you can speak the same word in many different ways, the way you write a word can convey emotion and attitude in addition to the meaning of the word itself.





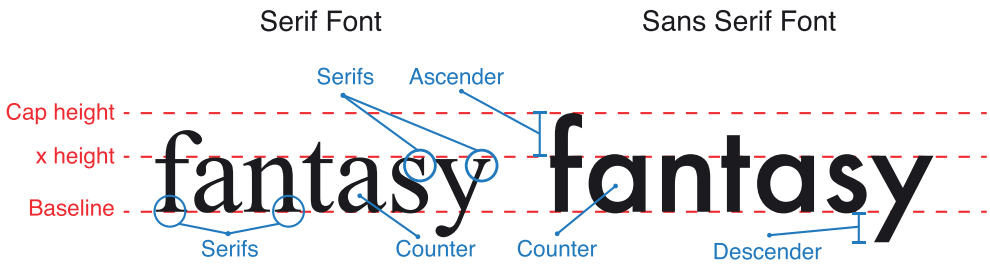




Dissection of a Font

What are the attributes of a font that confer its personality? Fonts are commonly classified as having serifs (slight projections finishing off a stroke of a letter) or not having serifs (called a *sans serif* font).

Besides the presence or absence of serifs, each font has its own height (distance from baseline to cap height), weight (thickness of lines), and counters (shape of the negative space within letters).



Note how different the word “fantasy” appears in these two different fonts. The serif font (Times New Roman) has a smaller cap height and line width than the sans serif font (Futura). Also notice the difference in counters in the letter “a”.

Personality of Fonts

Fonts convey tone and personality. Knowing which font to use in a presentation depends on the attitude you wish to convey, as well as which will be most legible in your presentation format.

Serif fonts are good for smaller character sizes (10–14 pts) in multiple lines of type. The serifs guide the letters into one another so it is easier for the reader to follow one line at a time. Most books and magazines are written in a serif font. In general, these fonts are best for manuscripts and other written presentations.

Font	Personality
Garamond	classic, refined
Georgia	elegant, mature
Times New Roman	professional, traditional

Sans serif fonts are usually perceived as simple or pure. They are easier to see from a distance, as in billboards or theater marquees. These fonts are usually best for slide and poster presentations in which an audience must be able to read text from across a room.

Font	Personality
Calibri	formal, neutral
Century Gothic	grand, optimistic
Helvetica	simple, pure, contemporary

Some sans serif fonts convey a bit more personality than others. They are more playful and can make a presentation seem less standard or routine.

Font	Personality
Comic Sans	silly, fun
Gill Sans	warm, friendly
Myriad Pro	jovial, friendly, casual

A word of caution about *Comic Sans*

Comic Sans is one of the most popular typefaces used in slide shows and poster presentations. The people who use it feel that it adds a lighthearted, jovial tone to a presentation. However, this can also be a problem. *Comic Sans* is conspicuously playful in a way that can distract from a message and make a presenter come across as trying too hard to be fun. In fact, many audience members think that *Comic Sans* is incredibly tacky, like wearing a Mickey Mouse tie to a business meeting. If you want to strike a more lighthearted tone that isn't as noticeable, try using another sans serif font like Gill Sans or Myriad Pro. These are more friendly than traditional fonts but are less overt (and detested by some) than *Comic Sans*.

Non-proportional (also called "**monospaced**") **fonts** are typefaces in which each character has the same width. This is in contrast to most typefaces, in which letters like "m" and "w" have larger widths than "i" or "l." Non-proportional typefaces were originally designed for typewriters, which could only move the same distance for any letter typed. Nowadays they are great for writing letters in a sequence, such as sequences of DNA, amino acids, or computer code.

Font	Personality
Courier	retro, nerdy
Letter Gothic	simple, elementary
Lucida Sans Typewriter	informal, quirky

Specialty fonts convey a lot of personality. They are ideal during moments when you want to conspicuously capture an audience's attention and convey an attitude. However, they can easily overshadow the message of a presentation. Therefore, they are best used in isolation, such as in title slides, flyers, or when emphasizing a major take-home point. Usually these fonts are illegible at small sizes and look best in sizes 30 pts and above.

ADVENTURE

PRINCETOWN LET

The New Yorker

Sizing Up a Font

A common misconception is that the size of a font is the distance from the bottom to the top of a character. In reality, a font size is the height of an imaginary metal block as it would appear in an old-fashioned typewriter. Even in the modern computer era, a font size is the height of the assumed equivalent of the block.

Computers specify the size of a font in "points." A point is defined as one-twelfth of a pica, which itself is about one-sixth of an inch.

Because the point size is the height of an imaginary block in an old-fashioned typewriter and not the height of the character itself, the only way to know exactly how large a font will appear in a particular point-size is to try it!

All of these letters are written in the same 45 point font size. The fonts, from left to right, are Gabriola, Calibri, Times New Roman, Helvetica, Futura, and Impact.

Casing

Casing refers to the degree to which you use capitalized letters. In an **ALL-UPPERCASE** format, every single letter is capitalized. This adds emphasis and weight to a title, but can be difficult to read unless the letters are very large. In a **Title Case** format, all words are capitalized except for certain subsets of words such as articles, prepositions, conjunctions, and forms of "to be." This is the format used most often for titles in American English, such as the titles of books and movies. In a **Sentence case** format, only the first letter of the first word is capitalized, along with proper nouns. This format is how most text is written (sentences you find in papers, books, magazines, etc.). Finally, in an **all-lower-case** format, no capitalization is used.

`I LIKE TO EAT CHOCOLATES AT BURROW'S CAFE`	Uppercase
`I Like to Eat Chocolates at Burrow's Cafe`	Title Case
`I like to eat chocolates at Burrow's Cafe`	Sentence Case
`i like to eat chocolates at burrow's cafe`	Lowercase

Considerations for different casing styles in various presentation media are described throughout the book, but certain guidelines apply. In general, it is usually best to avoid the all-uppercase format unless you use few words and the letters are very large (for example, subheadings on a poster). Title case is best for major heading titles, while sentence case is best for the titles of figures or figure legends.

Sometimes a scientific word needs to be in all-uppercase letters. If the word is long, it can often visually overpower a sentence. In these circumstances, try reducing the font size of the uppercase word by 1–2 pts to make the sentence appear more balanced.

We characterized the role of CMTRPB-3 in cognitive enhancement.

We characterized the role of CMTRPB-3 in cognitive enhancement.

In the top sentence, the name of the compound in all caps, CMTRPB-3, is large and seems to overpower the sentence. In the bottom sentence, the name is reduced in size by two pts relative to the other words and the sentence seems more balanced.

Legibility

Each decision you make about type, including casing (uppercase versus lowercase), style (bold, italics, etc.), size, underlining, and color, will affect the legibility of your sentences. In general, don't use all caps. Use bold or italics only to emphasize a specific word but not to stylize an entire sentence. Don't choose colors that are hard to see or fonts that are hard to read. When designing a presentation it's fun to experiment with the available options, but in the end always choose text that is highly legible unless you have a good reason not to do so.

Easier to read

Some sentences are more legible than others.

Some sentences are more legible than others.

SOME SENTENCES ARE MORE LEGIBLE THAN OTHERS.

SOME SENTENCES ARE MORE LEGIBLE THAN OTHERS.

Some sentences are more legible than others.

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Some sentences are more legible than others.

Some sentences are more legible than others.

Some sentences are more legible than others.

Some sentences are more legible than others.

Harder to read

Some sentences are more legible than others.

Some sentences are more legible than others.

Typesetting

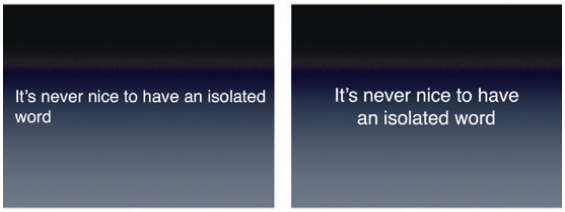
Typesetting refers to how characters are arranged together in a word, in a sentence, or on a page. Most people never consider changing the typesetting defaults on their computers, but sometimes changing the way words or blocks of text appear can have a powerful influence on the tone of a presentation.

Before | After

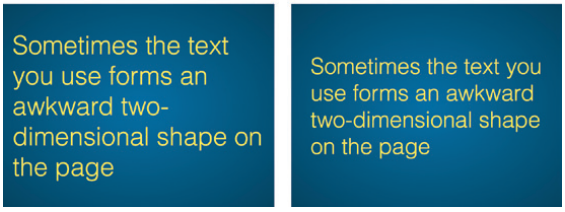
Varying the tracking (spacing) between characters can enhance the meaning of a word. Increasing the tracking makes words seem lighter and spacious; decreasing the tracking makes words seem tighter and more compact.

Changing the font height or size for specific words can enhance the meaning of those words. You can often convey the emotion of a word by literally changing how tall or big (or short and small) it appears.

Leading (pronounced "led-ing") is the spacing between lines of text. Some fonts naturally have a default leading that can seem too high or low. Usually a leading that is 2 pts higher than the font size is ideal, but it's ultimately up to you and what you think looks best.



Try to avoid isolated words. Sometimes a single word at the end of a sentence can seem to exist in isolation by itself. Try resizing your lines so that no words are left alone by themselves.



Typeset blocks of text so they form solid shapes. Arranging text into block-like shapes makes your text seem more tightly organized and easier to read compared to the random shapes that can form due to the lengths of words that fit on different lines.

Bullets

Bullets are a great way to group items into a list or sequence. Like any other visual element, their use should incorporate some simple design principles to increase clarity and communication.

Before | After

Never use a single bullet. Bullets are for lists. If you are only going to list one bullet item, just group it with the rest of the text.

Don't write wordy bullet items. The eye has a hard time following bullets after about three lines.

Increase the line space between bulleted items. This helps the audience visualize the separation between different bullet items.

Indent the text on your bullets. This not only makes your list look polished and professional but also helps the audience differentiate between different bullet items.

Before

After

Use numbers when you want to show a sequence and a symbol when the sequence is arbitrary.

Some Other Advice about using Bullets:

- Keep your bullet list brief. Try not to include more than four to six items.
- Try starting each bullet item with an active verb.
- Be consistent throughout your entire bullet list in the verb tense that you use (past, present, or future; active or passive).
- Be consistent about whether your bullets end with punctuation.
- Keep your bullet style simple. Dots are much better than any of the alternatives.

Good bullet: ●

Potentially distracting bullet: ■ ▶ →

Annoying bullet: — ○ ✓

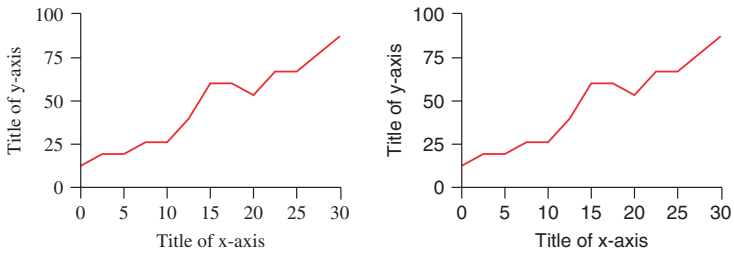
Numbers

1 l 1 1

When choosing fonts, be mindful about how your numbers appear. For example, the number one looks like an obvious 1 in some fonts, while in others it can look like the letter l.

Calibri	Century Gothic	Comic Sans	Courier	Garamond	Georgia	Gill Sans	Helvetica	Myriad Pro	Times New Roman
0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	l	1	1	1
2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9

In figures, numbers in sans serif fonts are always the most legible. When in doubt, use Helvetica. It's always a good choice.



The graph on the left uses Times New Roman and the graph on the right uses Helvetica. Which do you find most legible? Which looks most professional?

Make sure that superscript or subscript numbers are legible. Sometimes, depending on the font, it is best to change the font size of superscript or subscript characters so that the numbers become easier to read.

$1 \times 10^4 = 10^2 \times 10^2$ $\qquad$ $1 \times 10^4 = 10^2 \times 10^2$

The equation on the left was written using the default Helvetica settings in Microsoft Word. In the equation on the right, the superscript numbers are a bit more legible because the font size was increased by 1 pt. and the superscript settings were changed to raise the numbers by 1 pt.

Summary: Don’ts and Dos

Don’t ignore decisions about typography when designing a presentation.
Do deliberately make decisions that increase the legibility and clarity of your text.

Don’t ignore the inherent personalities of fonts.
Do choose fonts in consideration of your presentation format and the tone you want to convey.

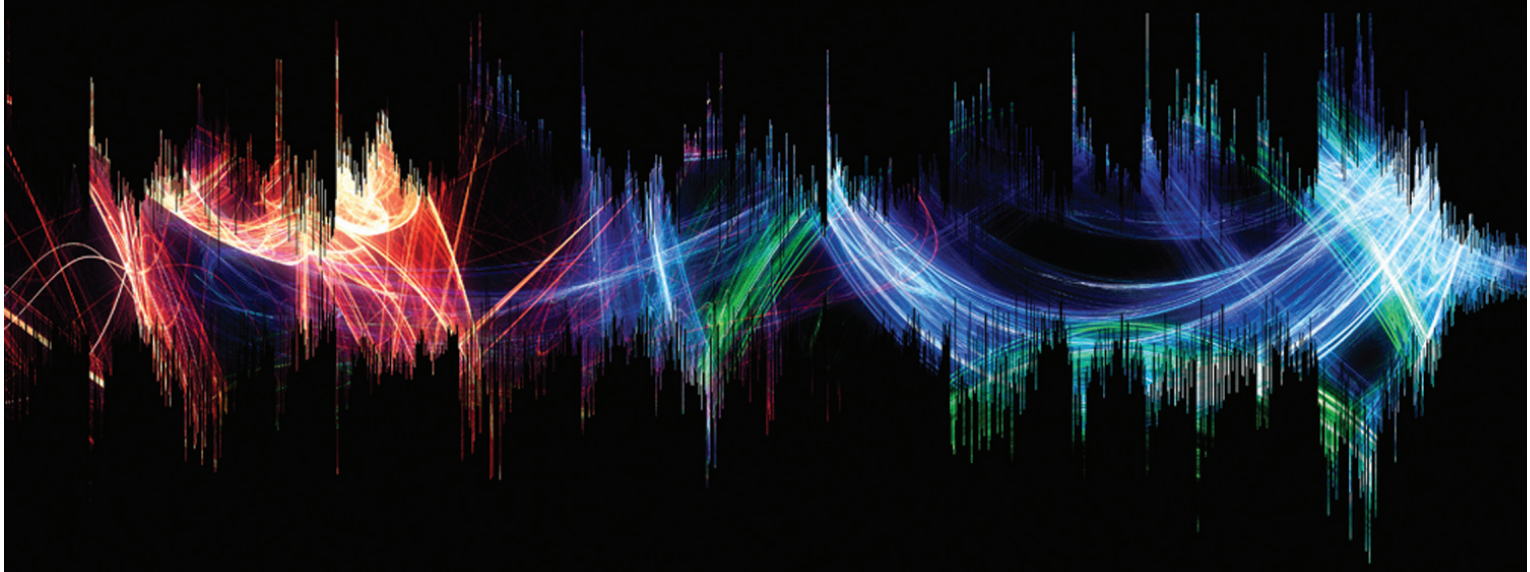
Don’t assume that the default settings in your software ensure maximum legibility.
Do visually inspect all of your choices about text and manually change settings that aren’t optimal.

Don’t let your paragraphs form awkward shapes in a slide or poster presentation.
Do typeset blocks of text and prevent “dangling” words.

Don’t use single bullets or ignore bullet indentations.
Do make your bullet list look crisp and professional by typesetting the entire list.

6
Words

It is often possible to express the same idea using many different combinations of words and phrases. The English language is rich in vocabulary, and many words have similar meanings. The key to good writing is to select the best possible combination of words so that you can express your ideas as precisely, concisely, and clearly as possible.



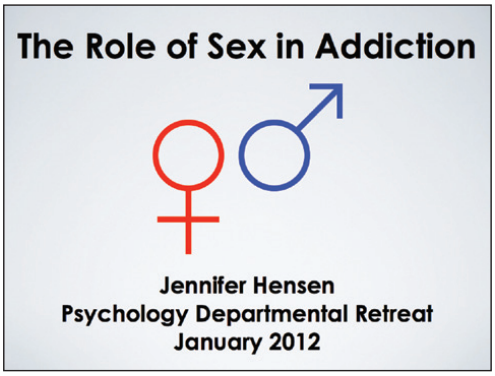
Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00006-4

Words Matter

All too often, scientists designing presentations think of what they want to say and then choose the first words that come to mind.

Instead of choosing words that *can* convey what you mean, try to always choose words that *precisely* convey what you mean.

Be picky. Own a dictionary and thesaurus (in print or on your computer) and consult them often. Study the differences between similar words, and practice reading and editing your sentences until you get the words just right.



This is a title slide from a talk at an institutional retreat. After reading the title, what do you think the talk was about? Perhaps about how a person's sex life influences addiction to drugs? Or maybe about addiction to sex? The study is actually a comparison between male and female rats and how they differ in their addiction to drugs of abuse.

This flyer (it's real!) caused a lot of unintentional laughs when it was posted throughout a science building. Even if you ignore the misspelling of the word "their" (which should be "they're"), the term "Brown Women's Glasses" was either a description of the glasses or an unfortunate racist characterization. Poor Monica was only trying to help!

Avoid Wordiness

In science presentations, you usually have an economy of words. Many journals insist on astonishingly low word limits, and slides and posters look best when you use as few words as possible. Therefore, brevity and clarity are paramount.

The best way to avoid wordiness is to carefully edit your sentences, omitting unnecessary words and shortening wordy phrases. Go through each sentence, one-by-one, and ask yourself if you can convey the same meaning with fewer words. Here are some common examples of wordy phrases in scientific writing:

Wordy	**Concise**
A total of…	*(Omit)*
All of…	All…
At the present time…	At present…
At this point in time…	At present…
Based on the fact that…	Because…
Both of…	Both…
During the course of…	During… or In…
Figure 1 shows that…	… (Figure 1).
For the purpose of…	For… or To…
Has been shown to be…	Is…
In light of the fact that…	Because…
In order to…	To…
In only a small amount of trials…	Rarely… or Occasionally…
In previous years…	Previously…
It may be that…	Perhaps…
It should be mentioned…	*(Omit)*
It is interesting to note that…	Of interest is…
More often than not…	Usually…
Quite unique…	Unique…
Really…	*(Omit)*
Small in size…	Small
The reason is because…	The reason is…
Very…	*(Omit)*
Would seem to suggest…	Suggest…

This list is obviously not exhaustive. The best way to avoid wordiness in a presentation is by carefully considering each sentence for concision.

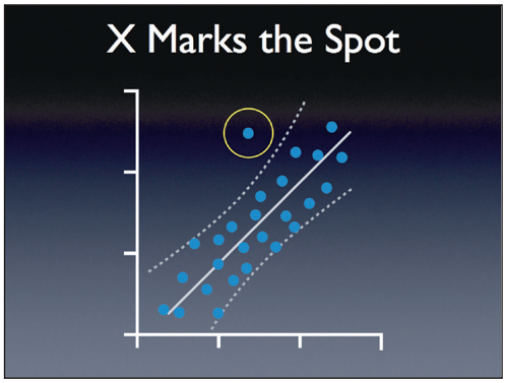
Colloquialism and Slang

Scientific writing has a reputation for being serious and dry. Even most scientists don't like professional scientific writing as an art form. As later chapters will discuss, serious writing need not be boring. But is it ever okay to be informal or colloquial with the words you choose?

In professional written presentations intended for other scientists, the answer is clearly no.

- Don't use contractions (e.g., can't, won't, don't). Spell them out.
- Don't use slang:
  "Cutting edge"
  "Rock solid"
  "Cop out"
- Don't use idioms:
  "Kill two birds with one stone"
  "Cream of the crop"
  "Eat your heart out"
  "Kick the bucket"

In poster presentations you have a little more freedom for informality (especially for non-professional, "in-house" poster sessions). Slide presentations can be the most informal of all. Depending on the venue, you can feel free to use contractions and more colloquial language. Just remember that the overarching goal is to communicate a message.



Singular versus Plural

To make most English words plural, you simply add the letter "–s". To make words that end in –ch, –x, or –s plural, you usually add an "–es". There are some exceptions for common English words, but there are *many* exceptions for words in science. Many scientific words maintain their original Latin or Greek form in plural, and their use may not seem intuitive or natural.

Single	**Plural**
Analysis	Analyses
Appendix	Appendices
Bacterium	Bacteria
Basis	Bases
Criterion	Criteria
Datum	Data
Focus	Foci
Genus	Genera
Homo sapiens	*Homo sapiens*
Hypothesis	Hypotheses
Index	Indices
Locus	Loci
Matrix	Matrices
Medium	Media
Nebula	Nebulae
Nucleus	Nuclei
Phenomenon	Phenomena
Serum	Sera
Species	Species
Symposium	Symposia
Thesis	Theses

"Data" is always plural

Probably one of the most common mistakes in science presentations from across disciplines is the use of the word "data" in reference to a single item. There is *one* instance in which "data" isn't plural: if you are referring to Data the android from *Star Trek: The Next Generation*, then you can can use the word as singular. In all other cases, it is plural.

Incorrect	Correct
The data is clear	The data are clear
The data shows	The data show
The data suggests	The data suggest
The data never lies	The data never lie
The data fits the hypothesis	The data fit the hypothesis
The data does not look good	The data do not look good

Active versus Passive Verbs

Be conscious about your use of active versus passive verbs. In the active voice, the subject of the sentence *does* an action. In the passive voice, the subject *receives* an action.

Active	We stained the cells using immunohistochemistry.
Passive	The cells were stained using immunohistochemistry.

Both of these sentences are grammatically correct, but each sentence emphasizes different information. In the active voice, there is more emphasis placed on who is staining the cells. "We" is the subject of the sentence. In the passive voice, it is unknown who stained the cells. "Cells" is the subject of the sentence.

It is customary to use the passive voice in scientific writing even though the active voice is often more concise and provides more information. There are at least two reasons to use the passive voice: (1) Passive verbs de-emphasize *who* is doing the work and instead emphasize the work being done. In science, the focus should be on the work, not the scientists conducting the experiments. (2) Passive verbs prevent repetition. For example, consider the following passage from a scientific methods section:

> *We dissolved the Hcrt antagonist in artificial cerebrospinal fluid and stored aliquots at −20°C prior to use. We infused the antagonist bilaterally using a minipump at a rate of 0.1 μl/min for 3 min. We used the same injection coordinates used to deliver AAV5 above the LC region.*

All sentences use the active voice, but all sentences start with "We…" and emphasize the scientists performing the experiments. In contrast, consider the same section with a mix of the active and passive voice:

> *We dissolved the Hcrt antagonist in artificial cerebrospinal fluid and stored aliquots at −20°C prior to use. Microinfusions were performed bilaterally using a minimpump at a rate of 0.1 μl/min for 3 min. Injection coordinates were the same used to deliver AAV5 above the LC region.*

There are no firm guidelines on whether the active or passive voice is best except to be deliberate about which you choose throughout your presentation. Try to use the active voice as often as possible, but not at the expense of effective, non-repetitive writing.

Verb Tense

The verbs you use can be in the past, present, or future tense. The future tense is obviously only used to describe potential or proposed actions/experiments that have not yet been performed. It is not immediately obvious, however, when to use the past and present tenses in science presentations. Scientists are not consistent. Open a single issue of a scientific journal and you may see inconsistencies among the use of the past and present tenses among the different articles.

In general, it is best to use the past tense to describe the experiments performed and the present tense to describe knowledge you accept as valid conclusions.

Always describe the results of experiments (performed by you or others) in the past tense because these experiments took place in the past.

*We **collected** five specimens from each plant…*
*Owen et al. (2005) **found** that…*
*Each mouse **was implanted** with a 22G stainless steel cannula…*
*Two days later, all of the cells **were dead** and detached from the culture plate…*

Describe the conclusions of experiments in the present tense because the conclusions don't change with time.

*Flies and mice **prefer** sweet compounds to bitter compounds…*
Owen et al. *(2005) found that dogs **increase activity** after consumption of caffeine…*
*The universe **is** expanding…*
*A 50% ethanol solution **is** toxic to cells…*

An **Abstract** should contain both past and present verbs; use the present tense to introduce relevant background information and the past tense to summarize what you did. An **Introduction** should mostly consist of information in the present tense. The present tense suggests your acceptance of the conclusions of past studies. **Methods** and **Results** should be in the past tense to describe the experiments you performed in your recent study. A **Discussion** should be a mixture of past and present verbs to integrate what you found (in the past) with what is already known (accepted as current knowledge). A final **Conclusion** should be in the present tense to place your findings in the context of the permanent scientific record.

Commonly Misused Words

There is nothing inherently wrong with using most of the following list of words; however, scientists commonly misuse them or use them in place of something better.

Above *Above* is sometimes used in written and poster presentations to mean *in an earlier section*. In papers, *above* might mean *on a previous page*, while in posters, *above* might mean *in a section to the left*. Consider using a more accurate term, such as "… mentioned previously."

Adaption "Adaption" is not a word. The correct word is *adaptation*.

As Don't use *as* in place of the word *because*. *As* means *in the same way that*…or *at the moment that*… For example: "English as a second language," or "The egg cooked as the water boiled."

Below Just like the word *above* (mentioned previously), the word *below* is often misused to mean *in a later section*. Instead, use *following*, *later*, or *upcoming*.

Comprise Don't use *comprise* when you mean *to constitute* or *to make up*. The word *comprise* means *to contain*, as in "the solar system comprises the sun and planets."

Correlate to Things might be related *to* each other, but they are always correlated *with* one another.

Could of *Could of* is grammatically incorrect; the correct usage is *could have*.

Dilemma *Dilemma* doesn't simply mean *a difficult problem* or a *quandary*. Instead, it means *a decision between two equally good or bad choices*.

Due to Don't use *due to* when you want to say *because of*. The word *due* suggests a debt or deadline.

Different than The correct way of saying that two items are different is to say they are different *from* each other, not different than each other.

Experience(d) This verb implies sensation. Therefore, only use it with living, sensing objects, as opposed to statements like "the Earth experienced a cooling period," or "The forest experienced high winds."

Irregardless Use *regardless*.

Literally *Literally* means that *something is completely and totally true, in a literal sense*. Because this word can be used for dramatic effect, sometimes people use it when they actually should be using the word's exact opposite, *figuratively*, which means that something is not true in a literal sense.

Peruse A common misconception is that *peruse* means *to browse or skim lightly*. It actually means the opposite: *to read with great care and attention to detail*.

Significant In science presentations, use *significant* only in reference to statistical significance. When not describing statistics, consider using the words *substantial*, *notable*, or *remarkable*.

Since Don't use *since* in place of the word *because*. *Since* connotes time, as in "I haven't seen you since this morning."

Thing The word *thing* is okay to use when referring to an object, but most people use it to represent an abstract concept: "The thing I don't like about the paper…"; "The thing I like about your proposal…"; "Here's the thing…" Try your best to be more specific. Use *thing* if you feel you have to, but trained writers don't like it.

This Don't use *this* in isolation. The problem with *this* is that it isn't descriptive enough. This just won't do. Instead, be specific: "this concept…," "this question…," "this example…," etc.

Where *Where* should always be used in reference to a location. Don't use *where* instead of *in which*, or *for which*. For example: "This is a protocol in which we need to pay careful attention to detail."

While *While* should always be used in reference to time. Don't use *while* instead of *and*, *but*, *although*, or *whereas*. For example: "The inner planets are mostly rocky, whereas the outer planets are mostly gaseous."

Understand the Distinctions between Similar Words

The following words are often mistakenly interchanged. Make sure you know which is the correct word to use in a given context.

Affect vs Effect: **Affect** is always a verb, meaning *to influence or cause an effect.* **Effect** is most often used as a noun, meaning *a result*. It is also sometimes a verb, meaning *to bring about*.

*How does the temperature **affect** the reaction?*
*What is the **effect** of temperature on the reaction?*
*We hope the results of this study will **effect** policy change.*

Appears vs Seems: **Appears** means becoming visible or coming into view. **Seems** means giving the impression of being.

*Our paper **appears** on PubMed sometime this week.*
*The data **seems** too good to be true.*

Compare to vs Compare with: **Compare to** means to represent something as similar to something else. **Compare with** means to determine the similarities and differences.

*Your style of delivering a talk **compares to** a game show host.*
*I think you should **compare** your results **with** the results of other studies.*

Denote vs Connote: **Denote** means to designate or indicate a primary meaning to something. **Connote** means to imply or hint about characteristics suggested by something.

*Her status as a Nobel Laureate **denotes** that she was awarded a Nobel Prize.*
*Her Nobel Prize **connotes** that she is an outstanding scientist and performs groundbreaking research.*

It's vs Its: **It's** is a contraction for "it is." **Its** is the possessive form of "it." Usually possessive words end with an apostrophe –s ('s), as in: "That is Pete's flame thrower." **Its** is an exception and never shows possession.

***It's** time to take out the garbage.*
*The dog hurt **its** tail as it went through its doggy door.*

Imply vs Infer: **Imply** means *to insinuate or suggest*. **Infer** means *to deduce or conclude*. Presenters **imply**, audience members **infer**.

*The politician **implied** that global warming is not real.*
*I **infer** from your speech that you don't believe global warming is real.*

Percentage vs Percent: **Percentage** is a noun meaning *an amount that is a proportion of a larger sum*. **Percent** is an adverb that always represents *a specified amount for every hundred*. **Percent** should always be used with a number.

*What is the **percentage** of people who follow your blog overseas?*
*Fifteen **percent** of Americans approve of Congress.*

Predominant vs Predominate: **Predominant** is an adjective meaning *principal, chief, controlling*. **Predominate** is a verb meaning *to be predominant and/or to be in the majority.*

*My **predominant** objective in presenting this talk is to attract graduate students to my lab.*
*Butterflies **predominate** over other species in this habitat.*

Principal vs Principle: **Principal** is either a a noun meaning *a person in charge*, or an adjective meaning *most important*. **Principle** is a noun meaning *a rule, doctrine, or truth*.

*She is the **principal** of the elementary school.*
*The **principal** finding of this study is that the universe is expanding.*
*The guiding **principle** of cell culture is to keep everything as sterile as possible.*

That vs Which: **That** and **which** both add additional information about the subject or object of a sentence. **That** usually does not follow a comma, and restricts or defines the meaning of something. **Which** almost always follows a comma, and adds additional information about the meaning of something.

The mice **that** *had been raised in an enriched environment lived longer than mice* **that** *were isolated in cages without running wheels.*
The mice, **which** *have a shorter lifespan than rats, were raised in either an enriched environment or in isolated cages.*

The Burden of Proof

Your choice of words is very important when describing the conclusion of an experiment or study. You will often want to emphasize the importance of scientific results, but you also don't want to exaggerate your conclusions with language that is too strong.

Choose your words very carefully and be honest about what your data show.

The results...

Strong Conclusion	...prove...
	...unambiguously show...
	...show...
	...demonstrate...
	...indicate...
	...substantiate...
	...strongly suggest...
	...argue for...
	...suggest...
	...support...
	...are consistent with...
	...are compatible with...
Cautious Conclusion	...are not inconsistent with...

Latin Abbreviations

Latin was the universal academic language of Western civilization for several centuries. Although scientists no longer speak this language, many Latin scientific terms remain in use, especially in abbreviated form. It is customary to write many Latin abbreviations in italics, however, each scientific journal has its own guidelines.

CV ***Curriculum vitae:*** "Course of life." A document that lists all of the relevant education, training, jobs, and successes in one's career. Usually more extensive than a resume.

I would be happy to consider you for a position if you send me your current CV.

e.g. ***Exempli gratia:*** "For example." For example; for instance. Always use this term in scientific presentations instead of "ex."

You must obtain IACUC approval before doing experiments on vertebrate animals (e.g., mice or rats).

et al. ***Et alia:*** "And others." The other people who contributed; coworkers. In science, this term almost always applies to coauthors of a research study.

Our results are consistent with the findings of Prolo et al. (2008).

etc. ***Et cetera:*** "And other things." Other people or items in the same category. Make sure to use at least two or more items preceding this term.

There are many neuropeptides in the brain, including hypocretin, kisspeptin, agouti-related protein, etc.

i.e. ***Id est:*** "That is." In other words…

Many lizard species demonstrate metachrosal circadian rhythms, i.e., the ability to change body color throughout the day.

Writing about Numbers

Sometimes it is best to write out numbers as words (e.g., sixteen, twenty-nine, etc.), and other times it is best to write out numbers as numerals (16, 29, etc.). Use the following guidelines to determine whether words or numerals are most appropriate:

Write out single-digit whole numbers and use numerals for numbers greater than nine.

We used eight mice in this study.
We used 26 mice in this study.

Be consistent within a category. If you choose to use numerals, use numerals for all numbers in that category. Likewise, if you choose to write out numbers as words, write out numbers in that category.

This study consisted of 6 girls and 14 boys.
We hoped to discover at least twenty new species but only discovered three.

Never start a sentence with a numeral. Try not to start a sentence with a number greater than ninety-nine.

Twenty-six mice were used in this study.
Since the study began, we have recruited over 1300 subjects.

Use numerals to report statistics, provide quantitative data using units of measurement, and when describing dates, times, pages, figures, and tables.

Only 5% of neurons transduced with GFP showed co-expression with c-Fos (Figure 1).
All stimulation episodes lasted 5 h (between 13:00 and 18:00).

Write decimals as numerals and always place a zero in front of a number less than one.

I can eat an entire pizza in 5.78 min.
The water level rose 0.13 m last year.

Always spell out simple fractions.

One-half of the mice were fed chow and one-half were fed sausages.
Two-thirds of the students come from disadvantaged backgrounds.

Express mixed fractions as numerals unless they begin a sentence.

The imaging procedure lasted 7½ h.
Seven and one-half hours later, the imaging was complete.

Never place two numbers next to each other without a comma unless you write one as a numeral and one as a word.

This study imaged thirteen 17-year-old males.
The ages of the four subjects were 17, 29, 39, and 45.

Hyphenate all compound numbers from twenty-one through ninety-nine.

Sixty-three adult males took part in the study.

Spell out centuries and decades either as words or numerals. If you use words, write the century or decade in lowercase. If you use numerals, use an apostrophe for abbreviated decades but never between then number and the –s.

Scientists began using fMRI in humans in the nineties.
Scientists began using fMRI in humans in the '90s.
Scientists began using fMRI in humans in the 1990s.

Summary: Don’ts and Dos

Don’t simply use the first words you think of to express an idea.
Do carefully choose the best words to precisely and concisely communicate what you mean.

Don’t be lazy about wordiness and using slang in a presentation.
Do reduce wordiness as much as possible and only use slang when it is appropriate.

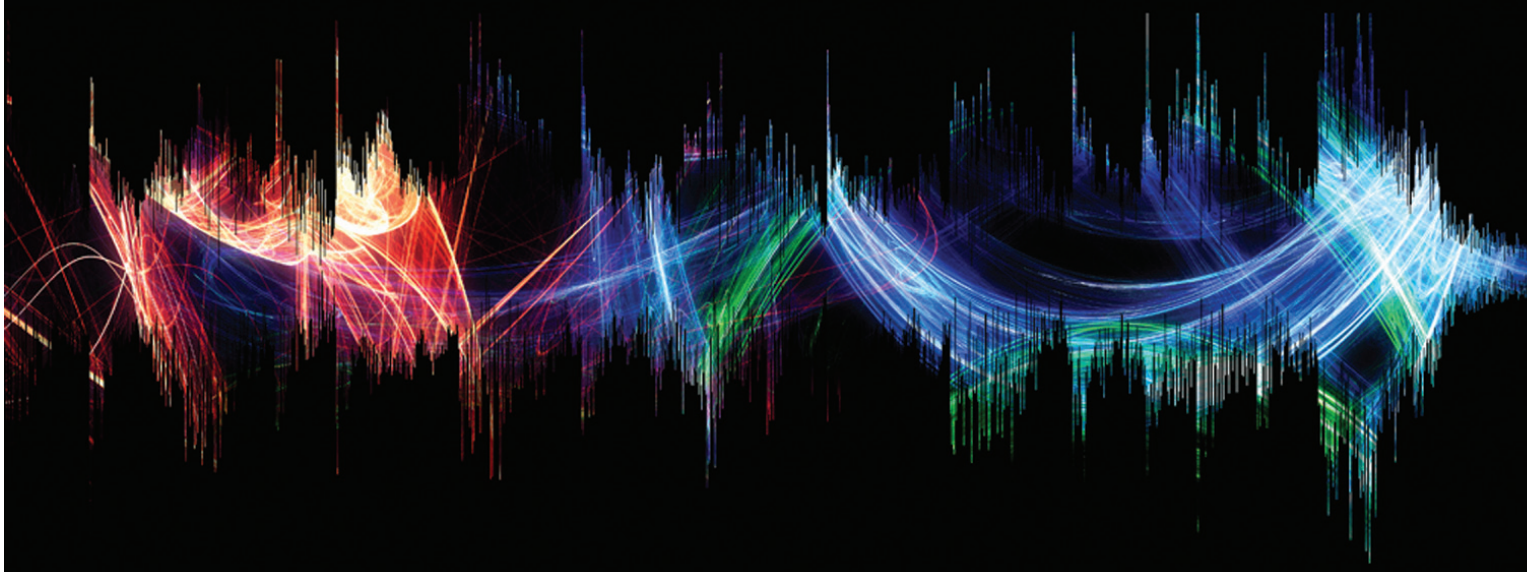
Don’t use words inappropriately or misuse words with similar meanings.
Do learn the subtle distinctions between words and choose the best words possible.

Don’t be ignorant about your use of verbs in terms of tense and active/passive voice.
Do deliberately choose to use verb tenses or active/passive verbs to emphasize what you want to communicate.

Don’t represent numbers haphazardly.
Do learn and follow guidelines about representing numbers so they are easier for your audience to read.

7
Tables

Tables display data (numbers or words) organized in rows and columns. Unlike figures, tables usually show data in their unprocessed, rudimentary form. The key to designing a great table is to arrange information clearly and logically so that data are easily accessible and comprehensible to an audience.



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Anatomy of a Table

Each scientific journal has its own guidelines for creating tables; however, all good tables share certain design principles.

A table should be completely comprehensible on its own. Information in a well-designed table should be easy to understand even if the table is removed from the rest of a presentation.

The **title** of your table must adequately and completely describe the contents of the table. Usually the title is a sentence fragment (lacking a verb) written in sentence case (only the first letter is capitalized). Never use vague titles.

Vague:	Injection coordinates
Specific:	Injection coordinates of all brain regions targeted with AAV
Vague:	Planetary probes
Specific:	A summary of the probes that have landed on other planets
Vague:	Lizards studied
Specific:	Sex, weight, and snout-vent length of *Sceloporus malachiticus* individuals

Column titles must be short and specific. To make these titles shorter, it is usually okay to employ abbreviations that normally you wouldn't use (e.g., "temp" for temperature or "conc" for concentration).

Lines demarcate different parts of a table to help categorize information. These lines should be placed above and below column headings and at the very bottom of the table.

Footnotes describe or clarify information from the table in more detail. These are always placed immediately beneath the table.

Title

Table 1. Percentage of neurons co-expressing c-Fos following stimulation of Hcrt neurons after 0 or 4 h sleep deprivation.

Column titles

	0 h sleep deprivation		4 h sleep deprivation	
Cell group	**No stim**	**Stim**	**No stim**	**Stim**
Basal forebrain	4.14 +/- 5.27 n=674	44.21 +/- 7.22** n=721	3.24 +/- 5.46 n=677	4.99 +/- 1.98 n=702
DRN	8.94 +/- 3.48 n=315	9.33 +/- 3.00 n=345	6.29 +/- 2.76 n=308	9.04 +/- 3.84 n=361
Hcrt neurons	13.49 +/- 3.89 n=761	42.98 +/- 8.33** n=802	13.99 +/- 4.18 n=739	39.66 +/- 6.13** n=779
LC	12.24 +/- 4.16 n=881	39.24 +/- 8.74** n=932	17.94 +/- 4.01 n=975	21.14 +/- 4.75 n=953
MCH	3.45 +/- 1.55 n=821	2.21 +/- 1.23 n=783	2.98 +/- 1.01 n=756	3.11 +/- 0.87 n=801
TMN	11.87 +/- 4.98 n=289	23.44 +/- 6.24* n=320	11.06 +/- 2.69 n=351	13.21 +/- 4.52 n=340
VLPO	2.87 +/- 1.23 n=57	5.42 +/- 1.65 n=71	3.54 +/- 1.82 n=63	4.44 +/- 0.98 n=69
VTA	5.68 +/- 2.03 n=893	25.12 +/- 4.87** n=927	4.25 +/- 1.65 n=910	7.82 +/- 2.31 n=917

Data

Footnotes

Values represent the mean percentage of neurons (n) that also co-express c-Fos, +/- the standard error of the mean. Double asterisk, $p<0.001$; asterisk, $p<0.05$; two-tailed Student's t-test between Hcrt::mCherry and Hcrt::ChR2-mCherry transduced animals. Abbreviations: DRN, dorsal raphe nuclei; Hcrt, hypocretin; LC, locus coeruleus; MCH, melanin concentrating hormone neurons; TMN, tuberomammilary nucleus; VLPO, ventrolateral preoptic nucleus; VTA, ventral tegmental area.

Demarcation lines

When to Use a Table

Tables are beneficial because they allow you to present a large quantity of information that would be too tedious and cumbersome to present as text.

Table 2. Stereotaxic injection coordinates for injection of adeno-associated virus into different brain structures

Structure	AP (mm)	DV (mm)	ML (mm)
Arcuate nu.	–1.6	6.5	0.3
Dorsomedial hyp.	–1.4	5.3	0.4
Lateral hyp.	–1.2	5.5	0.4
Parabrachial nu.	–5.2	3.5	1.5
Ventromedial hyp.	–1.4	6.5	0.4

AP, anteroposterior; DV, dorsoventral; ML, mediolateral.

The stereotaxic coordinates used to inject adeno-associated virus into brain structures were (in mm): arcuate nucleus (Anteroposterior–AP: –1.6, Dorsoventral-DV 6.5:, Mediolateral–ML: 0.3); dorsomedial hypothalamus (AP: –1.4, DV: 5.3, ML: 0.4); lateral hypothalamus (AP: –1.2, DV: 5.5, ML: 0.4); parabrachial nucleus (AP: –5.2, DV: 3.5, ML: 1.5); ventromedial hypothalamus (AP: –1.4, DV: 6.5, ML: 0.4).

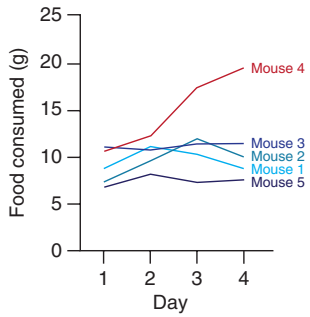
The table on the left contains the same information as the text on the right, however, the information in the table is much more accessible and easy to follow.

Although tables serve a useful purpose, they generally resonate less with audiences than figures. Audience members may remember figures after a presentation, but nobody ever remembers a table. Therefore, use tables judiciously, more as a reference of important information than as a main communication tool.

Do *not* use a table to convey differences, patterns, trends, or interactions between values. You don't want to force your audience to do any extra work to compare differences between different numbers. Figures are much better for highlighting the relationships between data.

Table 3. Food consumed (g) in five individuals following injection of compound JSB3341

Mouse	Day 1	Day 2	Day 3	Day 4
1	8.2	10.9	10.2	8.0
2	7.4	9.6	11.9	10.0
3	11.3	10.6	11.5	11.5
4	10.5	12.4	16.5	19.2
5	6.9	7.8	7.2	7.5



The table on the left contains the same information as the graph on the right, however, the relationship between the data is immediately more apparent and accessible in the graph.

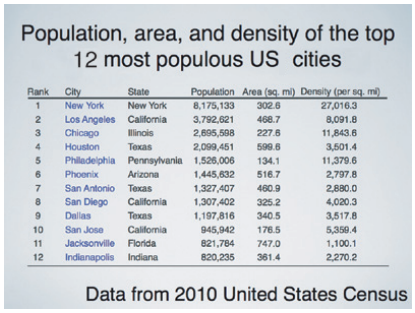
Tables Differ among Different Presentation Formats

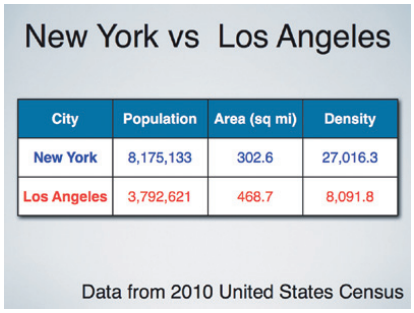
When considering the qualities of a good table, consider that different presentation formats have different needs. Tables in written presentations can serve as a reference for extensive quantities of information that a reader can peruse whenever necessary. In contrast, tables in slide and poster presentations need to be brief because the audience cannot keep track of a large amount of information during your real-time delivery.

Table 4. Population, area, and density of the top 12 most populous US cities[a]

Rank	City	State	Population	Area (sq. mi)	Density (per sq. mi)
1	New York	New York	8,175,133	302.6	27,016.3
2	Los Angeles	California	3,792,621	468.7	8,091.8
3	Chicago	Illinois	2,695,598	227.6	11,843.6
4	Houston	Texas	2,099,451	599.6	3,501.4
5	Philadelphia	Pennsylvania	1,526,006	134.1	11,379.6
6	Phoenix	Arizona	1,445,632	516.7	2,797.8
7	San Antonio	Texas	1,327,407	460.9	2,880.0
8	San Diego	California	1,307,402	325.2	4,020.3
9	Dallas	Texas	1,197,816	340.5	3,517.8
10	San Jose	California	945,942	176.5	5,359.4
11	Jacksonville	Florida	821,784	747.0	1,100.1
12	Indianapolis	Indiana	820,235	361.4	2,270.2

[a]Data from the 2010 United States Census.





The table on top is perfect for a written presentation, however, it could overwhelm an audience when used in a slide (as in the bottom left). The table in the slide at bottom right is very accessible to an audience, but would be too simple for written presentation.

There may be rare instances in which it is beneficial to present a complex table in a slide show. For example, if you want to communicate the message that there are a lot of data, then you could briefly present a complex table without explaining all of the information in the table. In this case, the size of the table *is* the message instead of the information contained within.

Logically Formatting a Table

Categories of comparative data should be presented vertically in columns, not horizontally.

Table 5. Area, length, and maximum depth of the three largest African lakes

Lake	Area (km^2)	Length (km)	Depth (m)
Malawi	30,044	579	706
Tanganyika	32,893	676	1470
Victoria	69,485	322	84

Table 5. Area, length, and maximum depth of the three largest African lakes

Lake	Malawi	Tanganyika	Victoria
Area (km^2)	30,044	32,893	69,485
Length (km)	579	676	322
Depth (m)	706	1470	84

Both tables present the same data, but the table on the left is organized more logically and is easier to read. The eye tends to read down columns more naturally than read across rows, so comparative statistics should be arranged vertically.

Use a hierarchical organization to emphasize the categories you think are most important.

Table 6. Number of men and women selected by NASA to be astronauts by year of selection

	Men			Women		
	1980	1990	2000	1980	1990	2000
Mission specialist	9	12	7	2	4	3
Pilot	8	6	7	0	1	0
Total	17	18	14	2	5	3

Table 6. Number of men and women selected by NASA to be astronauts by year of selection

	1980		1990		2000	
	Men	Women	Men	Women	Men	Women
Mission specialist	9	2	12	4	7	3
Pilot	8	0	6	1	7	0
Total	17	2	18	5	14	3

The table on the left emphasizes the comparison between men and women. The table on the right emphasizes the comparison between years of selection.

Horizontal entries of data should not be listed randomly. Order information in alphabetical or numerical order depending on which data you want to emphasize.

Table 7. Diameter and mass of planets in relation to the Earth

Planet	Diameter	Mass
Mercury	0.38	0.06
Venus	0.95	0.82
Earth	1.00	1.00
Mars	0.53	0.11
Jupiter	11.21	317.80
Saturn	9.45	95.20
Uranus	4.01	14.60
Neptune	3.88	17.20

Table 7. Diameter and mass of planets in relation to the Earth

Planet	Diameter	Mass
Earth	1.00	1.00
Jupiter	11.21	317.80
Mars	0.53	0.11
Mercury	0.38	0.06
Neptune	3.88	17.20
Saturn	9.45	95.20
Uranus	4.01	14.60
Venus	0.95	0.82

Table 7. Diameter and mass of planets in relation to the Earth

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Saturn	9.45	95.20
Uranus	4.01	14.60
Neptune	3.88	17.20
Earth	1.00	1.00
Venus	0.95	0.82
Mars	0.53	0.11
Mercury	0.38	0.06

The table on the left lists the planets in order from the sun. The center table lists the planets in alphabetical order. The table on the right lists the planets in descending order of diameter. Any order is acceptable as long as it follows an understandable hierarchy and emphasizes your message.

Text and Number Alignment

Scientists often spend a lot of time thinking about how to align text and numbers within tables. In slides, usually centering text and numbers is best (except for the first column, which should be flush left). For written presentations, use the following guidelines:

Table 8. Average mass and length of 10 of the heaviest mammals

Animal	Environment	Avg. mass (kg)	Avg. length (m)
Asian elephant	Terrestrial	4,150	6.8
Blue whale	Aquatic	110,000	25.5
Fin whale	Aquatic	57,000	20.6
Giraffe	Terrestrial	1,015	5.1
Gray whale	Aquatic	19,500	13.5
Hippopotamus	Terrestrial	1,800	4.0
Humpback whale	Aquatic	29,000	13.5
Sperm whale	Aquatic	31,250	13.3
Walrus	Terrestrial	944	2.8
White rhinoceros	Terrestrial	2,100	4.4

Do:

- Align the major items on the lefthand side of a table flush left.
- Align text entries in the center or flush left.
- Align whole numbers flush right.
- Align numbers with decimals or +/– symbols centered on the decimal point or +/–.

Don't:

- Align the major items on the lefthand side flush right or center.
- Align text entries flush right.
- Align whole numbers center or flush right.
- Align numbers with decimals or +/– symbols in the center or flush left or right.

Table 8. Average mass and length of 10 of the heaviest mammals

Animal	Environment	Avg. mass (kg)	Avg. length (m)
Asian elephant	Terrestrial	4,150	6.8
Blue whale	Aquatic	110,000	25.5
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Giraffe	Terrestrial	1,015	5.1
Gray whale	Aquatic	19,500	13.5
Hippopotamus	Terrestrial	1,800	4.0
Humpback whale	Aquatic	29,000	13.5
Sperm whale	Aquatic	31,250	13.3
Walrus	Terrestrial	944	2.8
White rhinoceros	Terrestrial	2,100	4.4

Gridlines on Tables

In written and poster presentations, it is usually best to avoid using gridlines to separate rows and columns of information. Unhelpful grids are unnecessary and can be distracting.

Name	Data	Data	Data	Data
Item A	2.3	1.9	8.7	9.0
Item B	4.0	7.2	9.1	5.5
Item C	0.4	0.8	5.2	0.6
Item D	8.0	9.4	1.0	4.2
Item E	6.3	3.5	8.0	6.0

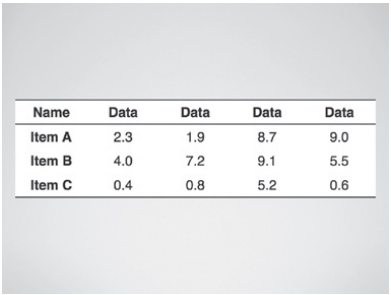
Name	Data	Data	Data	Data
Item A	2.3	1.9	8.7	9.0
Item B	4.0	7.2	9.1	5.5
Item C	0.4	0.8	5.2	0.6
Item D	8.0	9.4	1.0	4.2
Item E	6.3	3.5	8.0	6.0

Occasionally, especially in a large table, subtle gridlines can help guide the reader in a sea of numbers. If it is helpful, add light horizontal gridlines every three to five rows. There are no firm rules on when to use these gridlines, so only use them when you feel they would be beneficial.

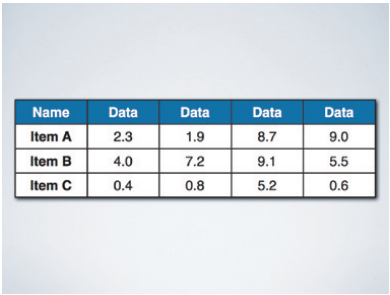
Name	Data	Data	Data	Data
Item A	2.3	1.9	8.7	9.0
Item B	4.0	7.2	9.1	5.5
Item C	0.4	0.8	5.2	0.6
Item D	8.0	9.4	1.0	4.2
Item E	6.3	3.5	8.0	6.0
Item F	0.5	1.7	3.8	0.9
Item G	7.0	1.4	9.2	8.7
Item H	1.6	0.3	8.1	9.7
Item I	4.7	9.2	3.5	0.6
Item J	9.1	4.8	3.2	1.2
Item K	7.1	4.2	3.3	5.4
Item L	8.0	2.8	4.7	9.3

Name	Data	Data	Data	Data
Item A	2.3	1.9	8.7	9.0
Item B	4.0	7.2	9.1	5.5
Item C	0.4	0.8	5.2	0.6
Item D	8.0	9.4	1.0	4.2
Item E	6.3	3.5	8.0	6.0
Item F	0.5	1.7	3.8	0.9
Item G	7.0	1.4	9.2	8.7
Item H	1.6	0.3	8.1	9.7
Item I	4.7	9.2	3.5	0.6
Item J	9.1	4.8	3.2	1.2
Item K	7.1	4.2	3.3	5.4
Item L	8.0	2.8	4.7	9.3

In contrast to written and poster presentations, gridlines are ideal for slide presentations. Audience members have a harder time distinguishing between rows and columns on a projected slide across a room. Adding subtle gridlines can help the eye track data among horizontal and vertical categories.



Name	Data	Data	Data	Data
Item A	2.3	1.9	8.7	9.0
Item B	4.0	7.2	9.1	5.5
Item C	0.4	0.8	5.2	0.6



Name	Data	Data	Data	Data
Item A	2.3	1.9	8.7	9.0
Item B	4.0	7.2	9.1	5.5
Item C	0.4	0.8	5.2	0.6

Summary: Don’ts and Dos

Don’t use a table when you can easily summarize information in the text or when you want to communicate the relationship between data.
Do use a table to summarize information that would be too tedious and cumbersome to mention in words alone.

Don’t design the same table for a written presentation as you would for a slide presentation.
Do design tables with consideration of your presentation format.

Don’t arrange information in a table randomly.
Do arrange information logically to emphasize relationships between categories of data.

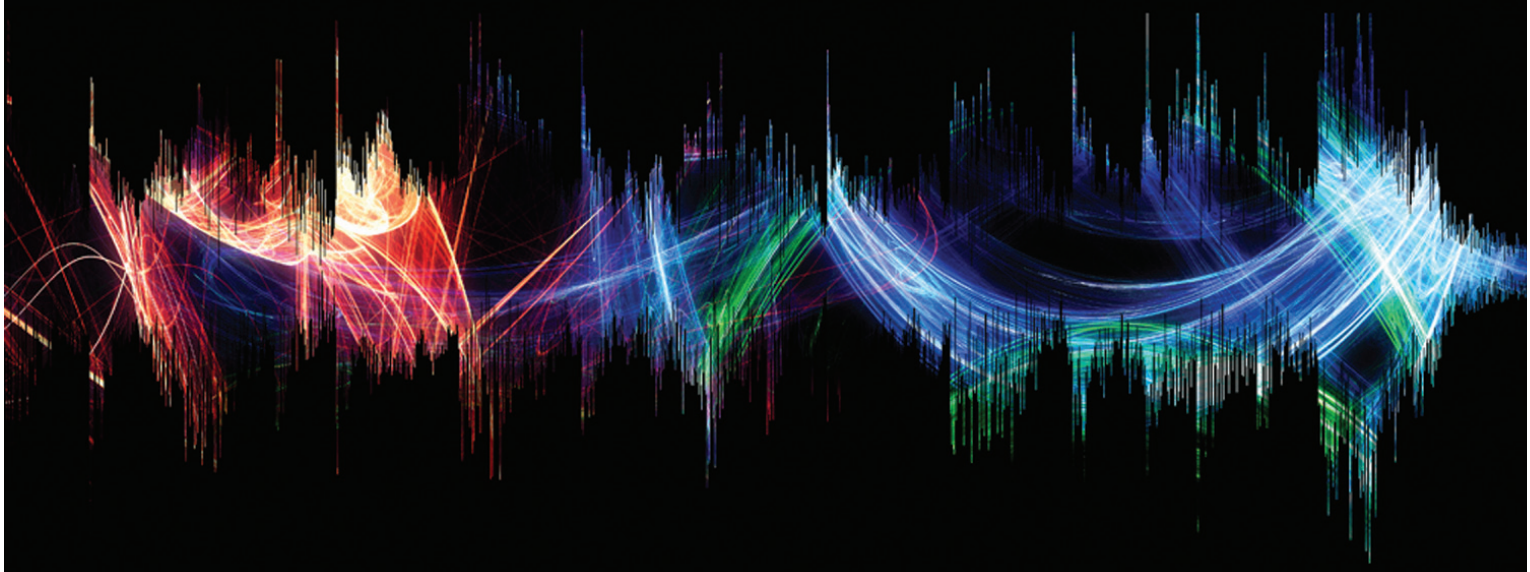
Don’t rely on computer default settings to align data or text within tables.
Do purposefully align information in a way that is pleasing to the eye.

Don’t use gridlines in written presentations unless they are helpful in large tables.
Do use gridlines in slide presentations.

8

Charts

Figures about quantitative data are the meat of most scientific presentations. Many audience members equate your quantitative figures with your results themselves, entirely judging the science you present by the information contained in your charts. In many presentations (especially written and poster presentations), quantitative figures are often the first, and sometimes the only, parts actively viewed by an audience. Therefore, designing quality charts is extremely important. As with the design of any aspect of a presentation, the goal is to communicate and highlight meaningful information in the simplest, clearest way possible.

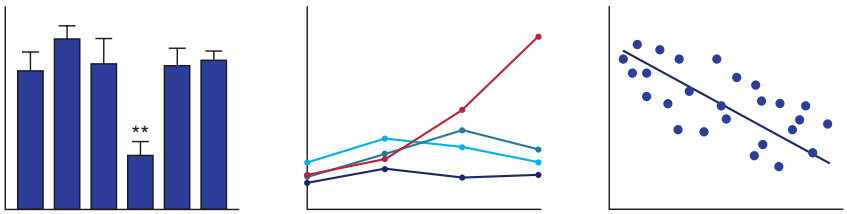


Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00008-8

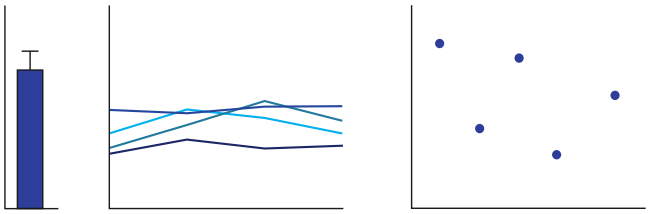
When to Use a Chart

Charts are ideal for communicating patterns or trends in data and differences or interactions among data. A chart is the most fundamental unit of a scientific presentation, representing a single aspect of a study with its own rationale, methods, and conclusions.

Well-designed charts are inherently more interesting than words or tables because they not only present data, they also communicate meaningful relationships.

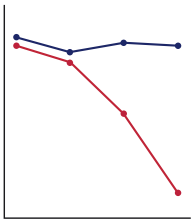


Don't use a chart if there is no interesting (statistical) relationship between data or if the data are too sparse to justify using a chart. Use words to present sparse data that are easily summarized in one to two sentences, or tables to present more copious amounts of data.

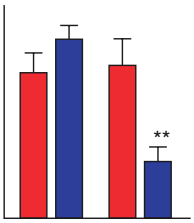


Categories of Charts

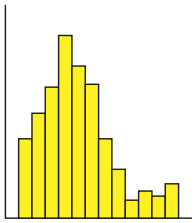
The five most common categories of charts used in science presentations are line charts, bar charts, histograms, scatterplots, and pie charts.



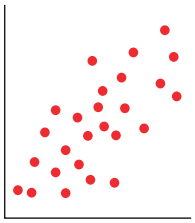
Line chart
Visualizes a trend of continuous data, usually over time



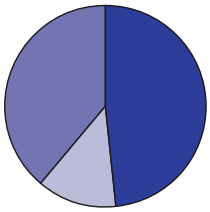
Bar chart
Compares discrete quantities of non-continuous data



Histogram
Reports the distribution of data and the frequency with which they occur

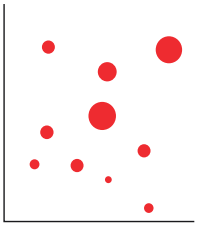


Scatterplot
Displays the relationship between two continuous variables



Pie chart
Shows the proportional values that make up a whole

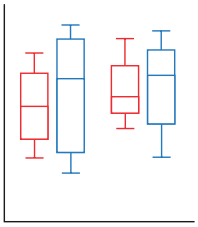
While these charts are the most prevalent, other forms of charts exist that may better represent more specialized datasets.



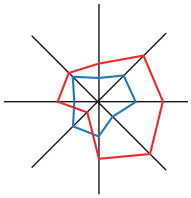
Bubble scatterplot
Displays the relationship between two continuous variables and a third variable represented by area

Heat chart
Displays the relationship between two variables and a third variable represented by a gradient of color

Area chart
Represents cumulated totals of multiple continuous data series, usually over time



Box and whisker chart
Compares the mimimum, lowest quartile, median, upper quartile, and maximum of a set of data



Radar chart
Compares values between two or more data series across multiple variables

Anatomy of a Chart

Audiences naturally focus on figures more than written text or oral narration. Therefore, well-designed charts should be comprehensible on their own, without the need for many supporting details found elsewhere.

Each category of chart has its own design considerations; however, the goal of designing any quantitative figure is to clearly convey the most information in the simplest, easiest way possible.

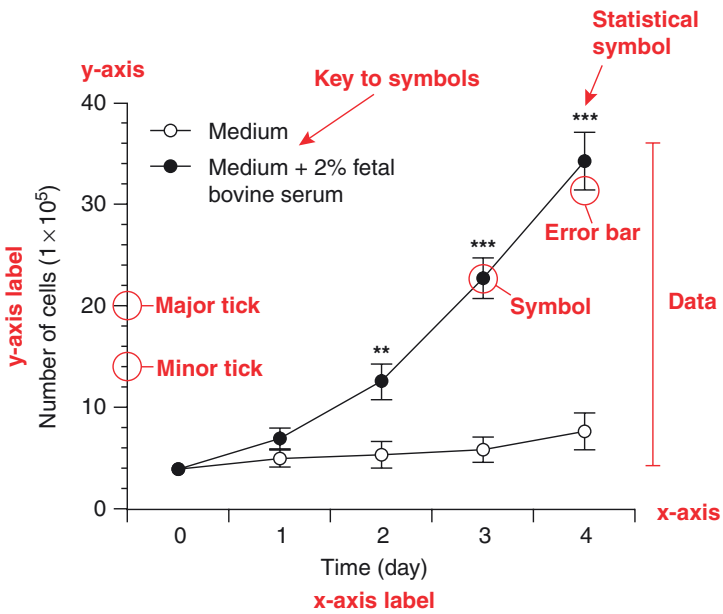


Figure 1. Addition of 2% fetal bovine serum to culture medium statistically increases the growth of DK cells. $^{**}P<0.001$, $^{***}P<0.0001$, Student's t-test between growth conditions.

The Best Chart Titles are Conclusions

Because well-designed charts should stand on their own, the best titles are conclusions about their content. Although good scientists will critically evaluate the graph and make their own conclusions, make it easy for them to understand what *you* conclude and want to say about your data.

It doesn't matter whether your title is a complete sentence or a sentence fragment—all that matters is that it communicates the meaning of your results.

Vague:	Mass of rats over time
Conclusive:	Rats on a high fat diet statistically increase mass over time compared to rats fed normal chow
Vague:	Annual income versus socioeconomic background
Conclusive:	Annual income positively correlates with socioeconomic background
Vague:	Effects of microstimulation of FEF on visual perception
Conclusive:	Microstimulation of the FEF statistically increases performance on a visual perception task
Vague:	Flies lacking *Smu2*
Conclusive:	*Smu2*-null flies show no preference for sucrose versus quinine
Vague:	Three-year prognosis after treatment
Conclusive:	Increase in survival rate 3 years after treatment
Vague:	Heart rate over time
Conclusive:	Reading long lists of titles does not significantly increase heart rate over time

About Figure Legends

Figure legends provide detailed information that would be too visually cumbersome if placed within the chart itself.

Information that belongs in a figure legend includes:

- A specific title (written presentations only)
- Legends about visual symbols (e.g., arrows, arrowheads, asterisks, etc.)
- Definitions of abbreviations
- Definitions of statistical significance and the statistical tests used
- *n* values, including number of subjects, trials, sessions, etc.
- Measurements represented by scalebars

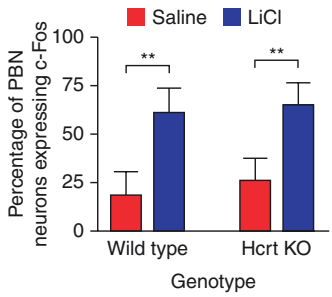
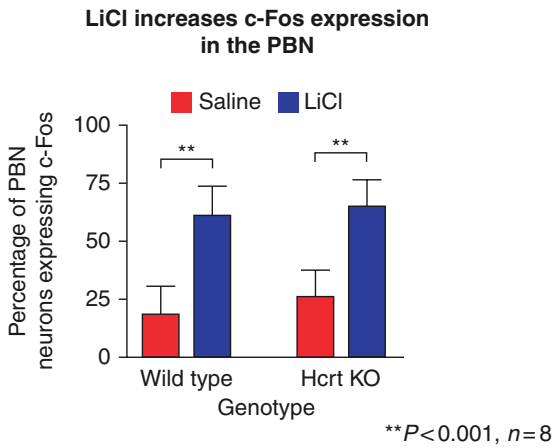


Figure 2. Intraperitoneal administration of LiCl causes a significant increase in the percentage of PBN neurons expressing c-Fos in both wild type and Hcrt KO mice ($n=8$ animals per condition). $^{**}P<0.001$, two-way ANOVA between genotype and treatment followed by Tukey post-hoc test. Hcrt, hypocretin; PBN, parabrachial nucleus.

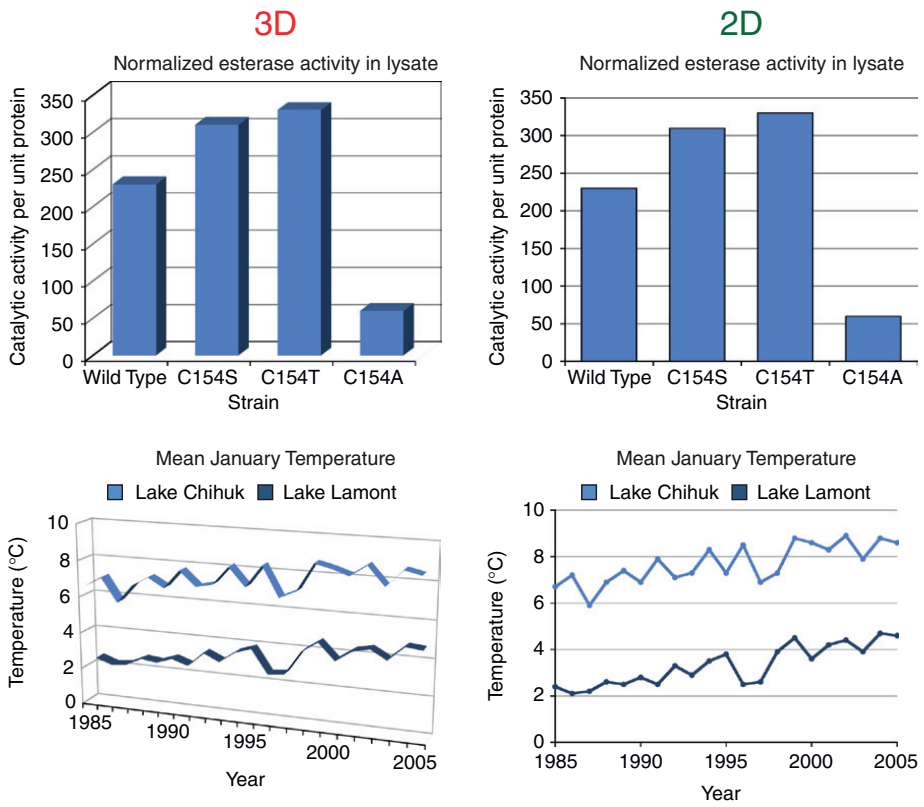
Detailed figure legends are best used in written presentations. In slides or posters, footnotes about a figure are best expressed in an abbreviated form beneath the figure.



2D Charts are Almost Always Better than 3D

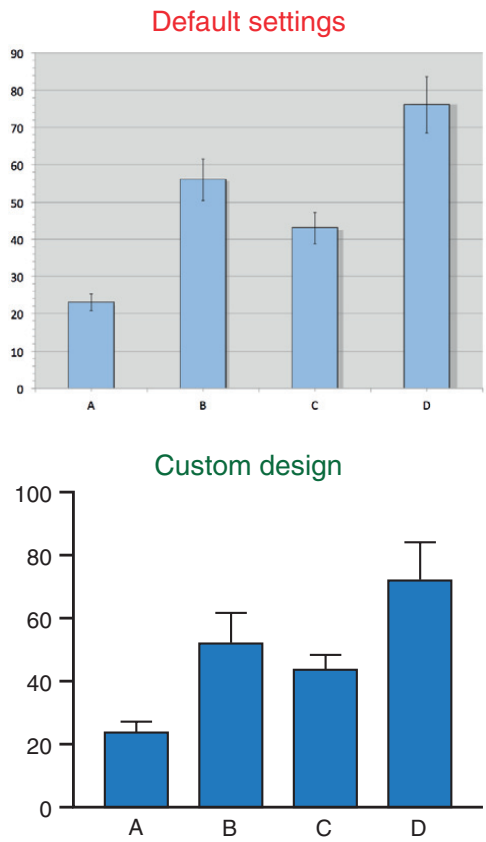
2D or not 2D…that is an easy question. A two-dimensional chart almost always does a better job representing data and communicating a message than a three-dimensional version.

Unfortunately, many presenters think that 3D charts look more professional and exciting than 2D. In reality, 3D charts contain awkward corners, shadows, and viewing angles that obscure the location of data points and cause difficulties in interpretation. Always remember that the purpose of a chart is to communicate a message, not to show that you have a mastery of graphics software. Don't introduce unnecessary complexity unless you have a good reason. 2D charts are more lucid and represent data more precisely.



General Design Considerations for Charts

Many scientists create charts by entering numbers into spreadsheet programs and then letting the software make the chart for them. Amazingly, the default settings of many of these programs are terrible. Never trust a computer to do all the work for you. Instead, deliberately choose the colors, fonts, lines, and legends you use to visually communicate data in a way that is clear, understandable, and uncluttered.



The chart on top was produced using the default settings on a standard graph-making program. The chart on the bottom was custom designed; all visual elements were deliberately chosen for optimal clarity.

Background Color. Don't choose a special color for a chart background (the area created by the x- and y-axes). Just use the same background as your presentation format. For written presentations, this will most likely be white.

Axes Color. The color of the lines that make up your axes and tick marks should allow for the highest contrast with your background. If your background color is low in value, make your axes black. Likewise, if your background color is high in value, make your axes white.

Data Colors. The colors you choose to represent your data depend on many factors (discussed in Chapter 4). Ideally, different datasets should contrast well with each other and be high in value so they are easy to see. Use a warmer color to represent data you especially want to emphasize. Whichever colors you choose to represent a specific category of data, keep those colors consistent across your entire presentation.

Gridlines. In line graphs or bar graphs, only use gridlines if you need them. They are usually unnecessary, but use them if you want your audience to perceive specific values of data that would be difficult to identify without grids. Never use gridlines in pie graphs.

Font. The fonts on graphs that are easiest to read are sans serif fonts with no overt personality (see Chapter 5). When in doubt, use Helvetica. Actually, even if you're not in doubt, use Helvetica.

Representing Significance. An asterisk is usually preferable over other symbols (e.g., %, #, &, @) that have other meanings. If you want to represent different significance values in the same graph, use repetitions of the same symbol (e.g., *, **, ***) rather than two or more different symbols.

Representing Error/Variability. Show error/variability (such as the standard deviation or standard error of the mean) in a way that does not clutter your graph. Design error lines that are easy for your audience to see, but that don't overwhelm the actual data.

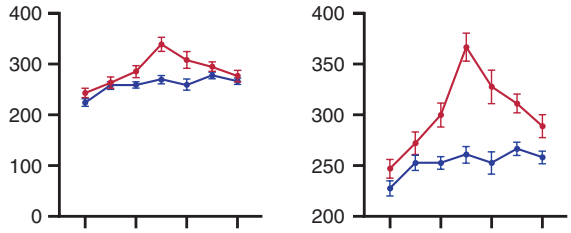
Pleasing Increments of Scale. Some values of tick marks are inherently easier for audiences to grasp than others. Use increments that people naturally use when counting, such as multiples of 2, 5, 10, 20, 25, 100. Avoid less-natural increments, such as multiples of 3, 4, 6, 12, 15, 75, etc.

Designing a Line Chart

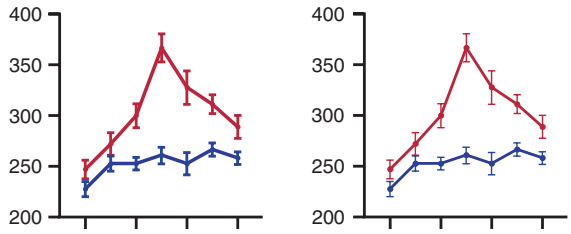
Line charts are used to display continuous data series and show trends over time. Usually the most interesting conclusions in these graphs are about how the data change over time as opposed to the discrete values of the data.

Before After

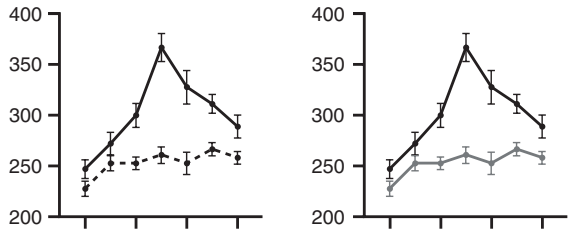
Ideally, the range in height of your data should take up about three-fourths the height of the y-axis. It is okay not to start the y-axis at zero as long as your origin is clearly labeled.



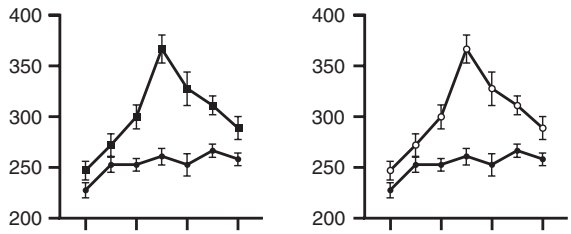
Choose line weights that are about the same as the lines of the axes. Data points along the lines should be at least twice as thick as the line itself, while error bars should be about three-fourths as thick.



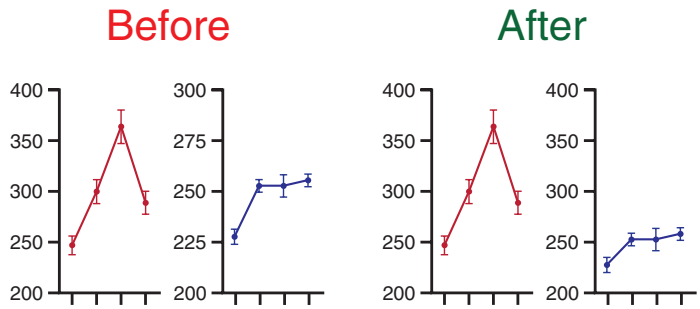
Dashed lines are hard to read. To increase the contrast between two different categories of data, use different colors or shades.



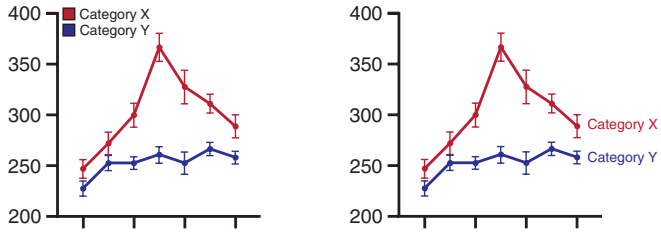
Alternatively, vary the symbols used to represent data points. It is easiest to distinguish between closed and open symbols (● versus ○) rather than different shapes (● versus ■).



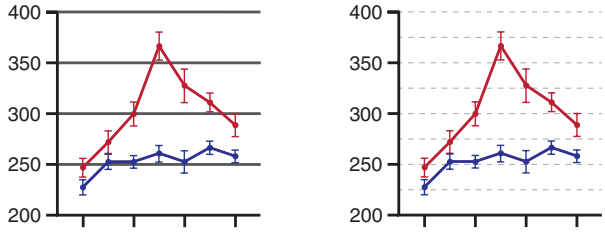
When presenting two charts next to each other that represent the same experiment, make sure your axes are similar in scale. Otherwise, you risk misrepresenting your data.



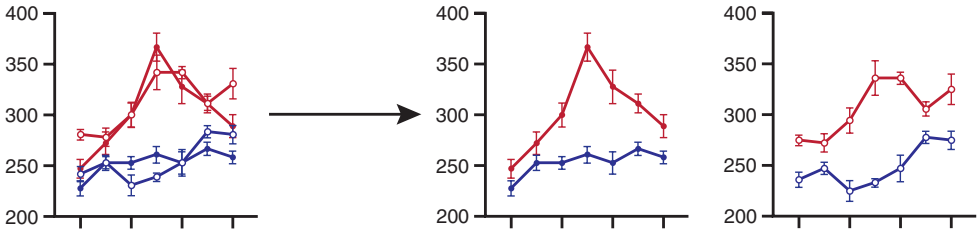
Try to place your data labels next to the lines themselves, rather than in a far off spot.



Don't overwhelm your chart with a distracting gridline. If you feel a gridline is helpful, place a subtle gray grid in the background.



Keep the maximum number of lines to about three or four. If you need more (or if your lines look crowded), separate your graphs into multiple panels.

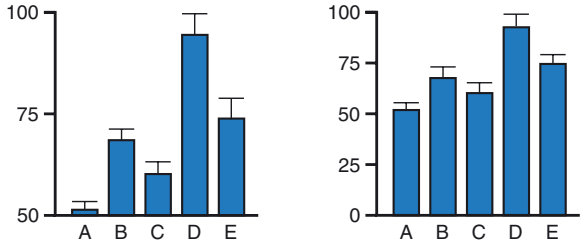


Designing a Bar Chart

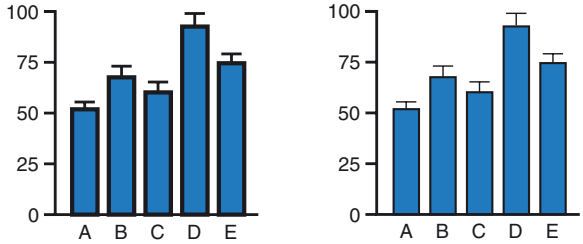
Bar charts are used to compare discrete quantities of non-continuous data.

Before After

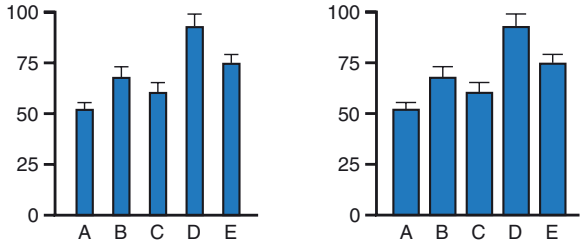
Always start the Y-axis of a bar chart at zero. No exceptions! Because the height of a bar represents a discrete value, charts that don't start at zero can be misleading.



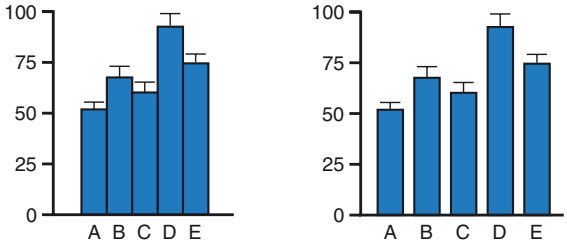
Be deliberate about the thickness of the lines outlining the bars. The most optimal line thickness is usually 75% of the thickness that make up the axes.



Be deliberate about the widths of bars, avoiding widths that are too think or thin relative to axes. The spacing between bars should be about one-third the width of the bars themselves.

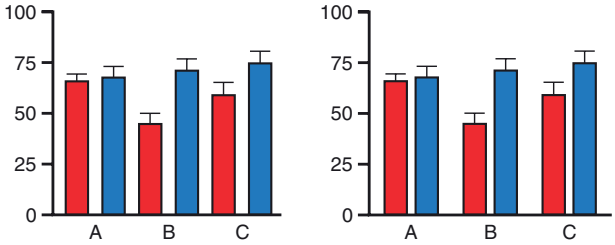


Don't place individual bars directly next to each other.

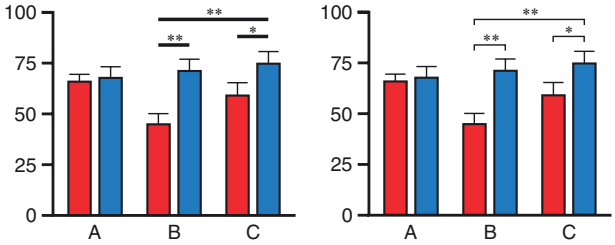


Before After

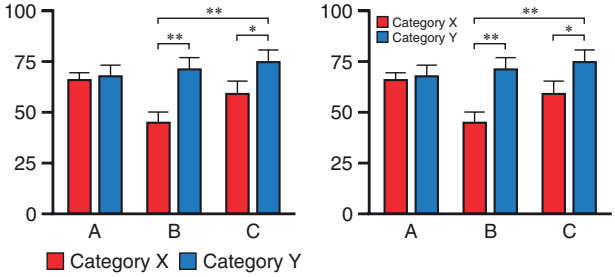
In bar charts with two or more categories of data, place a larger space between the different variables on the x-axis than between the different bars. Be sure to keep the order of the bars consistent across the x-axis.



Show statistical differences between two bars using a thin line with subtle overhangs to aid the viewer's eye.

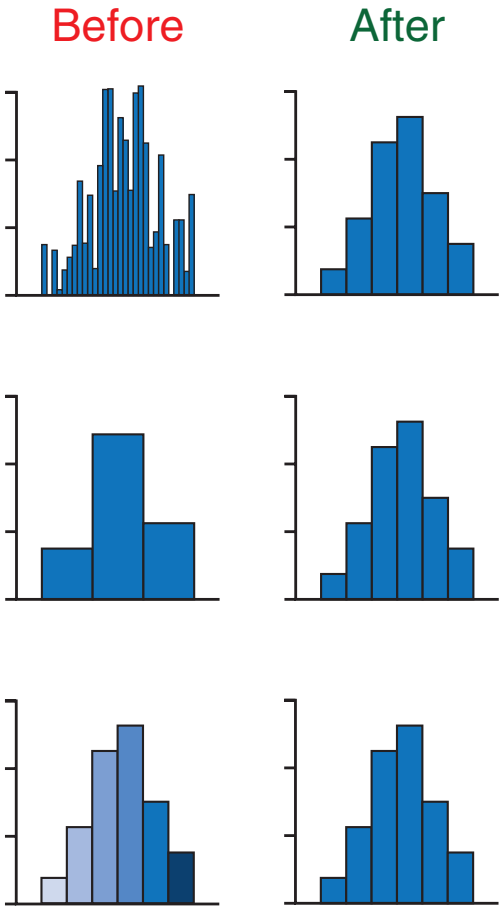


Place keys to data categories either to the right or on the top of a bar graph. If possible, the best way to save space is to place the key within the area of the bar graph itself.



Designing a Histogram

A histogram shows the distribution of data and the relative frequency with which the data occur. It essentially offers the audience an estimate of the probability distribution of a dataset.

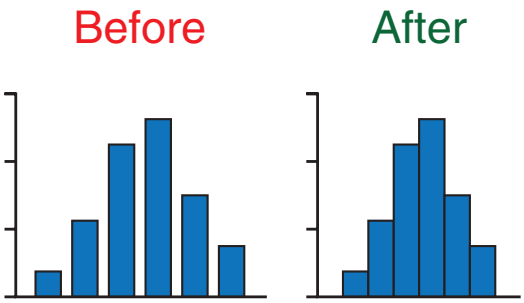


Group data into separate “bins” to increase the clarity of the overal trend and reduce the effects of outliers.

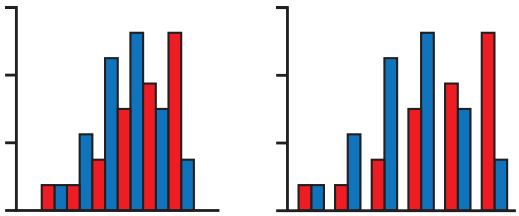
If you bin data, make sure there are at least five bins. It is harder to make conclusions about a dataset in a histogram with four or fewer bins.

Don’t assign random colors to different bins. If the histogram represents a single dataset, use the same color for all bins throughout the chart.

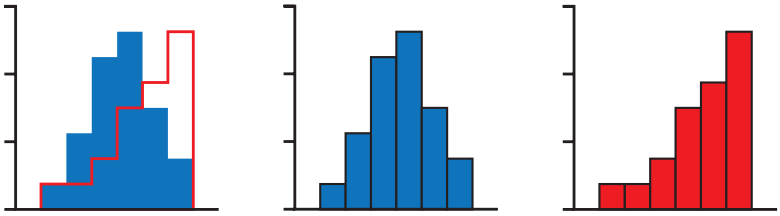
Don't use spacing between bars on a histogram as you would on a bar chart. Place the bars directly adjacent to each other.



In contrast, use spacing between bars if there are two or more datasets plotted on the same histogram.



Notice above that plotting two or more datasets on the same histogram makes it much more difficult to perceive trends in the data. If it is necessary to plot two datasets together, consider filling in the body of one dataset while outlining the other. If it is not necessary, the clearest way to show two separate datasets is to simply plot them separately.

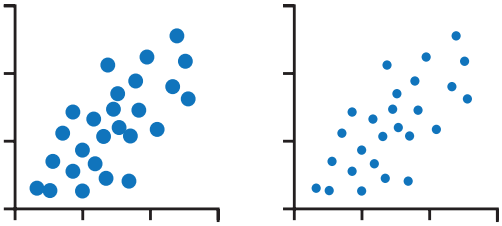


Designing a Scatterplot

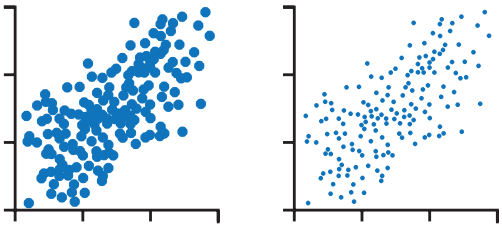
Scatterplots are used to show the relationship between two continuous variables.

Before After

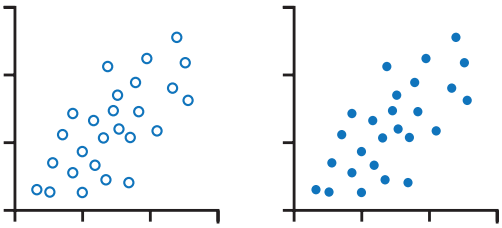
The size of the dots on a scatterplot depends on the quantity of your data. In general, a good starting point is to use dots that are two to three times larger than the line thickness of the axes.



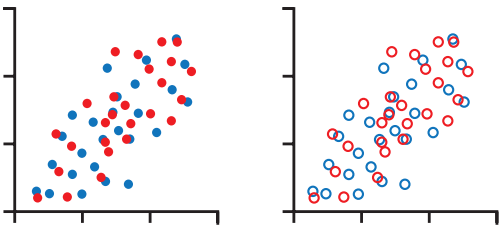
If you have a relatively large amount of data and it is hard to differentiate between separate dots, shrink the size of the dots by 1 pt until they are distinct entities.



Closed (filled) dots are easier to perceive than open dots...

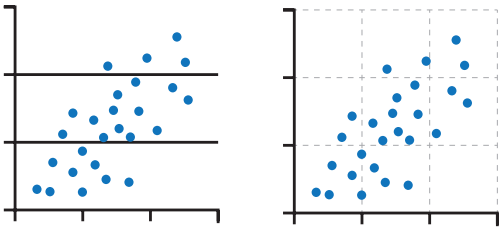


...however, when plotting two categories of data on the same scatterplot, open dots can make it easier to view both datasets at once.

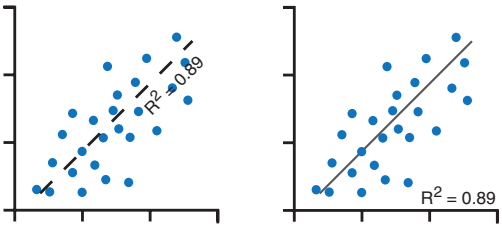


Before After

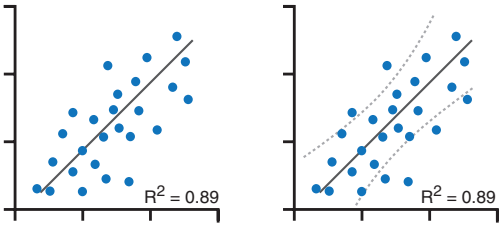
If you don't need to convey the specific value of data points, don't use gridlines. if it is necessary to help your audience determine specific values, don't overwhelm your scatterplot with distracting gridlines or only use lines on a single axis. Instead, place a subtle two-dimensional grid in the background.



Use a line of best fit to represent a statistical statement about the relationship between the variables. Make sure the line stands out from the individual dots but does not overwhelm the scatterplot. Place statistical values somewhere on the chart where they do not clutter the data.



Use subtle lines to show other statistical parameters, like 95% confidence intervals.

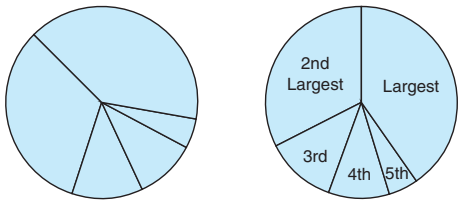


Designing a Pie Chart

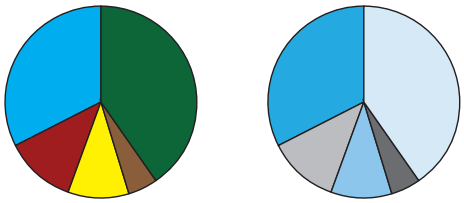
Use a pie chart to show relative proportions of a whole. Pies are not as good as bar charts for showing absolute amounts or variability between data, but they are sometimes better than bar charts for showing how constituent values add up to 100%.

Before After

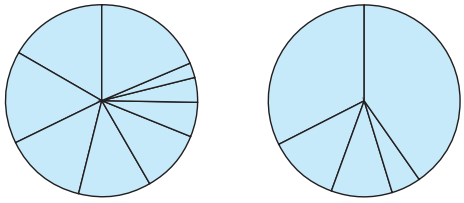
Always start the largest slice of a pie chart at the 12:00 position. Usually it is easiest to perceive the relative proportions of the slices if the largest slice runs to the right of the 12:00 position, the second largest slice runs to the left of the 12:00 position, and the rest of the slices descend in value counter-clockwise.



Don't use different shades or colors that could distract your audience from the data within the chart. If it is necessary to apply different shades or colors (for example, when keeping different categories of data consistent from figure to figure), choose color combinations as described in Ch. 4.

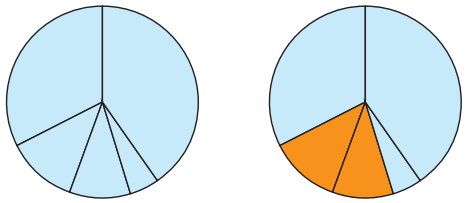


Don't use a pie chart if you would need more than five or six slices. Otherwise, the visual distinction between different slices becomes meaningless.

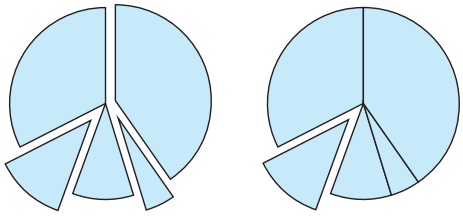


Before After

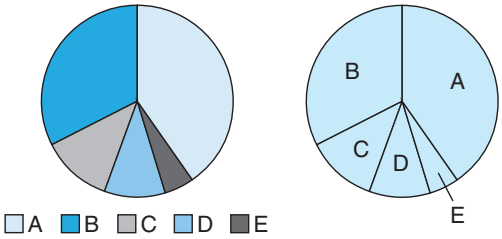
Use a different shade to highlight one or two important segments. If you want these segments to stand out, use a warmer color.



Alternatively, use an exploded pie to emphasize a single slice. Don't use this method to emphasize more than one slice at a time.

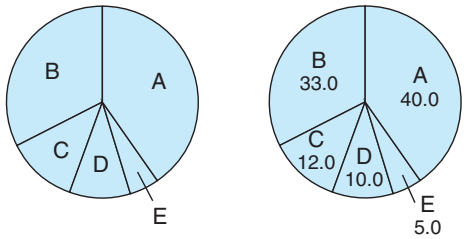


Instead of using a separate key (as you would for a bar graph), label the slices directly. If your label won't fit on the pie, place it immediately adjacent to the slice.



If you want to label each slice with the exact value or percentage of the whole, do so directly on the slice and not in a separate legend.

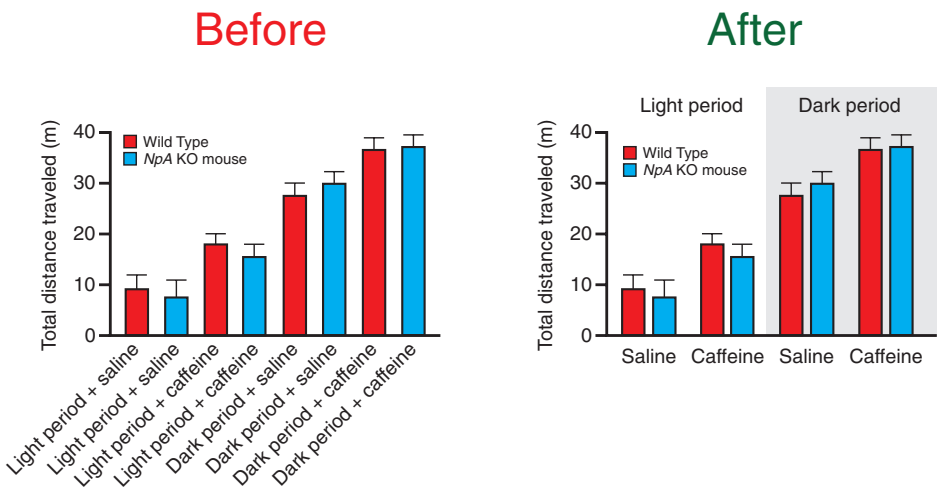
A: 40.0
B: 33.0
C: 12.0
D: 10.0
E: 5.0



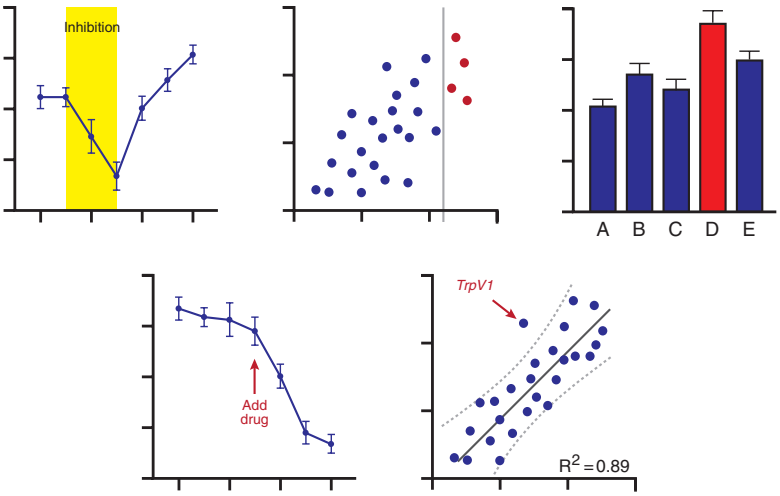
Help Your Audience Visualize What is Most Important

Charts are not only about axes and numbers; they are also about meaningful relationships between different data. Be deliberate about helping your audience understand what you find meaningful.

Design your charts so that the audience can immediately see relationships between different categories of data.



Highlight data points that are particularly meaningful to you.

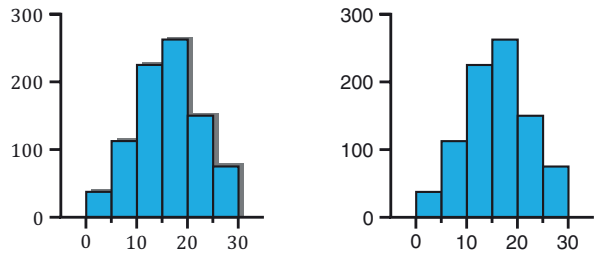


Reduce Clutter Wherever Possible

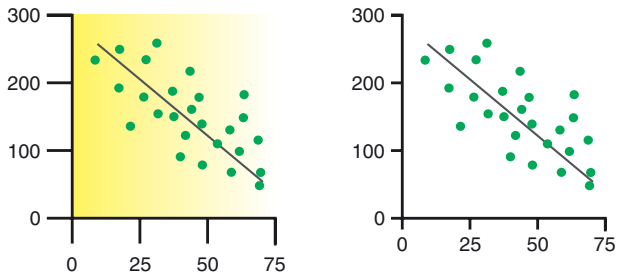
Another way to help your audience visualize what is most important is to subtract everything that is not important. Try to remove as many non-essential items as possible to improve the clarity of your message.

Before After

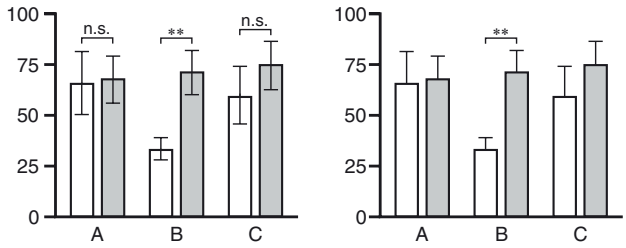
The chart on the right is more clear because the serif font has been changed to sans serif and the shadow behind the bars has been removed.



In the chart on the left, the gradient isn't necessary. Additionally, the length of the tick marks is too long relative to the size of the chart.



Error bars on bar charts only need to be placed above the bar. If you want to emphasize that there is no significant difference between two sets of data, "n.s" can be useful. However, in most cases, a lack of significance probably isn't necessary to emphasize.



Summary: Don’ts and Dos

Don’t use a chart to show isolated data devoid of interesting comparisons or relationships that are best expressed in words or tables.
Do use a chart to show patterns or trends in data, and differences or interactions among data.

Don’t design charts that depend on written or oral narration to be understood.
Do design charts that can stand on their own.

Don’t compose vague chart titles.
Do compose titles that state conclusions about your data.

Don’t trust graphing or spreadsheet software to make charts for you.
Do design your charts, deliberately choosing visual elements to best communicate your message.

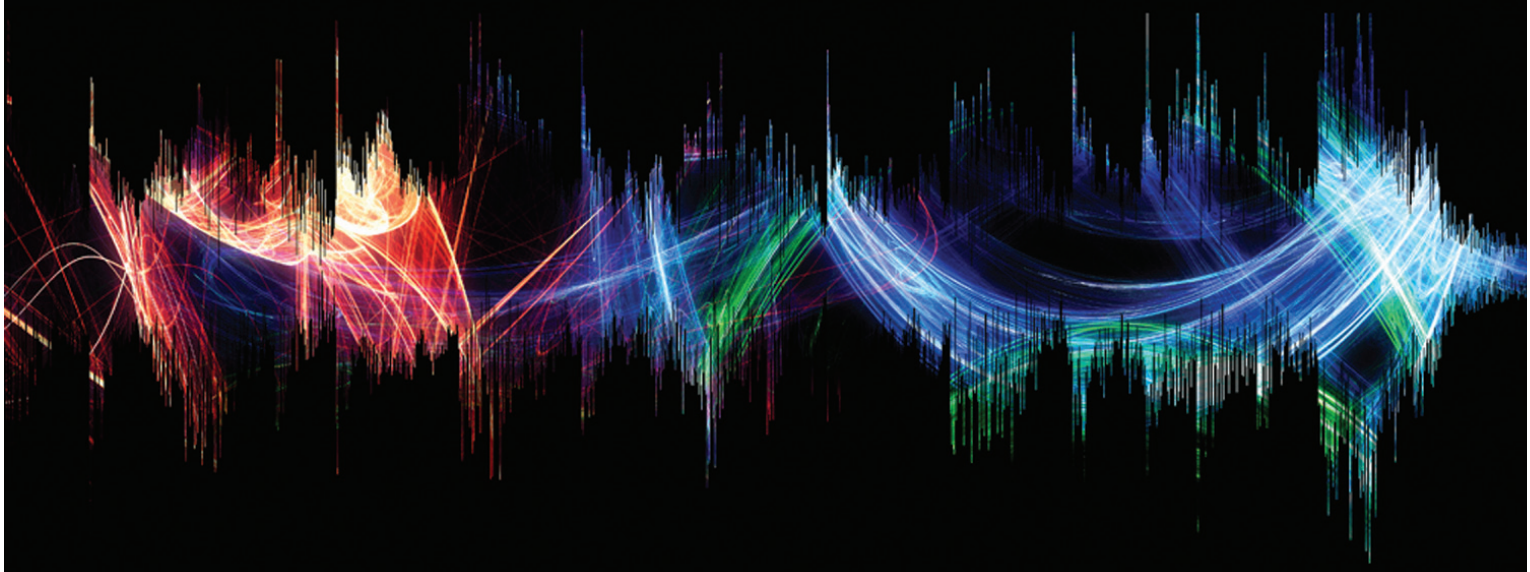
Don’t vary how you represent categories of data in multiple figures throughout a presentation.
Do be consistent about the colors and shapes you use to represent categories of data.

Don’t introduce unnecessary complexity in your charts or represent your data three-dimensionally.
Do avoid clutter and represent your data as clearly as possible.

9

Diagrams

Good diagrams are powerful visual tools. They can quickly show how something works, how individual components make up a whole, how multiple items interact, and how events are ordered in time and space. Historically, scientific diagrams were predominantly created by professionals at scientific journals because scientists themselves didn't have the tools to create illustrations quickly. Now any scientist can create illustrations in a variety of computer applications, and many journals even require authors to submit "summary diagrams" along with their manuscripts. The key to designing a good diagram is to always be conscious of its purpose, helping your audience to understand your main message while removing confusing distractions and meaningless information.



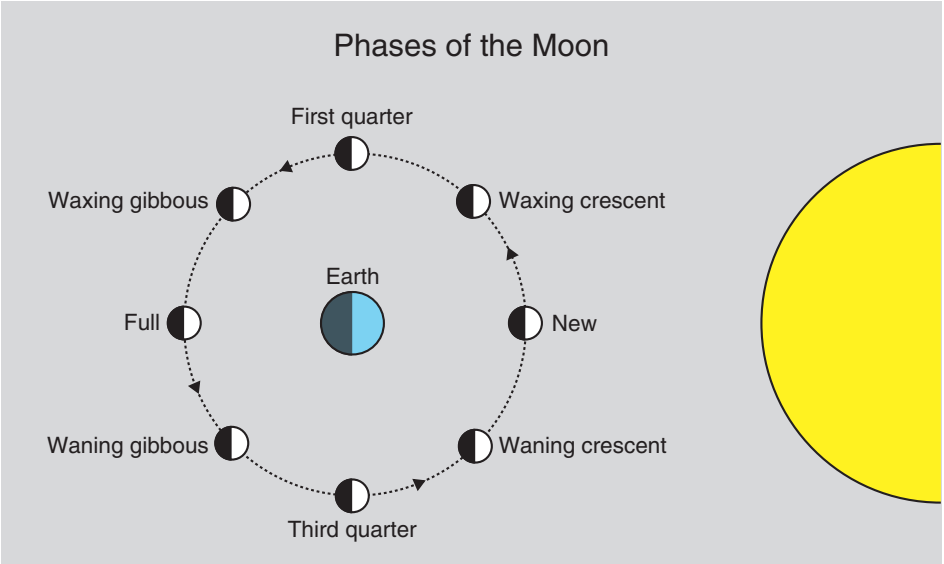
Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00009-X

When to Use a Diagram

Good diagrams present large quantities of information in visual form, capturing an audience's attention and conveying information more quickly and clearly than words alone.

Diagrams are ideal visual tools in many instances throughout a science presentation:

- when conveying background information to an audience
- when showing experimental strategies and techniques
- when sorting results into relevant categories
- when proposing a model
- when summarizing a study within the context of the larger scientific literature

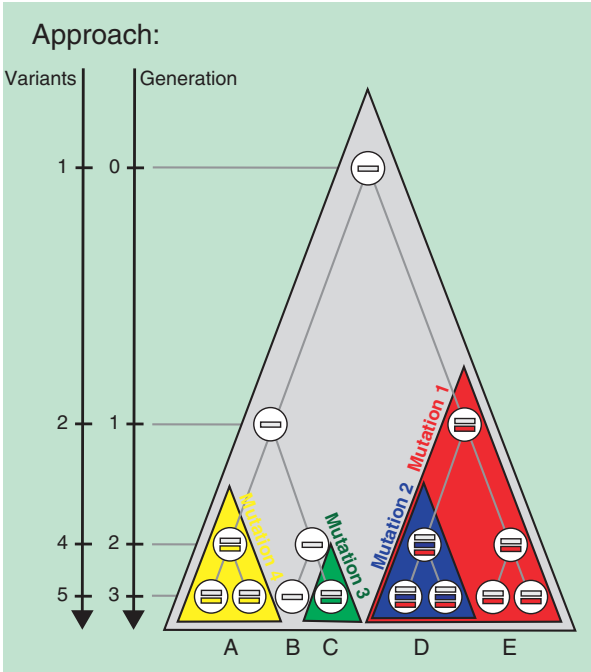


A good scientific diagram is irreplaceable. Imagine trying to convey the information in this figure using words alone. Although possible, an illustration greatly helps the audience visualize information and see how individual components of a process fit together into a whole.

Clearly Define the Purpose of a Diagram

Unfortunately, many scientific diagrams fail to communicate meaningful information to their audiences. Sometimes the author includes too much information, makes the illustration too complex, or becomes distracted with unimportant details. Sometimes an author fails to include any useful information at all.

The key to creating a good diagram is to start by clearly defining what you want your audience to understand. During the design process, add enough information to make your chart meaningful while subtracting anything unnecessary.



Can you say what the author of this diagram wanted you to understand? Always keep in mind that the purpose of a diagram is to enhance communication of a specific message. After producing a draft of your diagram, try asking others if they can understand your message without any additional info. If they are confused, then something about your design needs to change.

General Design Considerations for Diagrams

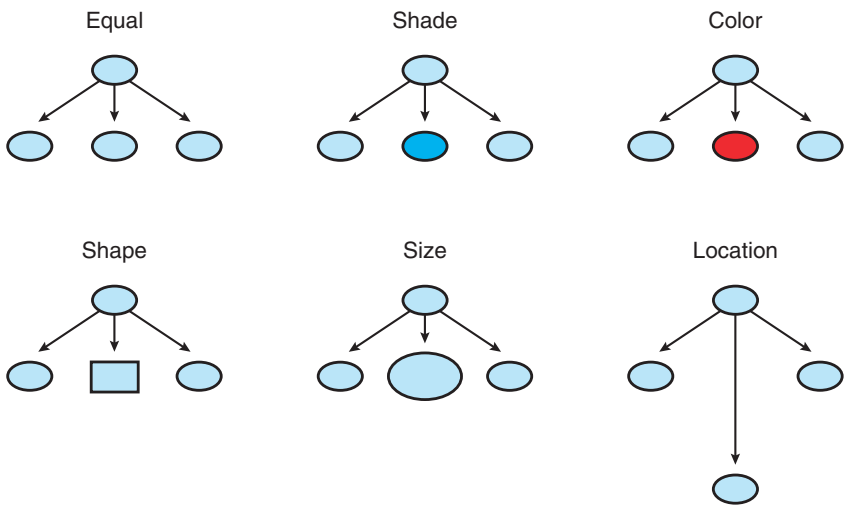
The most important design principles for diagrams are the same as for any other aspect of a presentation: strive for simplicity, clarity in your message, and good communication.

After clearly defining the information you want to convey in a diagram, the following questions may help you to begin the design process:

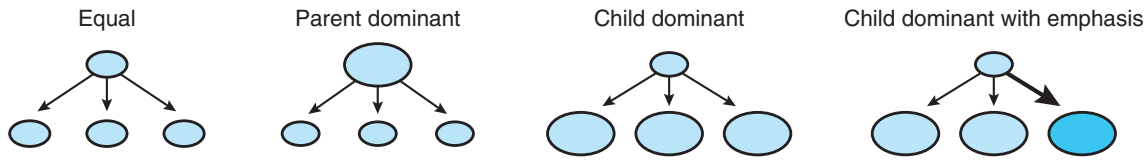
Questions to ask when designing a diagram:

- What is absolutely necessary to show?
- What is not necessary to show?
- What is most important and should be emphasized?
- What is not important and should be secondary to the main message?
- What are the relationships between individual elements?
- Does the diagram require a precise depiction of time?
- Does the diagram require a precise depiction of distance?
- What symbols should be consistent throughout the diagram?

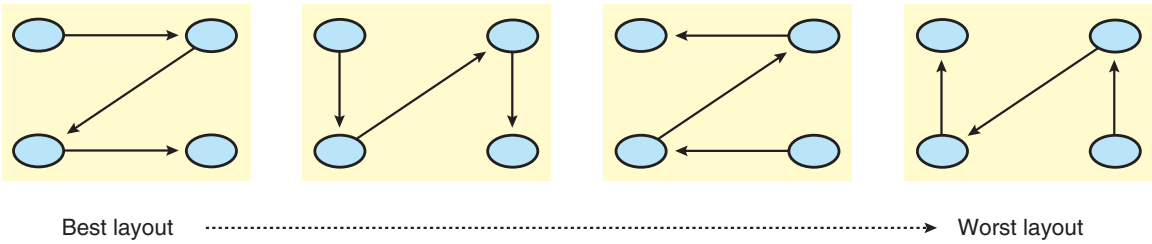
Decide which elements in your diagram are most important. Visually emphasize these elements using a different shade, color, shape, size, or location.

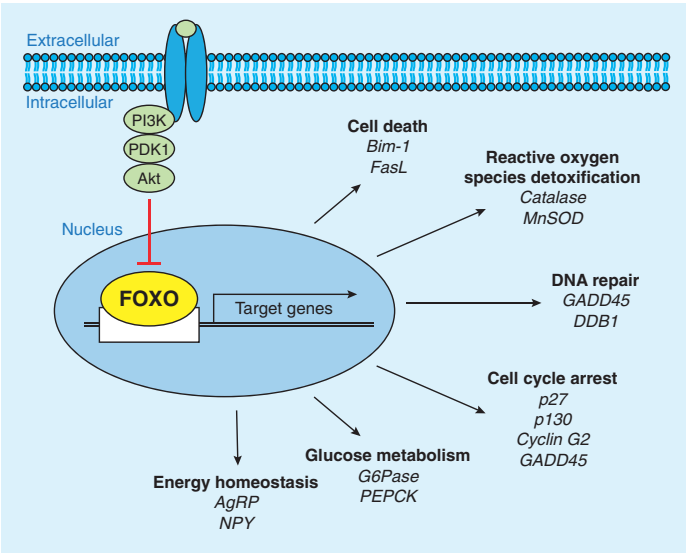


Consider the importance of the relationships between visual elements. Choose whether upstream or downstream elements are most important and emphasize specific connections by the weights or colors of lines.



Consider the order of information in your diagram. In Western cultures, we learn to read left to right, top to bottom. Try to arrange visual elements using a similar layout so information flows in a way that seems natural to your audience.





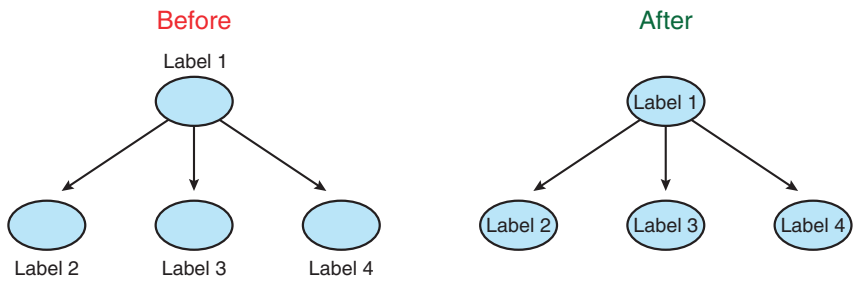
In this diagram, the visual element labeled "FOXO" is emphasized most, both in size and color. The audience has a clear sense of the flow of information (top to bottom, left to right) and that FOXO causes the activation of many distinct processes, all of which are emphasized equally.

Considerations for Labeling Diagrams

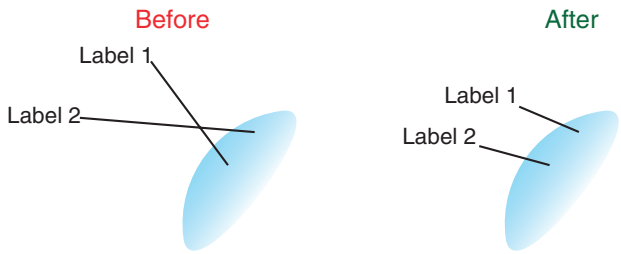
In most diagrams, visual elements must be labeled so that your audience knows the meaning of abstract drawings and symbols. Ideally, the labels themselves should add little visual impact to a diagram, defining other visual elements in the least distracting way possible.

Use a neutral font for labels. Just as in charts or tables, Helvetica is always a good choice.

When possible, try to place your labels directly on or near the items they define.

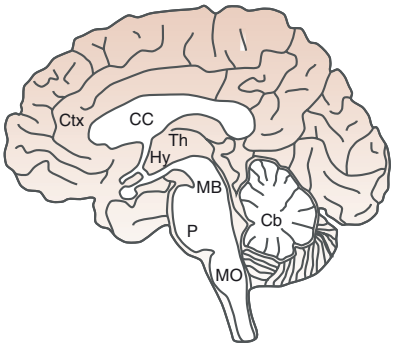


When using indicator lines to label parts of a diagram, keep the lines as short as possible. If possible, don't cross lines.



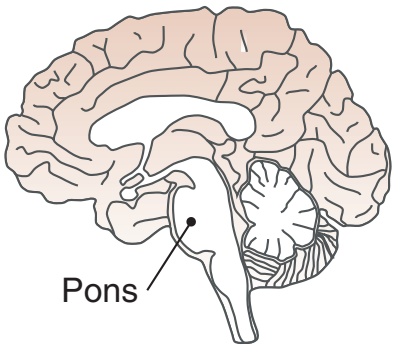
When using multiple labels, justify your labels flush left or flush right, where appropriate, to make your diagram more symmetrical and aesthetically pleasing.

When you receive diagrams from other sources (a colleague, the Internet, etc.), it is often advantageous to remove much of the labeling to fit your own needs. For example, this illustration of a human brain was originally designed for a neuroanatomy course. If you were to use this illustration for a talk about a specific structure, you might consider removing the extraneous labels that only distract from your message.



Before

The labels on this diagram initially served a useful purpose. However, for a talk about a specific brain structure, the multiple labels are distracting and cause the audience to stop focusing on what you care about. Use techniques in photo editing applications to remove these labels.

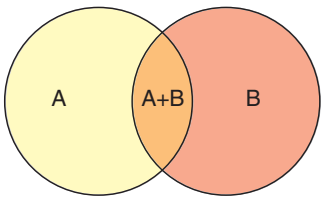


After

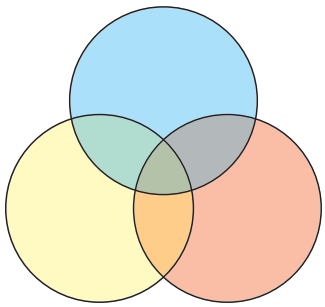
By only labeling the structure you care about, you remove distractions and the audience focuses on your message.

Designing Venn Diagrams

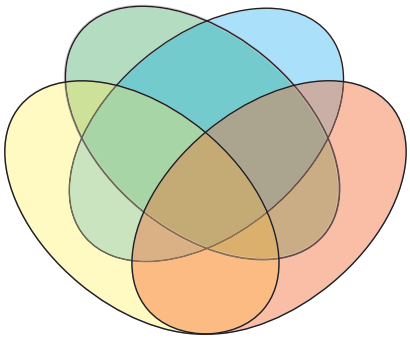
Venn diagrams visualize the composition of two to five datasets and the degree to which they overlap in their composition. Each set is represented by a circle or ellipse, and the overlap (called the "intersection") shows what the sets share in common. Most Venn diagrams show two or three sets, but it is actually possible to show four or five.



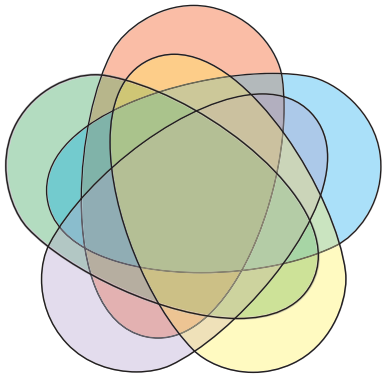
Two-set



Three-set



Four-set

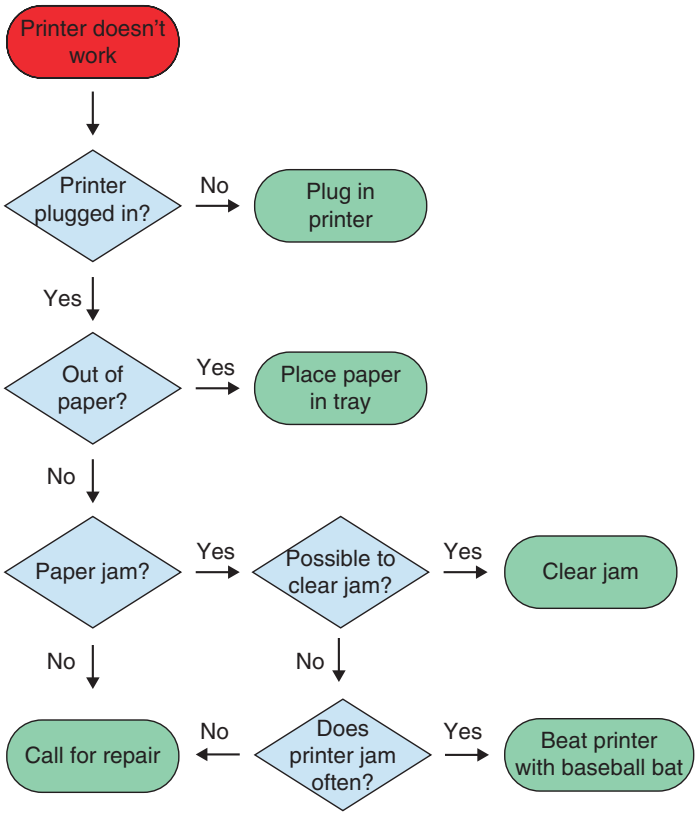


Five-set

Designing Flowcharts

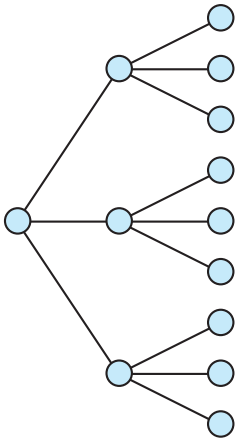
A flowchart is a visual representation of a decision-making process. The first item in a flowchart often starts with a problem or question. Various steps along the chart require a decision, which eventually leads to a solution or end result. These diagrams are excellent for showing audiences your experimental methodology, such as what you will do following one of multiple experimental outcomes.

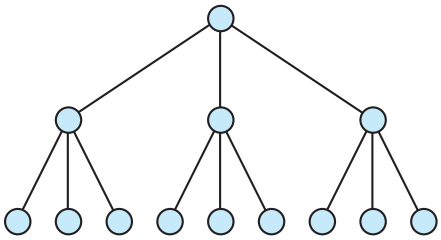
When designing a flowchart, use a different shape and/or color to represent different types of nodes in the decision-making process. For example, in the diagram below, the problem is represented in red, the decision-making nodes are represented as blue diamonds, and the various solutions are represented in green. Consistency among different types of information aids your audience in following your thought process.



Designing Tree Diagrams

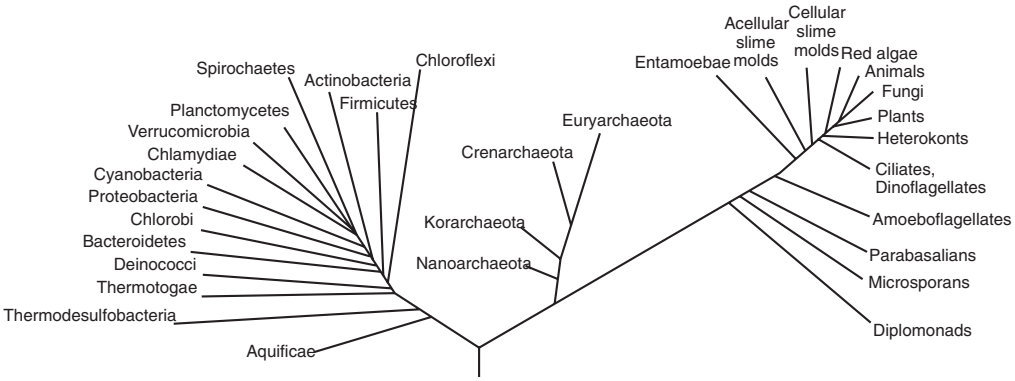
Tree diagrams are used to show relationships between items.





Tree charts can show the beginning of a chain of events or a hierarchical structure. When describing a cause-and-effect relationship, draw your diagram left to right (as in the diagram on the left). When describing a hierarchical relationship, use a top-down structure (above).

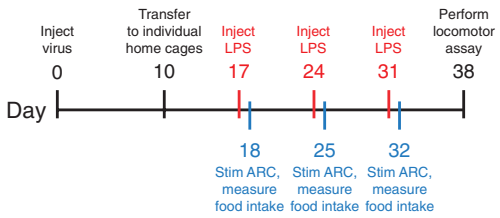
Some tree diagrams represent the relationship between different items, with the length of the lines that separate these items proportional to the strength of their relationship. For example, this phylogenetic tree diagram represents the evolutionary relationships of different organisms. The longer the distance between two elements, the more they are evolutionarily divergent.



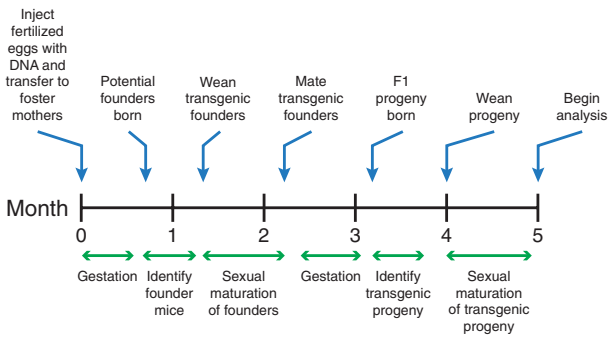
Designing Timelines

Timelines show the temporal relationship between discrete events. They are especially great tools for conveying historical background information or visualizing the order of events in an experiment.

The most common mistake people make when designing timelines is to let words or symbols become too crowded. Use the space above and below a timeline to separate information, employing different colors to group information into categories. And, of course, clearly label the scale of your timeline (days, months, etc.).



This timeline conveys the experimental design for a food intake study. Only the necessary information is provided; supporting details are explained elsewhere. Information is presented above and below the timeline to prevent overcrowding of text. Color is also used to distinguish categories of information.



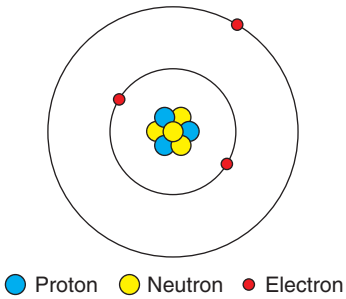
This timeline shows the steps in the process of producing a transgenic mouse. The blue arrows above the timeline denote the approximate times an investigator must perform a step in the process. The green lines on the bottom show the various breeding stages of the mice.

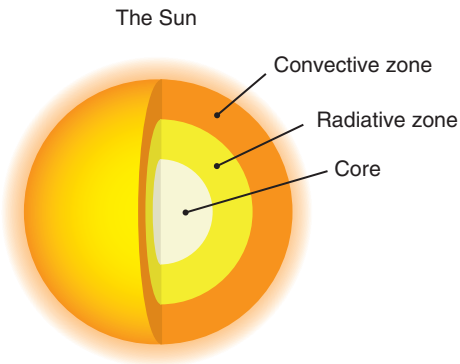
Designing Pictorial Diagrams

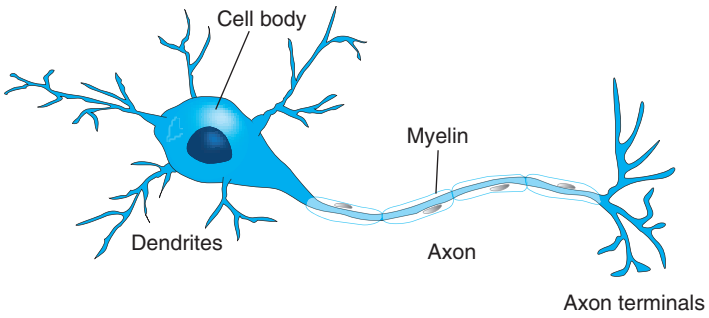
Pictorial diagrams visualize the component parts of real objects. Most scientists feel anxious about their drawing skills and unqualified to design these kinds of diagrams. Try not to feel intimidated… The most important feature of a good pictorial diagram is not the quality of the drawing but the clarity of the information. In fact, the most common mistake in representing objects is to include too much detail in the drawing. These diagrams are not intended to be works of fine art.

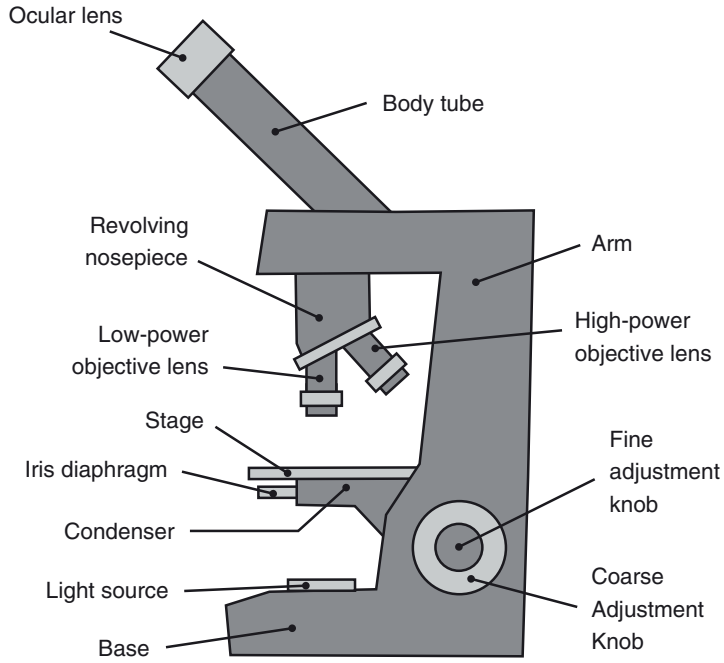
General tips:

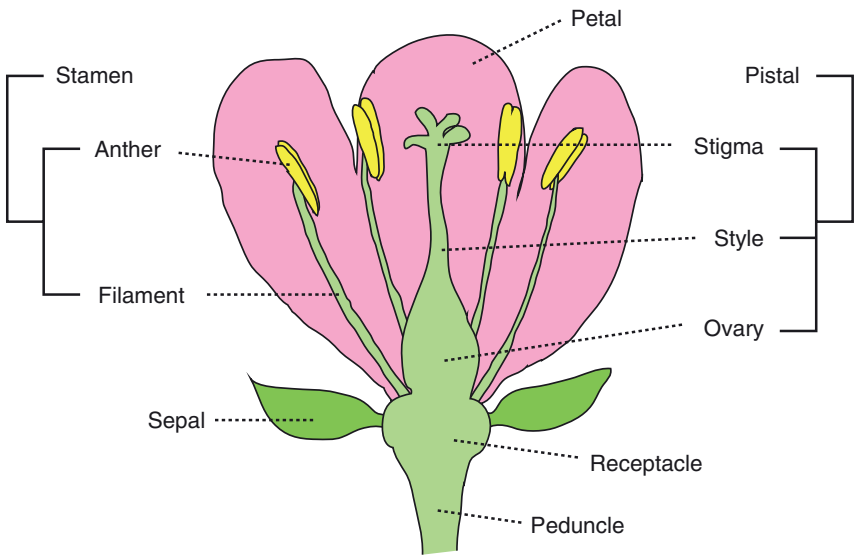
- Only draw visual aspects that are necessary for the audience to identify structures.
- Use the fewest number of colors possible. Note how the example diagrams on these pages each use two or three colors. Using more colors than necessary only complicates the diagram.
- Try not to overwhelm a picture with labels, only identifying structures that are necessary to show your audience.





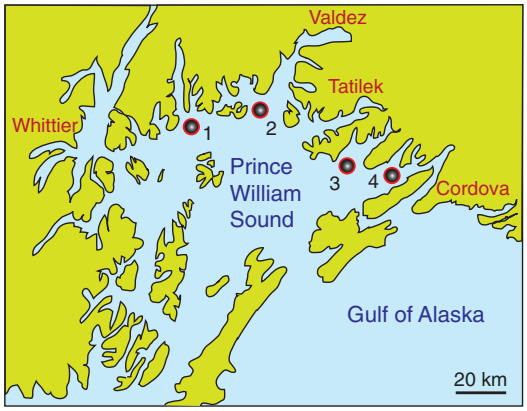



Ocular lens
Body tube
Revolving nosepiece
Arm
Low-power objective lens
High-power objective lens
Stage
Iris diaphragm
Fine adjustment knob
Condenser
Light source
Coarse Adjustment Knob
Base

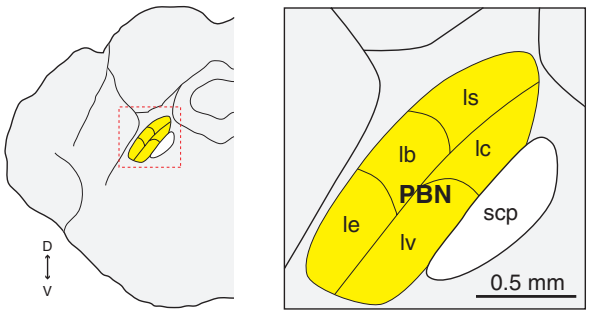

Petal
Stamen
Pistal
Anther
Stigma
Style
Filament
Ovary
Sepal
Receptacle
Peduncle

Designing Maps

A map shows the spatial arrangement of important features across an area. When designing a map, try to provide your audience with a sense of scale so they are better able to perceive physical distances. It is also beneficial to show at least one landmark for orientation. Sometimes it is helpful to add a "zoomed out" view so your audience can visualize the region in your map at a global scale.



This map of Prince William Sound shows the location of sampling sites for a fisheries study. There are few geographical landmarks presented, only enough to provide orientation.

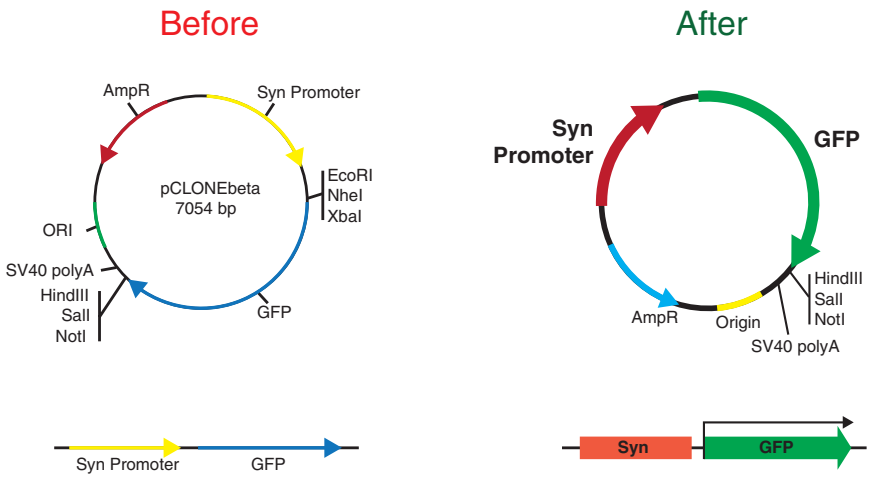


Maps can be of much more than just geological landforms. This map of the mouse brain highlights the location of the parabrachial nucleus. The diagram on the left provides orientation using an illustration of a brain section at low magnification. Color is used to highlight the salient structures and the structure labeled "scp" is used as a landmark for scientists in the field.

Designing Sequence Maps

Sequence maps are a special category of maps that display important information about biological (DNA, RNA, amino acids) or computational code.

These maps are useful both as a research tool and as a presentation tool. As a research tool, include as much information as you want to further your own goals; however, as a presentation tool, remember to only include as much information as will help your audience.



Just like graphing software, the default settings on most sequence mapping programs usually generate poor diagrams for presentation purposes. You might have to enlarge the fonts and arrows of the structures you want to emphasize, minimizing or completely removing information that isn't important. If any part of a sequence codes for a color such as green fluorescent protein (GFP), make sure the sequence is actually represented by that color.

```
         260                    280                    300
Human: ACAGTCGTGTCCAGTTTTGCACCACCTTTGCACTACACGACTCACT
Chimp: ACAGTCGTGTCCACTTATGCACCACCTTTGCACTACACGACTCACT
  Rat: ACAGTCGTGTCCACTTTTGCACCACCTTTGCACTACACGACTCACT
Mouse: ACAGTCGTGTCCACTTATGCACCTCCTTTGCACTACACGACTCACT
```

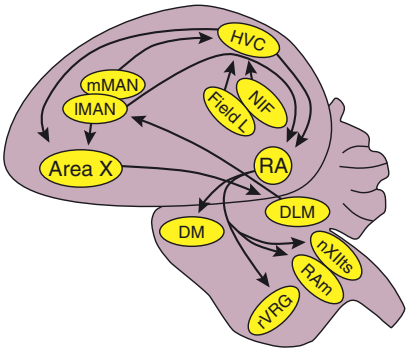
Write out sequence information in a non-proportional font (such as Courier) so that the sequences align. Highlight meaningful information within the code so it is easy for the audience to perceive.

Designing Network Diagrams

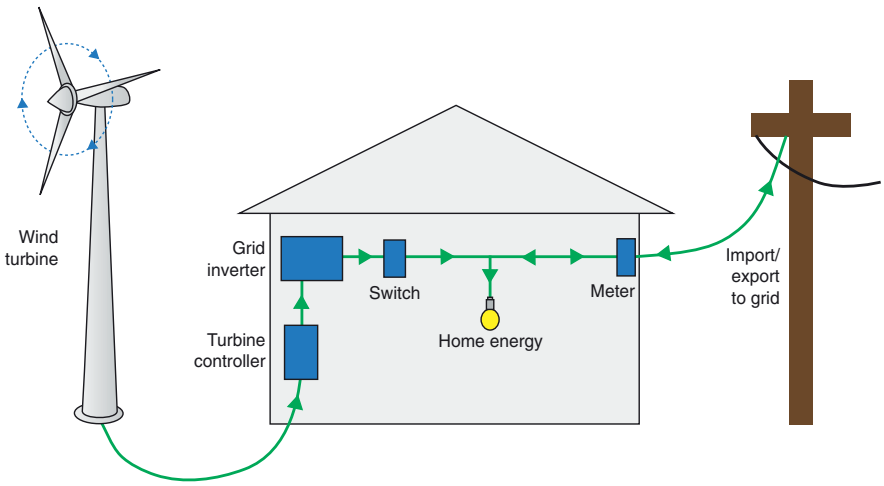
Network diagrams (also called systems or circuit diagrams) show the connections between elements in a system or process.

Perhaps the most difficult aspect of designing a network diagram is showing clear, simple connections between multiple elements. When there are several structures in your diagram, it can be hard to clearly separate the lines and arrows. You may need to spend some time trying different strategies of placing lines and labels throughout your diagram to determine the simplest method of representing connections.

At right is a network diagram showing some of the relevant circuit connections involved in birdsong superimposed on an avian brain. Crossing lines was avoided as much as possible, but necessary in a couple of locations.



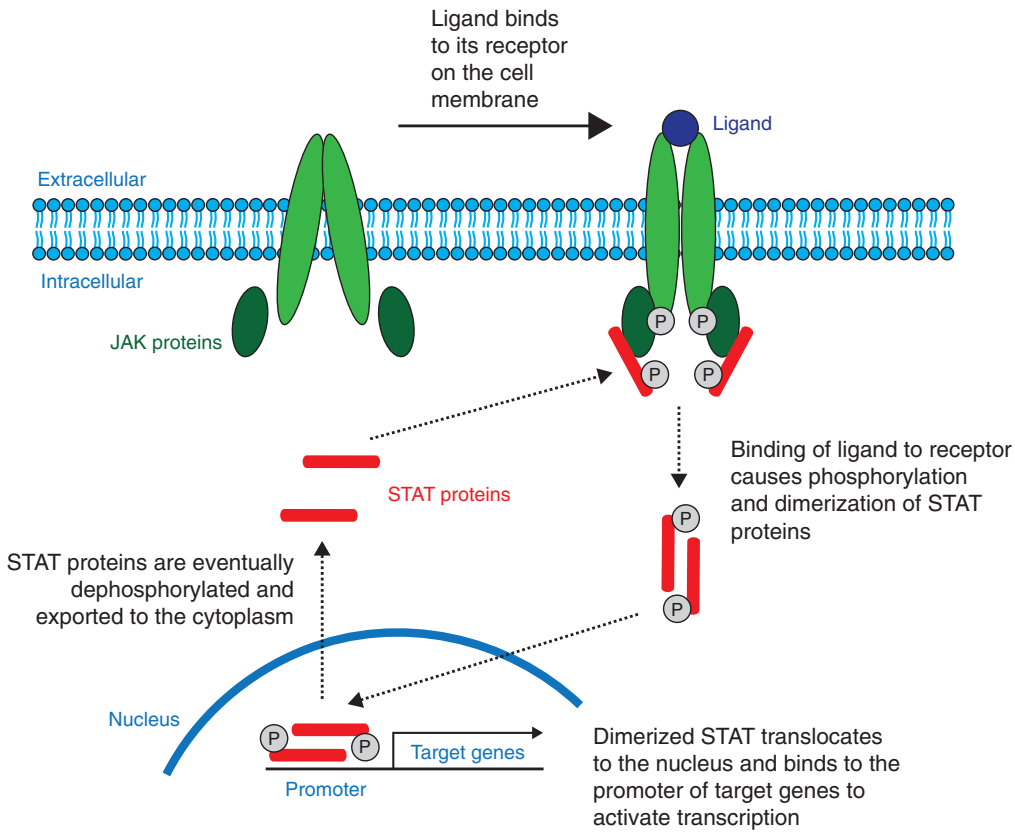
At bottom is a simple circuit diagram showing energy pathways into a home connected to a wind turbine and power line.



Designing Pathway Diagrams

Pathway diagrams show how distinct elements interact with each other during a process. Unlike network diagrams, pathway diagrams can tell a story with a beginning and end. Action is usually conveyed using arrows.

To make reading a pathway diagram more natural for the audience, order the events in the pathway left to right and top to bottom. Pathways can become extremely complicated very quickly, so be sure to omit elements that don't have an essential role in your story.

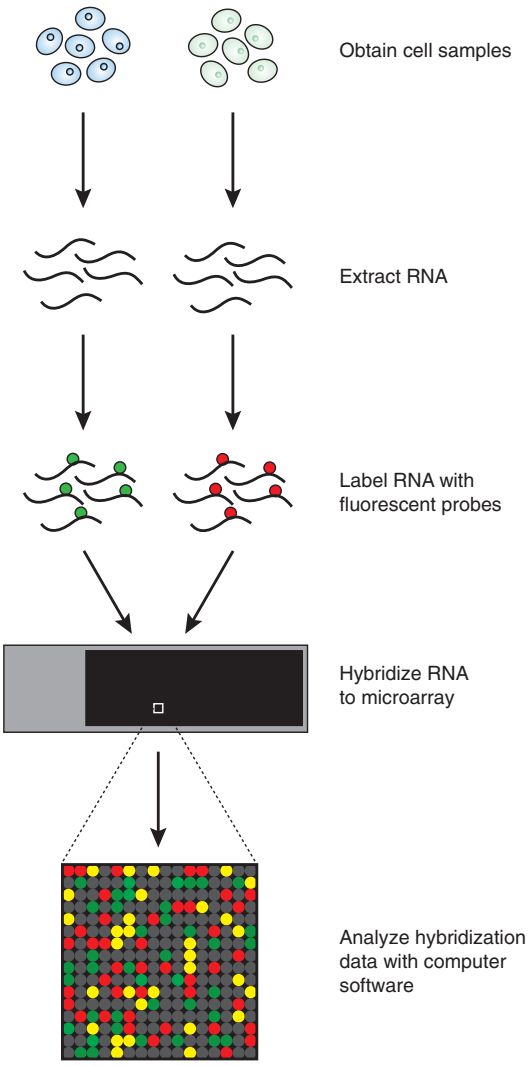


This pathway diagram tells a story of a series of biochemical events in a single illustration. The story starts reading left to right and then top to bottom (before circling back to the top). Foreground elements are in warmer, brighter colors. Explanatory text is in a slightly larger font size than the other labels. While there are many more components to this pathway, only the essential elements are included for clarity. If this figure is intended for a slide presentation, further explanatory power could come from simple animation techniques.

Designing Procedural Diagrams

A procedural diagram explains a process as a series of discrete steps. These diagrams are useful for helping an audience to understand each stage of an experimental protocol or procedure.

A good way to design a procedural diagram is to start by clearly defining each step in the process. Omit steps that aren't important. Try expressing each step as words before you add any accompanying illustrations so that it is easier for you to only illustrate what is important to show your audience.



This procedural diagram describes the process of performing a comparative hybridization experiment using a microarray. The individual steps could be numbered, but numbering is not necessary here because the flow of information is obvious. Many additional steps were deliberately excluded from the diagram (for example, the details involved in extracting RNA) because they distracted from the main focus on microarrays. The colors of the cells were muted because they are not as important as the fluorescent labeling and hybridization data.

Summary: Don’ts and Dos

Don’t ignore diagrams as a potential way to share information with audiences.
Do use diagrams to introduce and summarize concepts, as well as to visualize experimental design and methodology.

Don’t present a diagram nobody understands.
Do test the communication power of your diagrams by soliciting feedback from others.

Don’t forget the communication goals of your diagram throughout the design process.
Do remember the goal of your diagram, discarding elements that don’t help convey your specific message.

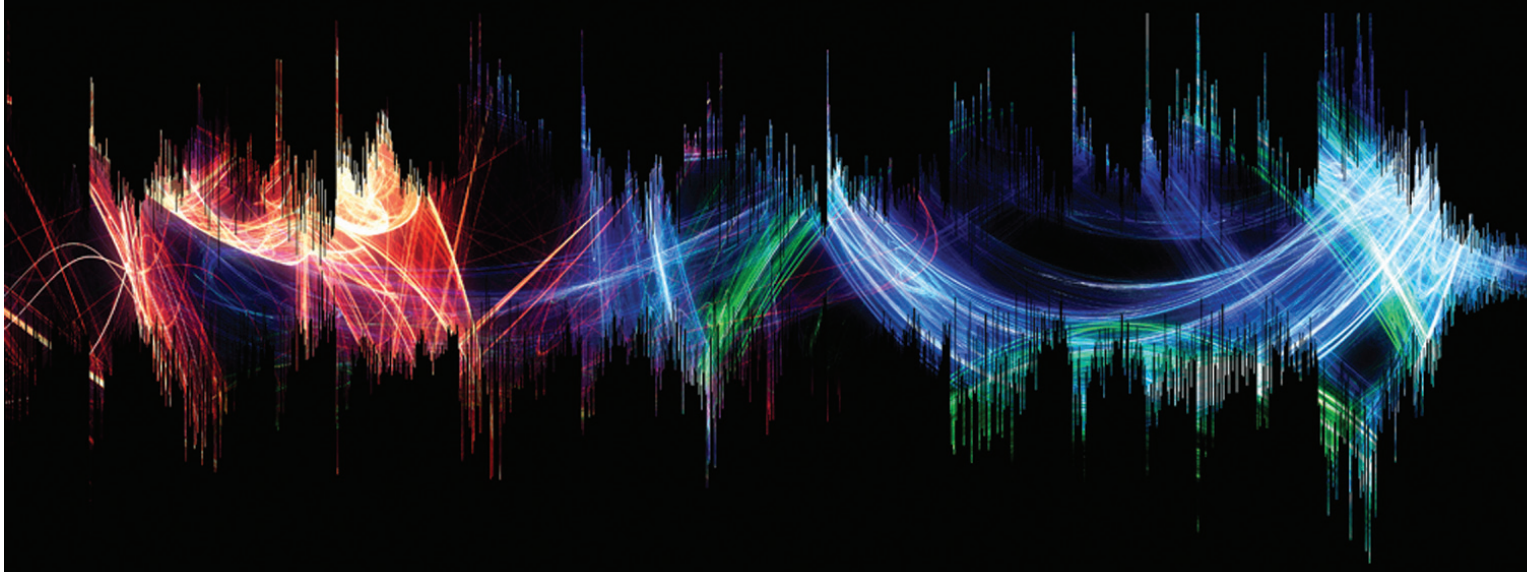
Don’t overwhelm a diagram with non-essential information that doesn’t relate to your diagram’s purpose.
Do only include elements that help transmit a message to your audience.

Don’t ignore the relationships between distinct visual elements.
Do consider which elements are of primary importance, which are of secondary importance, and how elements relate over time and space.

10

Photographs

Photographs instantly communicate data, ideas, moods, and/or emotions to an audience. They can seize people's attention, helping them to understand and remember your content much better than words, bullet points, or charts alone. Therefore, it is worth the investment in time to learn how to design clear, professional images to use in your presentations.



Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00010-6

Why Show a Photo?

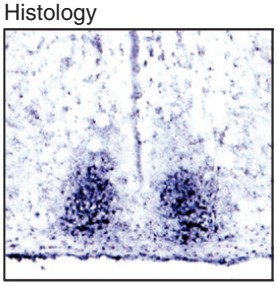
There are two reasons to use photographic images in science presentations: to present data and to communicate ideas.

Images representing qualitative data are abundant in the scientific literature:

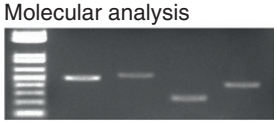
- Research subjects, including biological, geological, and cosmological specimens and samples
- Histological samples from biological tissue
- Gels and blots from molecular experiments

Research subject

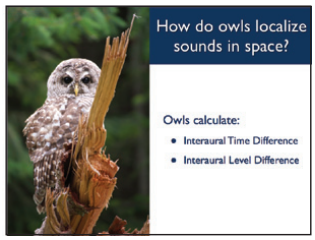
Histology



Molecular analysis



Alternatively, photos are excellent visual tools (especially in slide presentations) to communicate ideas and emotions to audiences and enhance the context of your scientific story.

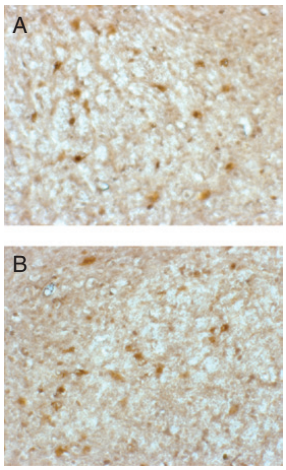


Assume That Representative Photographic Data Will Be Harshly Judged

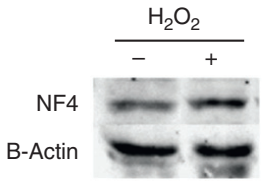
Some of the data that scientists show in presentations are "representative"—a single example of a histological figure, Western blot, DNA gel, specimen, etc., that indicates what all other data in the study look like. For obvious reasons, most scientists select what they consider their best photographs to show to others. A good, critical scientist reviewing representative data will assume that the other data not shown are of *an equal or lesser* quality than the images shown. If the image is suboptimal or difficult to interpret, critical scientists will question the validity of the results of the entire experiment.

Assume that the images you present will be harshly judged based on what you claim. Don't show photographic data unless the results are obvious, clear, and indisputable.

A good way to test the strength of an image is to show it to people unfamiliar with your work, asking what conclusions they would make from the image alone.



The author of these photomicrographs stained for one protein in brown and another in black and counted the number of cells that express both. He claims that there are approximately three times as many double-labeled cells in Figure A than Figure B. Do you believe him?



The author of this protein immunoblot claims that H_2O_2 causes a three-fold increase in signal for NF4. Do you agree?

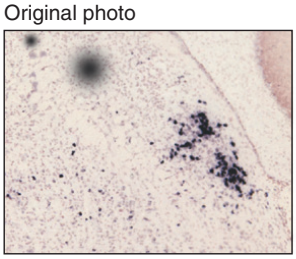
Adjust Data Images *Ethically*

There is a very fine line between enhancing an image for optimal quality and manipulating data. While you may have honorable intentions in adjusting an image to make it more clear and professional, be very careful to follow certain guidelines so that you do not risk misrepresenting your results.

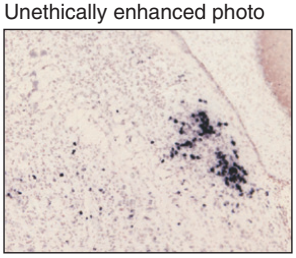
General guidelines:

- No specific feature within an image should be enhanced, obscured, moved, removed, or introduced. For example, never erase any part of an image, even if you consider it a smudge or artifact.
- Any modification you do to one image, you must do to any corresponding images. For example, if you modify a picture of an experimental histological specimen (for example, increase brightness or contrast), you must modify the picture of a control histological specimen in exactly the same way.
- Scientists assume that a single microscopic image represents a single microscopic field. Never combine images from separate fields into a single micrograph unless you make it very clear that you are doing so.
- In a primary research paper or poster, describe any image enhancements you make to your audience, either in the methods section or figure legends.
- In general, if you feel you are doing something that is crossing an ethical line, don't do it.

Original photo



Unethically enhanced photo



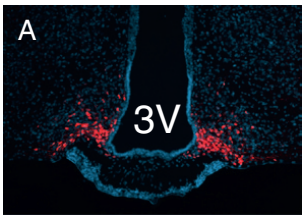
The photomicrograph on the left had some unfortunate artifacts in the upper left corner that the author decided to remove. Although digitally eliminating the artifacts probably did not change the conclusion of the experiment, such an action is unethical. Photographs are *data.*

Recommended reading: For a more extensive guide on the proper handling of digital photographic data, see an excellent article by Mike Rossner and Kenneth Yamada, "What's in a Picture? The Temptation of Image Manipulation," in *The NIH Catalyst* (May/June 2004) and republished in *The Journal of Cell Biology* (2004, Vol. 166(1): 11–15). Although intended for biologists, the principles outlined in this guide are applicable to all scientists.

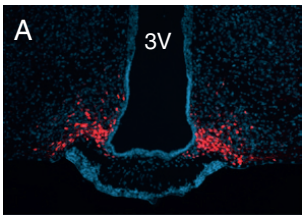
Labeling Photographic Images

When labeling an image representing data, remember that any label must be secondary to the image itself. Let the data in your image be the main focus, with symbols, arrows, and scale bars playing a subtle, supporting role.

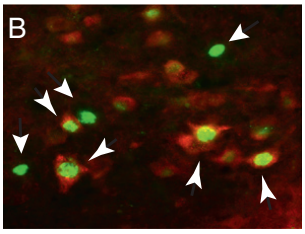
Before

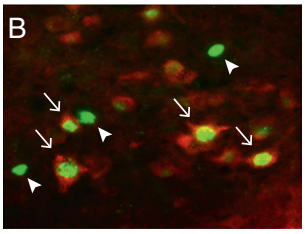


After

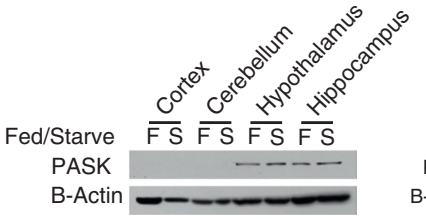


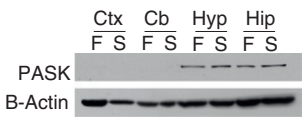
In the photomicrograph on the left, the figure label and identification of the third ventricle (3V) overwhelm the image. The figure is improved by reducing the font size and relocating the 3V label to a less conspicuous location.





In the photomicrograph on the left, the arrows overwhelm the image. The figure is improved by using two distinct types of arrows and decreasing the line width. Additionally, to help distinguish between categories of data, the two different types of arrows are aligned in opposite directions.





Some labels on the left figure can either be relocated to the figure legend or abbreviated. Font sizes and line widths can also be decreased.

Be Picky about Finding Images

Most scientists find non-data images for their presentations using Internet search engines. Google Images, iStockphoto, Shutterstock, and other image sites are a terrific resource, but make sure that the pictures you choose are the most optimal for your needs.

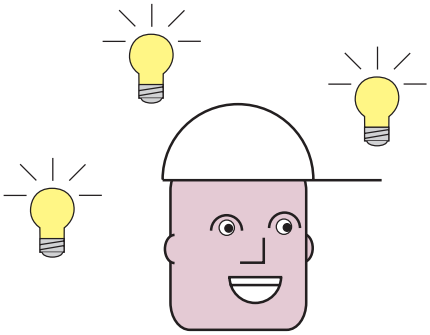
Be picky about the images you choose. Don't settle on the first images you find (or produce yourself), and edit photos as seriously as you would edit text.

Don't use images that have too low a resolution for your presentation format.

Don't use images that have obvious and distracting watermarks.

Don't use images with suboptimal settings (i.e. too light, too dark, too blurry, etc.).

Whatever you do, don't resort to using silly clip art.

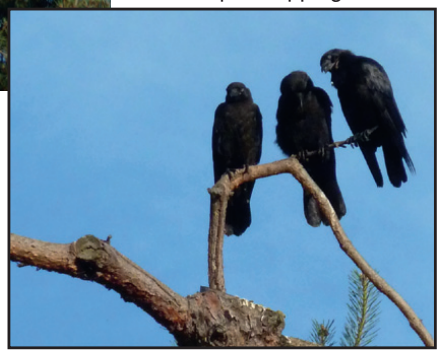


Crop Photos to Emphasize What Is Important

The images you take or find online can often be improved with simple cropping. This technique allows you to frame your images to better suit your needs, focusing on what is most meaningful to you and your narrative.

Original photograph

After simple cropping

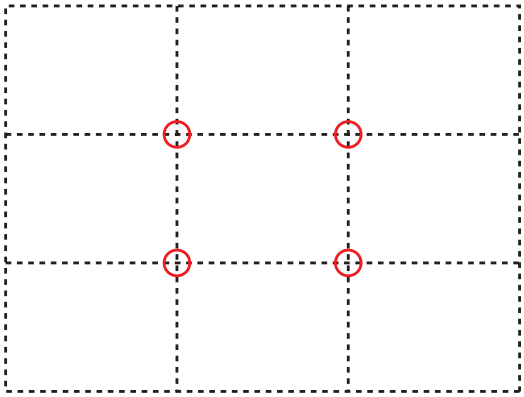


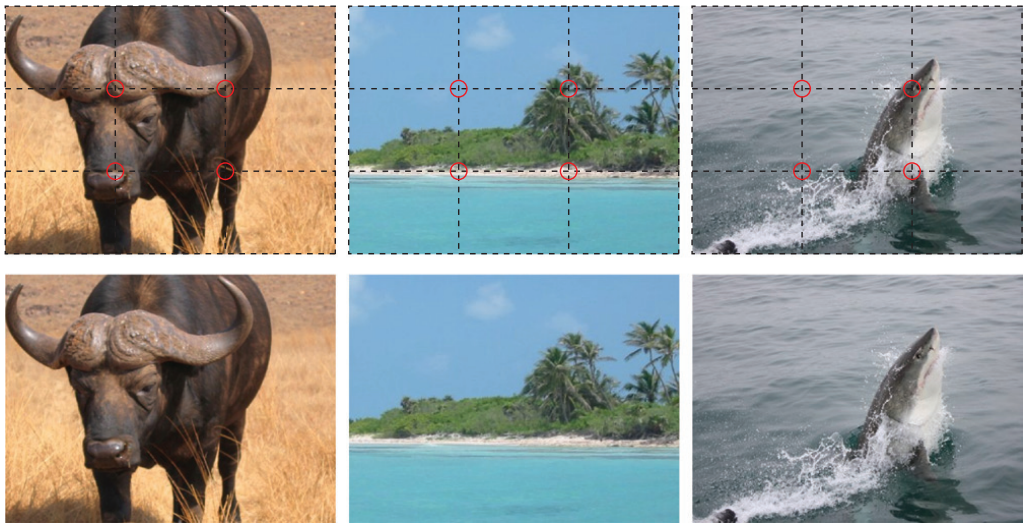
Use the Rule of Thirds to Improve Your Images

When taking photographs or cropping images, consider a fundamental technique used by professional film-makers, photographers, and graphic designers: the "Rule of Thirds." This simple principle can improve the composition of your shots and make them appear much more professional.

To use the Rule of Thirds, imagine a 3×3 grid overlaying your field of view and place important elements either along the lines or at the intersections. Arranging meaningful elements in this way will make your image seem more energetic and interesting compared with simply placing your subject of interest in the center of the frame.

The Rule of Thirds grid

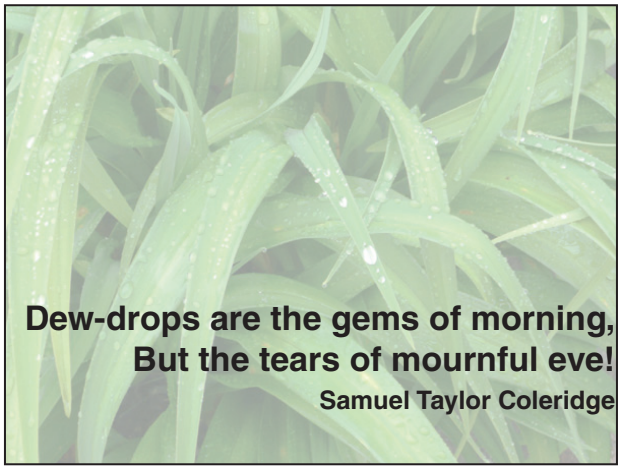




Adjust Image Settings to Your Needs

Many software applications allow you to adjust parameters of your images, including the brightness, contrast, hue, saturation, and sharpness. While these abilities were once limited to photography applications like Photoshop and Aperture, current versions of word processing (Word, Pages) or presentation (PowerPoint, Keynote) applications also allow you to adjust these settings.

There are many reasons you might want to adjust an image—to emphasize certain features, to change the mood or tone, or to better complement your images with text or other visual elements.



Darkening or lightening a photograph to better complement text. Either slide would look nice in a slide show. Which version you choose might depend on other factors, for example, the relative brightness of the backgrounds of your other slides.

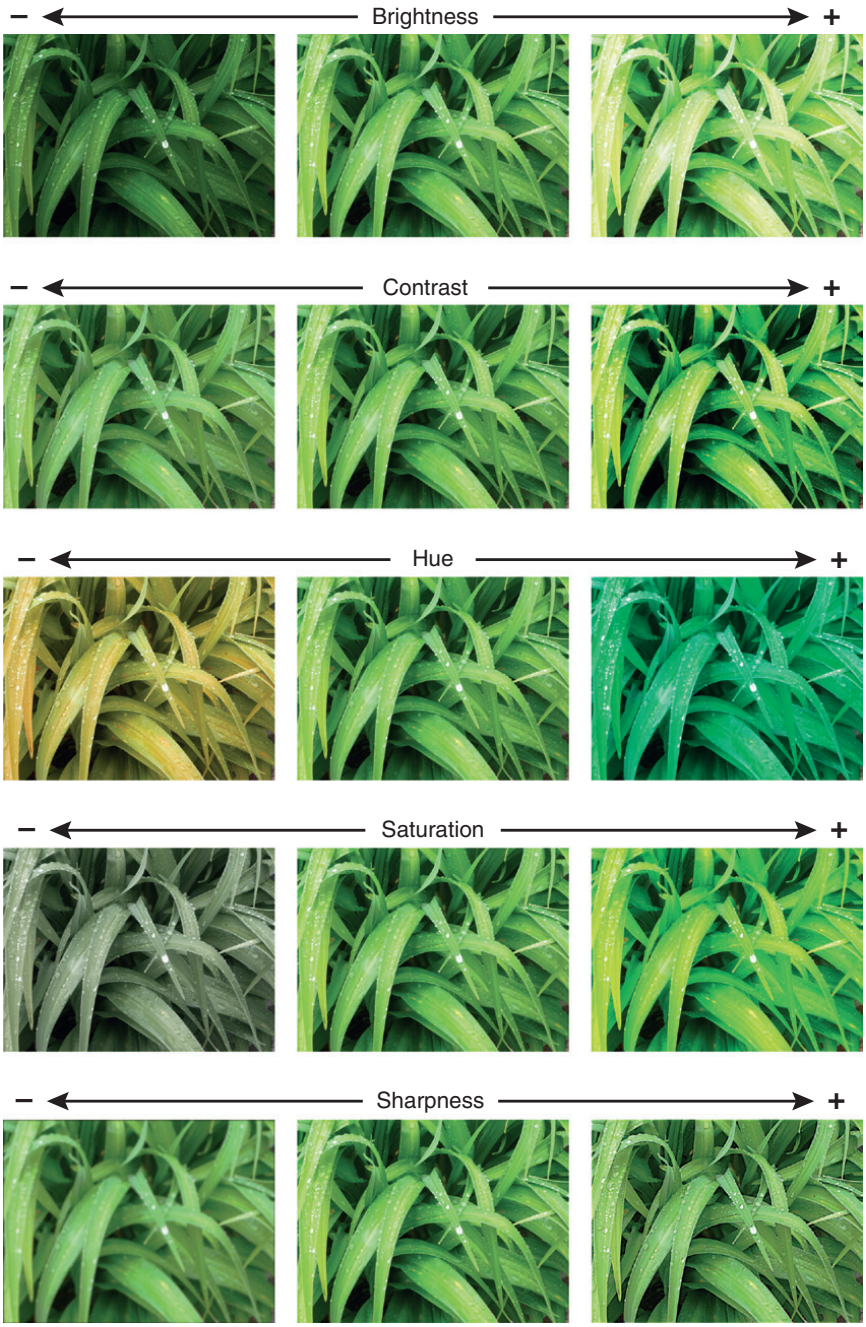

– Brightness +
– Contrast +
– Hue +
– Saturation +
– Sharpness +

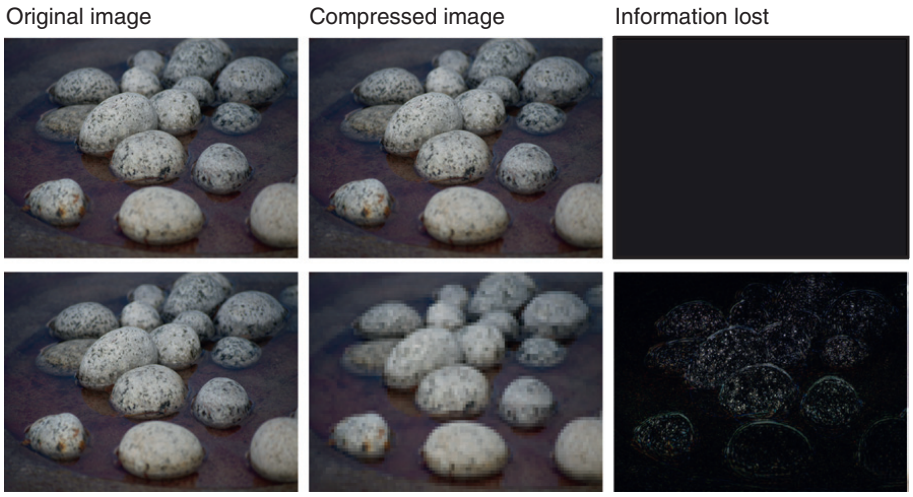
Image File Formats

Digital images are stored and recognized by software applications in various file formats, including JPEGs, TIFFs, GIFs, and PNGs. All of these formats code for pixels, with each pixel containing values for color and brightness. The file size of an image (measured in bytes) increases with the number of pixels composing an image, as well as the number of possible colors a pixel can represent. An 8-bit pixel (1 byte) stores 256 colors, while a 24-bit pixel (3 bytes) stores 16 million colors.

The goal of various image file formats is to code for images using the smallest file size possible. To accomplish this goal, the images are "compressed" using algorithms. It is not necessary to know much about these complicated algorithms or how they work, but you should be aware that there are two major categories of compression:

Lossless compression: reduces file size without reducing image quality.

Lossy compression: reduces file size by discarding information that is likely to be invisible to the human eye. Most of these algorithms have a variable quality threshold—as compression increases, the quality of an image decreases.



Examples of lossy image compression. The top row shows an ideal compression: the information that is lost is invisible to the human eye. As the level of compression increases, as in the bottom row, the discarded information becomes noticeable.

There are literally hundreds of different image file formats, but you will probably experience the following four formats most often:

JPEG **Joint Photographic Experts Group format.** JPEGs store information 8 bits per color (red, green, and blue) for a 24-bit total. This format uses lossy compression, which usually isn't noticeable unless the compression level is relatively high. JPEGs usually have a relatively smaller file size than PNGs and especially TIFFs, so they are a great format for sending and receiving (which is why they are often the default format for most digital cameras). A drawback to JPEGs is that they are highly susceptible to generational degradation when repeatedly edited and saved.

TIFF **Tagged Image File Format**. TIFFs save 8 bits or 16 bits per color (red, green, and blue) for 24-bit and 48-bit totals and can be either lossy or lossless, depending on the software reading the format. When printing high-resolution images, especially in the CMYK color mode (see Chapter 4), it is recommended that you use the TIFF format. Therefore, TIFF may be the best file format choice when designing written and poster presentations (many scientific journals require TIFF images over JPEGs). The major drawback of TIFF images is that they are usually large file sizes compared to other formats, which makes them less optimal for slide shows, websites, and sharing images with others (e.g., email and messaging).

GIF **Graphics Interchange Format**. GIFs only store information at 8 bits per pixel, reducing the colors in an image down to just 256. Therefore, this format is a poor choice for storing detailed graphics and photographs, but may be good for simple logos, shapes, and cartoons. GIFs feature lossless compression and also support simple animations, making them popular for use in websites and downloadable clip-art.

PNG **Portable Network Graphics format.** The PNG format was intentionally created to supersede the GIF format in websites and other media. While GIFs are limited to 256 colors, PNGs are 24-bit and can therefore specify 16 million colors. Like GIFs, PNGs feature lossless compression and do not suffer generational degradation like JPEGs. Therefore, this format may be most optimal for editing pictures until finally compressing the image as a JPEG and sharing it with others.

Ideal Image Resolutions for Presentation Formats

In general, it is always best to use high-resolution images in your presentations. However, as resolution increases so does file size, and even the newest, fastest computers can show a decrease in performance when opening and manipulating documents with multiple high-res images. The best way to optimize the balance between resolution and file size is to maximize the resolution of your images to the point at which the eye can no longer detect any increase in quality. Increasing resolution beyond this point will increase file size without a corresponding increase in perceived image quality.

When preparing an image for a presentation that will eventually be printed (e.g., written and poster presentations), set the resolution at 300 pixels per inch (ppi) for color and 600 pixels per inch for grayscale.

For images projected onto a screen, images can be as low as 100 ppi with no perceived difference in image quality compared to 300 ppi. Digital projectors operate at a much lower resolution than other media formats (including most modern smartphone displays). Increasing the resolution beyond 100 ppi will increase your file size with essentially no noticeable benefit.

Summary: Don’ts and Dos

Don’t use photographs as decoration.
Do use photographs to show data or as a deliberate visual tool to enhance your scientific story.

Don’t invite criticism of your experiments by showing inconclusive images as data.
Do assume that critical scientists will scrutinize your data images and look for obvious, indisputable results.

Don’t misrepresent data by unethically manipulating images.
Do follow image adjustment guidelines to ensure that you enhance images only for quality and not to alter conclusions.

Don’t allow labels in data figures to distract from the data themselves.
Do minimize labels so that they are secondary to the images shown.

Don’t be lazy or quick to choose the first images you find on Internet search engines.
Do be picky about the images you use, selecting the best for your needs.

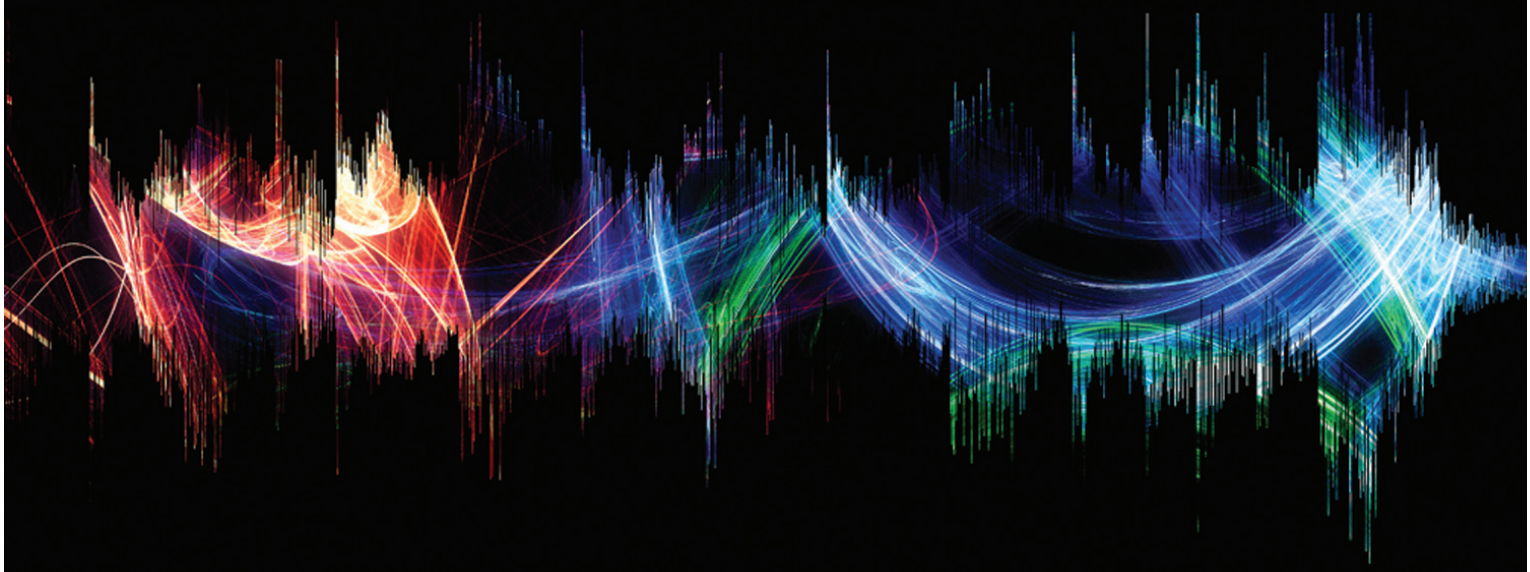
Don’t assume that the photos you take or find online will never need further adjustments or enhancements.
Do consider cropping or adjusting the image settings of your photos to better suit your needs.

Don’t burden your presentation files with unnecessarily large image files.
Do scale the resolution of your images to the maximum quality that the human eye can perceive.

11

Ten Techniques for Improving Scientific Writing

The importance of developing good scientific writing skills cannot be overstated. A scientist's career literally depends on the ability to publish scientific articles and write successful grants and fellowships to secure funding. Furthermore, good writing implies good science. When a written presentation is a pleasure to read, not only does your article or research proposal look good but *you* also look good, and your audience holds you in higher professional esteem. Fortunately, scientific writing is a skill that improves over time, and anyone can adopt general techniques to express their written ideas with elegance and clarity.



Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00011-8

1 Clearly State Your Scientific Topic and Goal

All research papers, review articles, and research proposals absolutely require a clear, explicit scientific topic and objective to prepare their readers for the specific details that follow.

The topic of your paper is a fundamental scientific question or statement regarding a field of study:

Research paper: "The neural basis of sodium appetite is unknown."

Review: "Over the past five years, biosilicates and biomimetic silicate synthesis have received increased attention."

Proposal: "We lack an understanding of the genetic basis of Vittegleo's Syndrome."

An objective describes the purpose of your article or proposal:

Research paper: "The goal of our study was to map brain regions that may be activated in response to sodium appetite."

Review: "This review highlights the important developments in silicate synthesis techniques."

Proposal: "The purpose of this proposal is to test the hypothesis that Vittegleo's Syndrome is caused by…"

Describing your fundamental problem and objective in the beginning of a paper may seem obvious, but many authors are so focused on experiments, results, and a discussion of the literature that they forget to adequately inform their readers of what their paper is all about.

If you don't adequately describe your topic and goal in the beginning of your paper or proposal, you risk losing your audience from the very start. If you describe your topic and goal clearly and explicitly, your audience will be able to follow the science that comes next.

2 Only Write Statements That Can Be Interpreted in a Single Way

Clear writing is specific and unambiguous. Sentences that offer multiple interpretations are confusing and potentially misleading.

Before: We examined mice with the TdTomato reporter.
After: We examined mice expressing the TdTomato reporter.

Before: If the drugs aren't injected into the sick mice within 2 days, they will expire.
After: If the drugs aren't injected within 2 days, they will expire.

If a sentence can be interpreted in more than one way, it's not good enough. Keep editing until its meaning is clear and unambiguous.

If poorly written, an entire rationale or objective of a paper can be misinterpreted. Some journal editors describe receiving angry letters from authors of research articles who complain that the anonymous reviewers misinterpreted the objectives of their studies. However, the blame lies not with the reviewers but with the authors. In the end, it is *your* responsibility to ensure that your writing is only open to a single interpretation.

3 Order Information Consistently

To help your readers follow your story, order information consistently throughout the different sections of your paper:

- If you mention in the abstract and introduction that "Gene X is both necessary and sufficient for Phenotype Y," then make sure you present your necessity experiments first and sufficiency experiments second.
- If the title describes a consistent biological feature in mice, dogs, and humans, be sure to describe the feature in mice first, then dogs, then humans.
- If the title of a figure refers to "wind, rain, and temperature fluctuations," order your subfigures to show data on wind first, rain second, and temperature last.

Using a consistent order provides a sense of overall harmony and allows the reader to predict what comes next.

4 Use Strong Topic Sentences

A common problem in science writing is a lack of structure within the individual sections of a paper. Sometimes an introduction can seem like a jumbled mess of background information while the discussion seems like a never-ending train of thought. Individual paragraphs blur together and the reader lacks a clear sense of order.

One useful strategy for imposing order within a paper is the deliberate use of strong topic sentences at the beginning of your individual paragraphs. Topic sentences not only inform the reader of the scope of the particular paragraph, they also serve as a skeleton that provides the structure for the entire article or proposal.

Topic sentences specify the theme of each paragraph. By designating paragraphs as distinct units, you establish order in your writing that prevents a free-flow of random information.

During the editing process, you should be able to determine whether your paper has a good structure and flow of information by reading the topic sentences alone. If you can understand the substance of the paper by reading these sentences alone, you know your paper is well-structured and arranged clearly. If topic sentences seem out of place, you may need to adjust the order of your paragraphs.

5 Use Transitions to Unite Your Paper

A science paper should not seem like a disjointed series of isolated sentences, paragraphs, and sections. Good science writing seems fluid, with an elegant and seemingly natural flow of information. To increase the flow of a paper, deliberately employ the use of transitions—literary devices that establish connections between individual elements.

Good transitions are often composed of words or short phrases that convey a relationship between the two sentences or paragraphs you want to connect:

Relationship	Transition
Addition	additionally…, furthermore…, in addition…
Causality	consequently…, therefore…, thus…
Contrast	but…, however…, in contrast…, nevertheless…
Ending	finally…, in conclusion…, in summary…, taken together…
Example	for example…, for instance…
Sequence	first…, second…, third…, finally…
Similarity	likewise…, similarly…
Truth	indeed…, in fact…, in reality…

In addition to using transitions within and between paragraphs, transitions can also exist as *entire* paragraphs. For example, at the end of a long section in a paper, a transition section can summarize the information you presented and pivot to the topic of the next section.

6 Avoid Wordiness

Word choice and examples of wordiness are described in Chapter 6. Using more words than necessary to describe an idea is harmful to a paper for at least two reasons: (1) There is an economy of words in a paper, and increasing the number of words you use to describe an idea lowers the amount of useful content you can provide your readers; (2) Increased verbosity makes your paper less of a pleasure to read.

Be concise. Optimize your "meaning to words" ratio to communicate the most information using the fewest words possible.

Before: We next turned our attention to the role of TRPV1 in motor learning. *TRPV1*$^{-/-}$ mice were compared with their wild-type siblings as controls using the rotarod assay. This assay is well-known to test for coordination and balance over time (deLarge *et al.*, 1971). There was no significant difference in motor learning between the experimental animals and control animals. Therefore, we conclude that TRPV1 does not play an essential role in motor coordination.

After: To determine if TRPV1 is necessary for motor learning, we compared coordination performance of *TRPV*$^{-/-}$ mice with wild-type siblings using the rotarod assay (deLarge *et al.*, 1971). We found no significant difference in motor learning between the two groups, demonstrating a non-essential role for TRPV1 in motor coordination.

In addition to individual sentences, omit unnecessary material from entire sections of a paper. For example, a paragraph in an introduction may be extremely well written but unnecessary because it does not introduce information meaningful to the rest of the paper. During the editing process, check to make sure that everything included in a paper is relevant.

7 Own and Use a Style Guide

Try not to be intimidated by all of the rules of good mechanistic writing. Guidelines about grammar, punctuation, and sentence structure are numerous but manageable. Thankfully, there are many accessible guidebooks that provide a ready reference that you can quickly access when needed.

Recommendations:

The Elements of Style, by William Strunk, Jr., and E.B. White (first published 1918, 4th edition 2005). Boston, MA: Allyn and Bacon.

A Writer's Reference, by Diana Hacker (first published 1989; 7th edition 2010). Boston, MA: Bedford/St Martins).

Both of these books are modern classics. They aren't the kind of books you would read cover-to-cover in a single sitting or bring with you to the beach, but they serve as excellent, accessible resources you can use while working on any form of writing.

8 Avoid Reader Turn-Offs

One of the worst mistakes you can make as an author is to annoy your readers. Not only do you irritate your audience, you also cause major distractions from your scientific message and interrupt the flow of your ideas.

Some of the turn-offs that readers hate the most:

- **Typos and grammatical mistakes.** When an editor, reviewer, or other reader finds these mistakes, they immediately become distracted from your content. Worse, if they find multiple mistakes, they will associate the lack of quality in your writing with a potential lack of quality in your scientific execution and results.
- **Inappropriate references.** If you describe a result from a previous study and cite a specific reference, that reference *must* contain the specific result. Citing a paper that doesn't actually report what you claim represents bad scholarship. Furthermore, don't describe a previous result and then cite a review article; only refer to past studies by citing the primary literature.
- **Overstated conclusions.** Scientists are inherently skeptical and don't like overinflated conclusions, whether they are about your data or other papers in the field. Be very careful about the words you use to describe your results (see Chapter 6, p. 80).
- **Long paragraphs.** Readers like digesting information in manageable chunks. Two paragraphs that are the same length as one long paragraph are more pleasant to read. If you find yourself writing an extremely long paragraph, devise a way to break it apart so that you don't risk causing information fatigue in your audience.
- **Ugly figures.** Ugly figures aren't just an aesthetics issue—they are also hard to read, and limit clear communication of information.

In addition to the items above, journal editors and grant review committees consistently report that the most common reason for rejections is authors who don't follow directions. Make sure that if you submit a manuscript or research proposal, you do so based on the specified guidelines.

9 Know That Good Writing Is Great Editing

First drafts of papers are always lousy. In fact, even second or third drafts, when compared to the final version, are sometimes embarrassingly bad. The only way to make a paper great is to edit—not just once or twice, but until you can't conceive of changing another word.

One of the biggest differences between good writers and poor writers is that good writers usually spend as long, if not longer, editing papers as they do writing them.

Pore over your drafts again and again, constantly questioning and optimizing your words, the order of your sentences, and the clarity of your message. Read your drafts multiple times, carefully considering all of the qualities you appreciate in the good writing of others. When you have read your draft so many times that you can't think of changing it in any meaningful way, it is time to begin seeking detailed feedback from others.

10 Seek Feedback

In written presentations, feedback is absolutely essential. Unlike a slide or poster presentation, a written document is permanent, immutable, and forever accessible to others. Written presentations are also the most valuable: they determine your success, reputation, and funding.

Not asking for feedback from your colleagues is one of the worst mistakes a scientist can make. Seeking criticism from your peers does not require much time, and is guaranteed to improve the end result.

Many scientists don't seek feedback from their colleagues because, after heavy self-editing, they feel their draft is "done." In reality, a draft can never be truly perfected, and it is when you feel your draft seems finished that you should seek criticism the most—your peers will likely show you that your manuscript can continue to be improved.

Summary: Don’ts and Dos

Don’t be so focused on your science that you forget to clearly specify your topic and goal.
Do explicitly state your overall topic and goal in the beginning of your article or proposal so your reader is clearly primed for the science to follow.

Don’t write ambiguous statements that convey multiple meanings.
Do write statements that can only be interpreted in a single way.

Don’t vary the order of information you present throughout the various sections of your paper.
Do keep a consistent order of information to unite your paper and allow the reader to sense what comes next.

Don’t allow the sections of your paper to seem like a free-flow of ideas.
Do use strong topic sentences to clearly provide your sections with a sense of structure.

Don’t let your paper seem like a disconnected collection of sections and paragraphs.
Do explicitly use transition phrases and statements to give your paper a natural flow.

Don’t allow your writing to become too wordy or verbose.
Do try to be as concise as possible and reduce wordiness during the editing process.

Don’t feel intimidated by the mechanics of the English language.
Do own a good style guide and consult it frequently.

Don’t engage in some of the writing practices that readers hate the most.
Do consciously learn what readers dislike and strive to eliminate those turn-offs from your own articles and proposals.

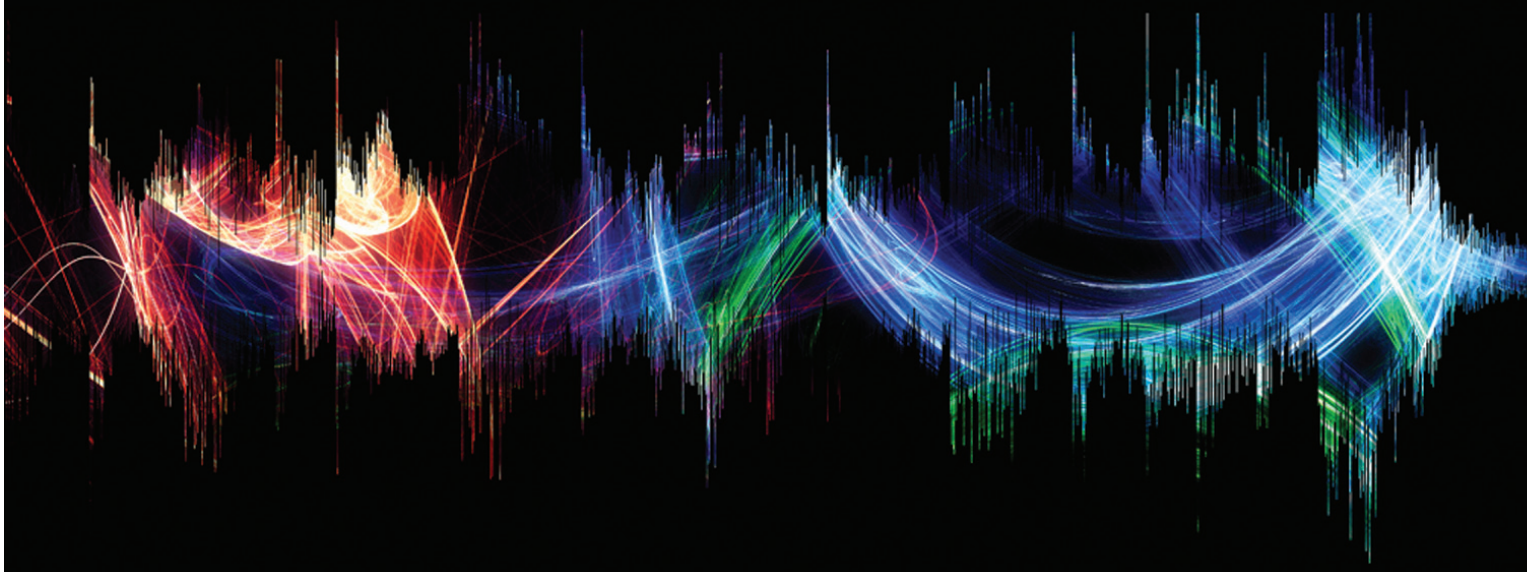
Don’t think of editing as a quick task once you finish writing a paper.
Do think of editing as an essential part of the writing process itself, sometimes spending as long, if not longer, to edit a paper as you do to write it in the first place.

Don’t assume that your writing is so good that you don’t need feedback from others.
Do seek feedback whenever possible, knowing that advice from others can only make your work stronger.

12

Research Articles

A scientist's success is primarily measured by the quantity and quality of his or her peer-reviewed research articles. To publish regularly, scientists must have both great scientific content and the skills necessary to accurately present this content in written form. When poorly written, journal editors and anonymous reviewers are less enthusiastic about manuscripts, especially if they cannot adequately or accurately understand the study. When well written, a paper presents research in the best possible light and increases the chances that a manuscript will be accepted. Fortunately, there are proven techniques for writing the various sections of a research article that scientists can use to improve their ability to communicate in written form.



Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00012-X

The Purpose of a Research Article

The most important reason to publish a research paper is to add your results to the permanent domain of scientific knowledge. Your primary audience is other scientists in your field, but your potential audience is anyone with access to a computer.

An advantage of a research article compared with a slide presentation or poster is that it is enduring and immutable. Your published work is always available for anyone to access: now, 50 years from now…perhaps even hundreds or thousands of years from now.

Research articles represent the ultimate, final product of a scientific study. A published paper shows that you have completed a research project, from beginning to end, and the peer-reviewed results are indefinitely available for anyone in the world to access.

Twenty years ago, the scientific record consisted of collections of journals and reprints in libraries and individual publishing houses. Nowadays, the scientific record exists digitally in the cloud. Most scholarly articles from the past are available online, and every article published now and in the future will be available online. To publish a research article means to permanently add your science to the scientific record such that it can theoretically be accessed by anyone, anywhere, anytime.

Of course, there are many other important reasons to publish research articles. Publishing papers establishes your reputation among your peers and demonstrates to your funding agencies that you are a responsible grantee who delivers results. Graduate students need papers to get good postdoctoral fellowships, postdocs need papers to get good permanent jobs, and principal investigators need papers to get funding and promotions. Writing and publishing strong research articles is one of the most important skills a scientist must learn.

The Structure of a Research Article

The structure of a research article depends on both the scientific journal you publish in as well as the specific category of article within that journal. Most journals use subheadings with dedicated introduction, results, and discussion sections, but some journals do not employ subheadings at all and read as one continuous article. In either case, a well-written research article will usually contain the following components:

Title: A specific statement that conveys the topic and conclusion of the paper.

Abstract: A complete summary of the paper designed for experts and non-experts.

Introduction: The beginning of a paper that transitions from a general background to a specific research question or goal.

Materials and Methods: A brief but detailed description about the tools and methods you used to perform experiments and analyze results.

Results: A presentation of all your experiments and data, represented both as text and in tables, charts, diagrams, and photographs.

Discussion: An opportunity to discuss your interpretation of your results and explore your findings within the context of the larger scientific record.

References: Your citations.

Supplemental Material: Additional figures, videos, and sometimes elaboration on methods and computational analysis.

Depending on the journal and category of article, these sections will be of different lengths or appear in a different order. For example, some journals place the materials and methods section just after the introduction, others place it at the end of the paper, and some even put this section entirely online in a supplemental material section.

The Title Should Emphasize What is Most Important

Consider that the title of your article is going to be read by thousands of people. Many of them will be perusing the table of contents of the journal, or, more likely, examining the results of a searchable online database. Most scientists will decide whether to read your abstract based entirely on their impression of your title. Therefore, your title is one of the most important factors in determining whether your paper will even be read. Because titles usually have a word limit, every single word counts.

Your title must adequately and accurately describe what your paper is about. If your audience needs to look at your abstract to determine what you studied, your title has failed.

The best titles are often conclusions because they communicate the most information to your audience.

Before: The effect of positive reinforcement on mathematics performance in 10-year-old females
After: Positive reinforcement increases mathematics performance in 10-year-old females

Before: The role of Sufl2 in primary necrosis
After: Sufl2 blocks primary necrosis by preventing mitochondrial outer membrane permeabilization

Before: Gene expression profiles of inner and outer hair cells
After: Comparative gene expression profiles of inner and outer hair cells reveals a multitude of uniquely expressed genes

Sometimes authors like to emphasize methods in their titles—e.g., "fMRI analysis of visual attention." You must decide what it is you want to emphasize and what will be most informative to readers. Usually the most informative titles are conclusions; cool methods come and go, but conclusions are always interesting.

Methods-based: Optogenetic investigation of the inferior colliculus in the big brown bat, *Eptesicus fuscus*
Conclusion-based: The inferior colliculus is tonotopically organized in the big brown bat, *Eptesicus fuscus*

The Abstract

Most people who come across your paper in a journal or Internet database will decide whether to read your full paper based on your abstract. In fact, in an Internet database, an abstract is likely the only part of your paper that your audience will see at first. If they want to keep reading, they will have to actively access your paper. Therefore, your abstract has to be well written: if it contains errors or is difficult to read, it will potentially turn away most of your audience.

A good abstract is like a mini-version of your paper, with a background, scientific question, results, interpretation, and discussion, all within a single paragraph.

Pacific salmon hatcheries raise and release juvenile fish in order to supplement wild stocks and enhance commercial harvest. Over 100 salmon hatcheries in Hokkaido, Japan, raise and release a total of over one billion chum salmon fry each year in order to supplement wild populations that have decreased steadily since the 1930s. Whether sufficient prey are available to absorb the additional consumption demand by hatchery-produced chum salmon is unknown. The increased abundance of juveniles from hatchery production has elicited concerns that the carrying capacity for juvenile chum salmon has been reached or exceeded; juvenile chum salmon could potentially become food-limited at one or more stages in their life cycle in one or more geographic regions. Here we show that the localized standing stock biomass of key prey was not enough to sustain the high level of consumption required by chum salmon to satisfy observed growth during the first five months at sea. The high percentage of prey biomass consumed and the fact that growth and consumption rates were higher for all cohorts during years of high survival indicate that Hokkaido chum salmon are food-limited during the juvenile stage. Competition for limited prey resources between hatchery and wild salmon could present potential risks to the health of wild stocks in particular. Our findings demonstrate that the potential benefits of hatchery programs should be weighed against risks to wild stocks and the greater ecosystem. Furthermore, production should be aligned with the carrying capacity of the region.

1–2 sentences to introduce the paper to any scientist

2–3 sentences to introduce the paper to more specialized scientists within your field

1–2 sentences to describe the main findings of the study

2–3 sentences to elaborate on what was observed

1–2 sentences about the conclusions and implications of the study

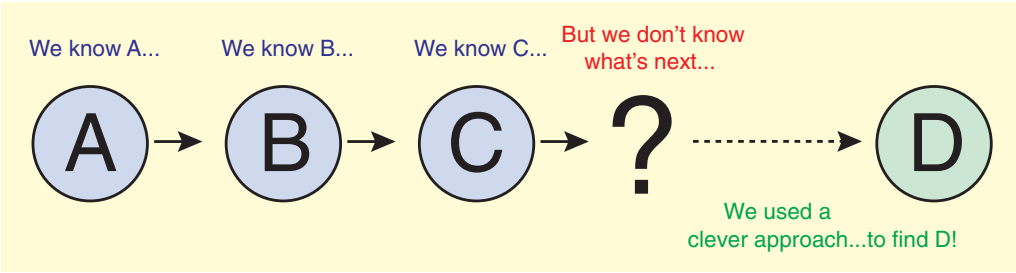
Key tip: Searchable online databases often include all of the words in the abstract in search queries. This means that if someone types a word that is found in your abstract into a search field, your paper will be listed in the search results. Therefore, be strategic about including words in your abstract that will help your paper reach a larger audience.

The Introduction

The introduction to a research article has five crucial goals:

- To declare the overall topic for the reader (e.g., dark matter, obesity, seed dispersal)
- To provide relevant background material to demonstrate the work leading up to your study
- To define a clear problem or research question
- To describe the objectives of the study and approach
- To briefly summarize (in one or two sentences) what was achieved in the study

A generic introduction might look something like this:



After your audience reads your introduction, they should be able to accurately describe the work that preceded your paper, the interesting scientific problem addressed in your paper, and the overall findings.

Because much of the introduction is about the current state of scientific knowledge, you should write your introduction in the present tense. The only exception is the statement at the end about what you achieved, which should be written in the past tense.

Key tip: When citing papers in the introduction, be strategic about the papers you cite. The anonymous reviewers who receive your manuscript are likely to work in the same field as you and appreciate having their work referenced. Therefore, be deliberate about including papers written by labs within your field that are likely to receive your paper for review.

Materials and Methods

The purpose of a methods section is to provide enough detail about how you conducted your study so that an independent investigator could repeat the exact experiment. Because your experiments took place in the past, you should always write this section in the past tense. To make this section easy to read and to allow your audience to find information quickly, be sure to use subheadings for each distinct method performed. Do not describe detailed procedures about commonly used, standard techniques that most people in your field routinely perform (e.g., Western blots, immunohistochemistry, molecular cloning); however, carefully describe the specific details of your materials so that others could perform experiments with exactly the same reagents that you used.

Details to include about materials

- The number, age, source, and (for animals) sex of research organisms
- The name and version of all computer software used for data analysis
- The source and product numbers of all non-commonly used chemical reagents
- The source and product numbers of all commercially available antibodies
- The exact genetic locations or sequences used in cloning or subcloning experiments
- The spatial coordinates of any specific locations where samples were collected or a study was performed
- The names and sources of any specialized scientific equipment

In truth, many readers will probably skip your methods section. Depending on your field and the nature of your study, there is a high likelihood that no other scientist will even attempt reproducing your experiments. (Is another scientist really going to duplicate landing a probe on Titan? Or sequencing the chimp genome?). Nevertheless, the scientific method demands that you describe your methods so that they are reproducible. The potential for reproducibility must always exist, even if the likelihood does not.

Aside from reproducibility, a secondary goal of the materials and methods section is to establish your credibility. When the methods section is well written, you come across as knowing what you are doing and your audience is more likely to trust your results.

The Results

Because science papers can be long and complex, it is extremely helpful to readers to remind them of the purpose of individual experiments as you present your results. Therefore, the results section should be written such that every paragraph is something like a "minipaper," complete with its own rationale, statement of methods, results, and conclusion. Use the past tense to describe what you did, and the present tense to describe your conclusions and what was learned from the experiment.

Consider beginning the first or second sentence in each paragraph with the word "To…" This technique will force you to begin each aspect of the results section with a justification of why you performed the experiments.

Before: We next overexpressed full-length versions of Tav1, Farr3, and Farr6 in HEK293T cells and performed co-immunoprecipitation experiments using an antibody to Tav1. Tav1 interacted with both Farr3 and Farr6.

After: To determine if Tav1 interacts with Farr3 and Farr6, we overexpressed full-length versions of these proteins in HEK293T cells and performed co-immunoprecipitation experiments using an antibody to Tav1. We found that Tav1 interacted with both Farr3 and Farr6, indicating that Tav1 interacts with either receptor *ex vivo*.

Before: Following injections of 4% (hypertonic) or 0.9% (physiological) saline directly into the OVLT, we stained for c-Fos, an indirect marker of neural activity. We found a statistically significant increase in c-Fos expression in the OVLT from mice receiving hypertonic saline ($P<0.05$, Student's t-test).

After: To determine if the OVLT increases activity in response to hypertonicity, we injected 4% (hypertonic) or 0.9% (physiological) saline directly into the OVLT region, sacrificed the animals, and stained the brain sections for c-Fos, an indirect marker of neural activity. We found a statistically significant increase in c-Fos expression in the OVLT from mice receiving hypertonic saline compared to control mice ($P<0.05$, Student's t-test), demonstrating that hypertonicity increases activity in this brain region.

Marrying Figures with Text

Scientists will read your paper in one of two different ways: they will focus exclusively on your figures, ignoring much of what you write in the text, or they will read the paper from start to finish.

Designing good tables, charts, diagrams, and photographs was described in Chapters 7–10, respectively. Your figures should ideally communicate information on their own for any reader who wants to quickly understand the main findings of the paper. The best titles of figure legends are conclusions, and the legend itself should convey everything necessary to understand the symbols, lines, and bars in the tables and charts.

You will almost always refer to figures in your results section. Try to avoid describing your figures in the text. Your readers don't want descriptions of figures; they want descriptions of your results. Therefore, focus your results section on your experiments and findings, citing your figures as you would cite references.

Before: Figure 3a shows that nitric acid caused structural degradation of the carbon nanotubes.
After: Nitric acid caused structural degradation of the carbon nanotubes (Fig. 3a).

Before: We present the geographical coordinates used in this study in Table 3.
After: We placed eight atmospheric monitoring stations within a 6-km^2 area (Table 3).

Before: In Figure 7 we show a diagram depicting an indirect feedback loop between miRNAs and SMB7.
After: Our results suggest a model in which miRNAs indirectly regulate SMB7 (Fig. 7).

Many journals also allow authors to submit supplementary figures and videos that readers can access online. Most readers won't expend the effort to access these figures unless they are particularly interested, so only put information that isn't crucial to the main findings of the paper in your supplementary figures. Usually these figures validate or demonstrate methods rather than contribute novel scientific findings.

The Discussion

Most scientists find the discussion section the most difficult to write because, unlike the other sections, there is no obvious structure or information to include. In general, this section is your opportunity to briefly summarize your findings, interpret any interesting, contradictory, or confusing results, and place your results in the context of the larger scientific record.

Don't...

- Recapitulate all of your results. Begin your discussion with a brief recap of your results, but don't describe all of them throughout your discussion section. Only discuss those data that require further explanation.
- Write a discussion section that is too long. How long is too long? The length depends on the nature of your field and your findings, but in general, a discussion section should be shorter than your results section. Only include discussion if it adds meaning to your paper.
- Speculate on future directions. In slide or poster presentations, it can be informative to discuss future experiments because those presentation formats usually describe works in progress. Leave them out of papers. They usually come across as too speculative, and sometimes anonymous reviewers will ask why you didn't already do those experiments and include them in your current submission.
- Overstate your conclusions. See the "hierarchy of claims" on p. 80.

Do...

- Highlight the significance of your results and the contribution of your study to your field.
- Show how your results are in agreement or disagreement with previous studies.
- Discuss any results from your study that seem confusing or paradoxical, either with each other or with results found in the literature.
- Consider alternate explanations of your findings.
- Discuss the practical applications of your work.

Additionally, it is always nice to end a paper with a final conclusion that summarizes the major contributions of the paper in one or two sentences and establishes its place within the larger scientific record. This conclusion not only provides your paper with a solid ending but also serves as a final "take-home" message for your audience.

Common Reasons for Rejection

When writing a research paper, it can be helpful to think about not only the qualities that will make your manuscript a success, but also the mistakes to avoid. Editors of scientific journals are usually very open and honest about the most common reasons why manuscripts are rejected for publication. Some of these reasons are obviously about the content of a manuscript, but many of them are actually about the writing of the article itself.

Problems with content

- The results do not justify the conclusions
- The topic of the paper is too specialized for the journal
- Inappropriate experimental design
- Lack of novelty
- The research is trivial or incomplete
- The research is too similar to the author's previous publication(s)

Problems with writing

- The author did not follow directions regarding how to write the manuscript
- The manuscript is poorly written and hard to understand
- An important interpretation or explanation of experiments is missing
- Speculation in the discussion is not based on data and unwarranted
- Improper references cited in the introduction or discussion
- Poorly designed figures
- Too many errors, typos, mistakes

When reviewing and revising your manuscript, think about your paper from the point of view of an editor, and see if you can "reject" it before you even submit. Ask colleagues for harsh feedback, both about your content and about your writing. Consider the lists above and try to avoid the common mistakes made by others.

Summary: Don’ts and Dos

Don’t choose an uninformative title.
Do use a title that emphasizes what is most important about your study—usually the conclusion.

Don’t write your results section as a long stretch of continuous findings.
Do write every one to two paragraphs as a “mini-study,” complete with a unique rationale, statement of methods, results, and conclusion.

Don’t focus on your figures in the text of your results section.
Do emphasize your results, citing your figures rather than describing them.

Don’t use your discussion to simply recapitulate all of your results.
Do use your discussion to highlight the significance of your results and compare your findings with those of previous studies.

Don’t make the same mistakes as countless other scientists who experience rejections from journals due to issues with writing.
Do follow the directions of journals and meticulously proofread your manuscript to ensure it is error free.

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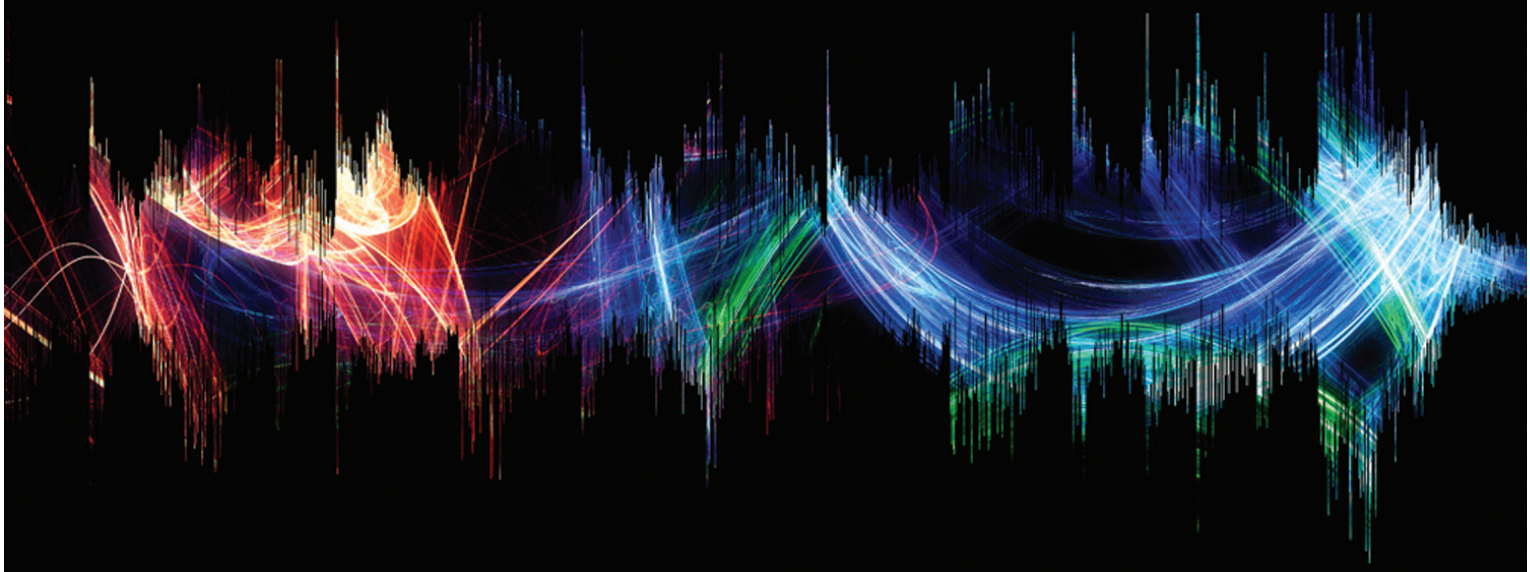
Review Articles

Writing a review article is completely different from writing a research article or proposal. Broader in scope, a review is less about your work and more about an entire scientific topic. Furthermore, a review doesn't have an inherent structure—there are no standard sections, figure requirements, or common expectations about how you discuss the literature. The freedom to compose a review with your own vision and ideas can be liberating, but also intimidating—especially if you have never written a review before. Fortunately, there are many useful strategies for approaching the composition of a review so that it is a pleasure to read and adds insight to your field of study.



Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00013-1

The Purpose of a Review Article

A review article assembles the results of dozens or even hundreds of primary research articles into a coherent narrative about a specific scientific topic.

One of the major purposes of a review article is to make sense of the scientific literature. When you enter a search term into an online database, the result is often hundreds, if not thousands, of papers that may or may not be relevant to your interests. If you are interested in learning about a new scientific topic, it is difficult to know which papers are the most important to read. A good review article that describes the current state of a field by presenting salient information is an invaluable resource.

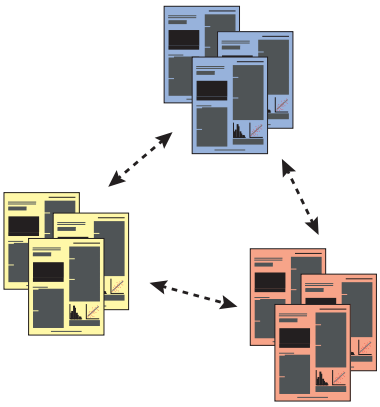
However, a good review should be much more than just a list of relevant information. If the purpose of a review were only to itemize papers on a single topic, a review could consist entirely of a references section. Instead, a good review provides a comprehensive understanding of a subject. It explains a topic from a bird's-eye view of the literature, arranging ideas into a larger narrative. When writing a review, you need to think about not only what material you present, but also *how* you present it.

The best reviews compare and contrast different studies and offer opinions on the relative strength and importance of ideas. They also add something new: a scientific model, a new insight, or a suggestion for how a field can move forward to solve a scientific problem.

The audience of a review is usually much broader than that of a primary research paper. Your readers will consist of scientists in the field, but also other scientists who want to learn about a new topic. Therefore, your review needs to be both specific enough to satisfy colleagues in your field and broad enough to inform novices from a different scientific background.

When writing a review, you start with the chaos that is the scientific literature...

...you identify the research articles that are the most important and salient to your topic...



...and you analyze different categories of information to provide meaningful conclusions about your topic. In the end, you make a statement about a scientific topic that is greater than the sum of its parts.

Different Methods of Presenting the Literature

Before you begin writing a review, be clear about the way in which you want to present and discuss scientific ideas. Consider that you can present information about your topic with varying degrees of insight, and more insightful reviews have a greater impact on a scientific field. The different levels of insight range from simply explaining other studies to constructing new ideas based on a synthesis of the information.

Depth of insight

Explanation	categorize, classify, enumerate, explain, list, report
Analysis	compare, contrast, discriminate, examine
Evaluation	appraise, argue, defend, judge, support
Construction	build, create, formulate, propose, speculate, suggest

Explanation: provides a summary of the primary literature. It is the simplest way to present information in a review and usually most beneficial to readers new to your topic.

- Survey all of the recent publications that describe a single phenomenon, subject or technique
- Describe how a natural phenomenon or complicated technique works

Analysis: compares and contrasts multiple studies.

- Compare the relative advantages and disadvantages of using various methods to perform an experiment
- Examine how a phenomenon in one species exhibits differences compared with a phenomenon in a different species
- Discriminate between the experimental designs of two studies that produced contrasting results

Evaluation: judges quality and forms an opinion

- Determine the conclusions of a series of studies to be inaccurate
- Argue in favor of a scientific theory
- Defend an unpopular scientific point of view

Construction: offers new ideas that add depth and insight. Truly original concepts in a review may impact the field even more than an original research study.

- Propose a scientific model based on the results of several studies
- Speculate about a new way to accomplish a goal
- Design an experimental strategy to answer an unresolved question

Help Your Readers

Review articles are unlike other forms of scientific writing in that they have no inherent structure. Unlike research papers and proposals, there is no set specification for the quantity or types of subsections found in the main text. There is also no requirement to include figures or tables. Therefore, when a scientist begins reading a review, he or she typically has no idea what to expect other than a vague notion of the subject matter. As the author, you can help your readers by providing an overall sense of structure and readability.

Design a review article to maximize the reading experience of your audience, considering not only the subject matter you present, but also how you present it.

Include subdivisions throughout your paper to provide organization and structure. Unless your review is relatively short, your main text will be too long to flow undivided. Because you don't have natural subheadings as you would in a research paper (e.g., methods, results, discussion), include your own subheadings that clearly follow a logical narrative.

Explicitly outline your review in the abstract and/or introduction. To help your audience immediately perceive the overall objective and structure of your review, deliberately state the composition of your review in the abstract, introduction, or both. Readers will appreciate a roadmap of where you are about to take them before they go on the journey.

Include as many informative figures and tables as possible. Figures and tables are always necessary in research papers, slide presentations, and posters, but they aren't explicitly required in reviews. That doesn't mean you shouldn't include them—quite the contrary. Diagrams that illustrate concepts or tables that categorize primary papers help communicate messages and make your paper more visually interesting. In fact, the more visually stimulating a review appears, the more likely potential readers are to actually read from start to finish.

Choose and highlight the best references. Many scientists read reviews primarily to gain an understanding of the most salient primary papers in a field. Help your readers by showing them which papers are potentially the most interesting. Some journals allow (or require) annotated references in which you highlight some papers as particularly interesting. You can also highlight references by designing a table that presents categories of information and the references where readers can find out more about them. Finally, in the text, be sure to highlight your favorite reviews with descriptive statements that add value (e.g., "A transformative study from Cross *et al.* showed that…").

Advice on the Writing Process

When you begin composing a research paper or proposal, it is often possible to write certain sections (such as your methods) relatively easily because you are personally familiar with the subject matter and probably already have an idea about what you want to communicate. In contrast, when writing a review, you should close your word processing program until you've thoroughly outlined how you want to present your information.

The following strategy seems to work well for many scientists:

1. **Identify the specific topic of your review.** Examine the literature to determine if a quality review about the same topic already exists. If so, consider slightly adjusting your focus so that your review doesn't reinvent someone else's work and will have a greater impact on your field.
2. **Search the literature for all relevant papers.** This can be daunting, and don't be intimidated if your first few searches using Internet databases return thousands of results. Try increasing the specificity of your searches using a variety of search terms. It may also help to narrow your results by only examining papers from the past few years, which will probably cite the important older papers, anyway. Also consider only looking at papers from the highest impact journals in your field so that the papers are likely to be more important.
3. **Once you have performed an initial search, try not to become focused on other review articles.** You can become crazy by continually evaluating how other authors addressed your topic, even if your focus is slightly different.
4. **As you read papers, separate them into useful groups.** Some people like to use a spreadsheet to categorize papers, others put papers into different piles...do whatever works best for you to keep track of information.
5. **Consider the level of insight you would like to provide your readers.** Are you simply explaining and listing concepts, or are you also analyzing, evaluating, and offering opinions of your own?
6. **Create a rough outline or skeleton of your review. This is the single most important aspect of the writing process** because you begin making important decisions about the structure, scope, and depth of your review. Decide not only what information you will present, but also how you will present it.
7. **Think about useful diagrams and tables you can provide your readers.** Consider designing your figures first and then writing your manuscript second.
8. **When you write your first draft, start with major headings and concepts instead of specific references.** If you start the writing process by focusing on structure, all of your details will fall into place when you add them later.

Summary: Don’ts and Dos

Don’t consider a review a simple list of primary articles that all address a single scientific topic.
Do write a review that provides a comprehensive narrative about a field of study.

Don’t assume that because your review isn’t a primary research article, it cannot offer anything new.
Do write a review that provides essential explanation, analysis, and evaluation of the literature, adding insightful models, ideas, and opinions that can potentially add impact to your field.

Don’t write a long, continuous narrative with no structure in your main text.
Do divide your manuscript into subsections that ensure your readers have a clear sense of organization.

Don’t forget about the power of figures and tables to communicate information to your readers.
Do add multiple informative figures and tables throughout your main text to increase communication and the pleasure of reading your review.

Don’t write a review until you have a clear, ordered outline of the ideas you want to discuss.
Do write about big concepts first, adding specific details and references at the end.

Don’t write a review that has already been written.
Do examine the literature for reviews on similar topics, adjusting your focus or topic, if necessary.

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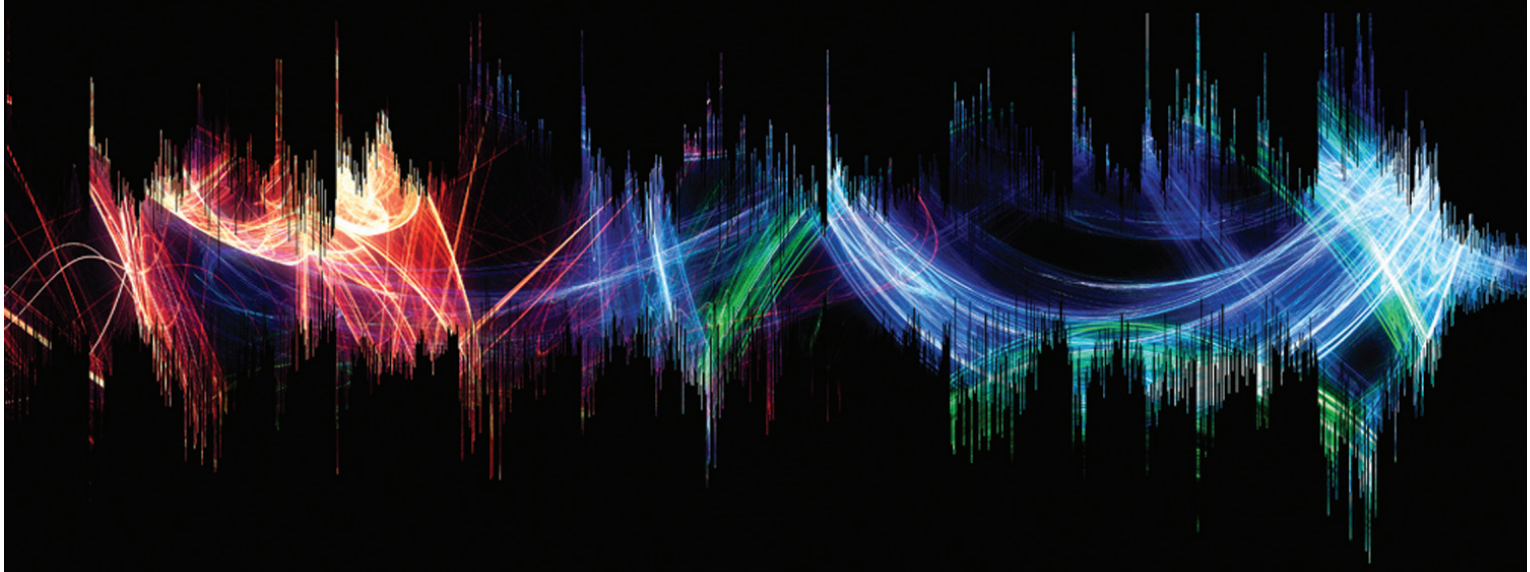
Research Proposals

Writing research proposals is such a common task among scientists that sometimes we forget what we are literally doing: asking for a substantial sum of money. Ask yourself, what would it take for *you* to give someone the amount of money you are requesting? What would you want to know about the person asking for funding and how they planned to use it? Although research proposals discuss scientific ideas, they are ultimately about convincing an organization that your objectives are worth the time, effort, budget, and other support that you request.



Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00014-3

The Purpose of a Research Proposal: To Justify

The obvious goal of a research proposal is to obtain funding for your experiments, your salary, and (at the faculty level) your personnel. If you are a graduate student, you may write research proposals for class assignments or your qualifying exam, but the main function of these exercises is to prepare you for writing a real grant or fellowship proposal in the future.

To achieve your goal of securing funding, it is useful to think of your proposal as having a fundamental purpose: to justify.

The ultimate goal of a research proposal is to justify why an outside organization should give you financial support instead of someone else.

Your research proposal may be well written and your scientific ideas may seem obvious to you, but if you don't clearly justify your rationale and thought process, your proposal will fail to convince your readers that your ideas are original, important, logical, and feasible.

What you must justify in a research proposal:

- Your scientific topic is important
- Your specific scientific question/goal is important
- You are an expert on your topic and have a command of the relevant scientific literature
- You are fully qualified to perform the study
- Your institution is a terrific place to perform the study
- Your preliminary experiments suggest a likely chance of success
- Your experimental design is logical
- Your methods are feasible and you have the necessary expertise to perform them
- You have alternative approaches in case your plan is initially unsuccessful
- The results of your study will make a substantial contribution to a scientific field

Writing a research proposal requires a different kind of salesmanship than other forms of scientific writing. If you are new to the process, it is highly beneficial to enroll in a grant-writing workshop at your institution and examine several previously funded proposals. Notice how these successful proposals justify nearly everything they describe.

Pleasing Your Reviewers

Different funding organizations review research proposals in different ways. Your proposal will typically be considered by one or two primary reviewers and possibly a third who may offer additional opinions when necessary. Your proposal will probably be discussed within a larger group of reviewers, although only those assigned to your proposal will read it thoroughly.

Always consult the funding organization's instructions to determine how reviewers will evaluate your proposal. Every grant or fellowship has different criteria, but the following criteria from the NIH are typical:

Significance. Does the proposal address an important problem or a critical barrier to progress in the field?

Investigator. Are the principal investigator [this term also refers to graduate students and postdocs applying for fellowships] and other collaborators well-suited to the project? If in the early stages of a career, do they have appropriate experience and training? If established, have they demonstrated an ongoing record of accomplishments that have advanced their fields?

Innovation. Does the application challenge and seek to shift current research or clinical practice paradigms by utilizing novel theoretical concepts, approaches or methodologies, instrumentation, or interventions?

Approach. Are the overall strategy, methodology, and analyses well reasoned and appropriate to accomplish the specific aims of the project? Are potential problems, alternative strategies, and benchmarks for success presented?

Environment. Will the scientific environment in which the work will be done contribute to the probability of success? Will the project benefit from unique features of the scientific environment, subject populations, or collaborative arrangements?

After reading your proposal, the answers to all of these questions should be an enthusiastic YES.

In addition to the above criteria, funding agencies will require detailed information about your personal background, physical setting, use of humans or vertebrate animals, etc.

Reviewers will also expect a professional, well-written proposal. Because only a small percentage of applications are likely to be funded, every detail counts. Reviewers will check to make sure that you followed all directions and will care that your writing is accurate in grammar and style. Always remember that good writing implies good science.

The Structure of a Research Proposal

Every funding agency has its own guidelines for the different sections of a grant or fellowship, and you absolutely must read and follow the instructions to ensure you write your proposal correctly. Usually a research proposal contains the following sections:

Title. The best title succinctly describes the entire purpose of your proposal.

Executive Summary (also called the Abstract or Specific Aims). This is a half-page or one-page summary of your entire research proposal in which you present your entire rationale, purpose, and specific aims. If well written, reviewers will look forward to reading the rest of your proposal. However, if you do not convey a clear sense of importance and novelty, some funding agencies may decide that your proposal is inadequate based on this section alone.

Background and Significance. This consists of a brief literature review in which you clearly describe the relevant past work on your topic. This section leads to the declaration of your hypothesis or goal. If the work you cite does not relate to the research you propose, your reviewers will doubt your rationale (not to mention your scholarship) and your proposal will not be funded.

Preliminary Data. Some funding agencies will require that you present preliminary data. This section demonstrates that you have initial success toward achieving your goal, increasing the likelihood that your proposed experiments will lead to positive results.

Research Design and Methods. The meat of your proposal, this section contains a complete description of your research plan, usually divided into two or three individual specific aims. For each specific aim, you should address the following topics (even if not explicitly required by your funding agency):

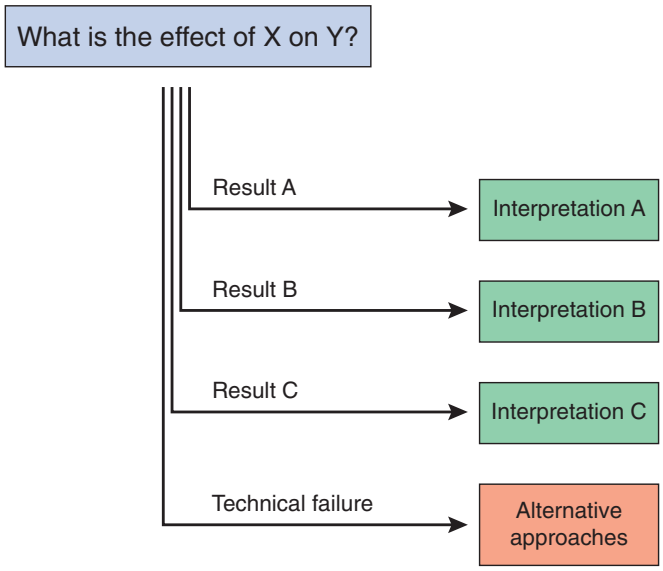
Rationale: The purpose of the experiments
Experimental design: The experiments you will perform and the methods you will use to answer your scientific question
Potential results and interpretations: All of the potential outcomes of your experiments, and how you will interpret each
Potential problems and alternative approaches: The experimental or technical problems that can cause your experiment to fail and your alternative plans to ensure your study can continue

Conclusion. This is a brief paragraph to cement why your proposal is highly important to fund.

The Logic of Your Experimental Design

Your "Research Design and Methods" section may be the most important part of your entire proposal, not only because it presents your specific goals, ideas, and experiments, but also because it showcases the way you think as a scientist. In addition to details, this section must convey an overall sense of logic, demonstrating to the reviewers that you have a clear line of reasoning and well thought-out plan.

You probably won't have room to create a summary diagram for every specific aim in your proposal, but your reviewers must be able to perceive that for every question you ask, you have thought through the potential outcomes and associated interpretations. You must also describe back-up plans in the case that your initial experiments don't work.



If your reviewers cannot perceive your logical thought process, your proposal will make less of an impact and will not be funded.

Enhance the Visual Design of Your Proposals

When you write a research or review article, your manuscript is typically 20–40 pages in length and (if accepted) will be reformatted by a page layout specialist prior to publication. In contrast, a research proposal is typically 5–10 pages in length and your target audience will see exactly what you submit to them with no improvement to the visual design.

The visual layout and design of your research proposal is highly important because it enhances the communication of your ideas, increases the perception of structure and logic, and implies clear, organized thinking.

Also consider that the typical reviewer critically examines four to eight research proposals during a single funding cycle. Reading dozens of pages of text eventually becomes tedious, and anything you can do to make your proposal more pleasing to read will be much appreciated.

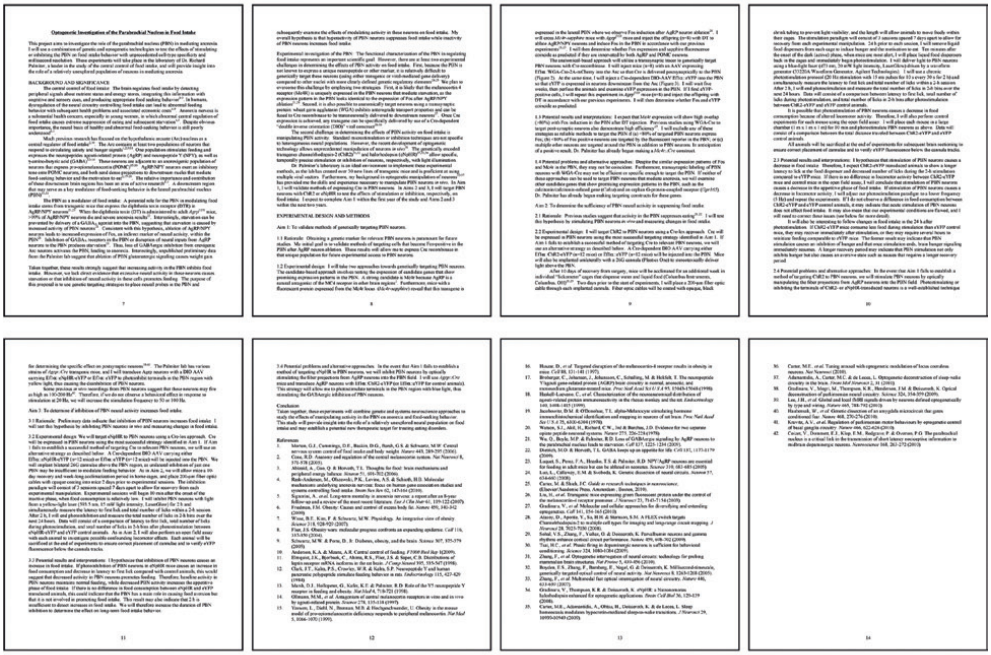
Highlight your organization. Write all of your major headings (e.g., "Background and Significance," "Preliminary Data," "Research Design and Methods") in a larger font size, in bold, and in all capital letters. Also write all of your subheadings in bold.

Highlight your research hypothesis/goal. Both in your Executive Summary and at the end of your Background and Significance sections, write a clear, discrete sentence declaring your overall hypothesis or goal. Emphasize this sentence by underlining it or writing it in bold and/or italics.

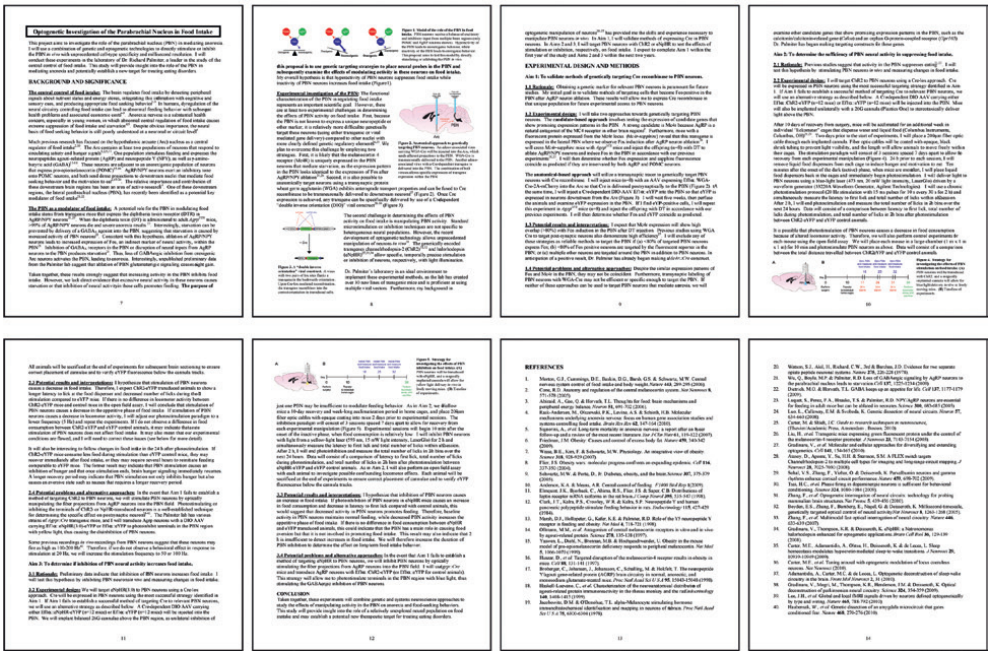
Include as many diagrams as possible. Diagrams are visually interesting and communicate information very quickly. In research proposals, you might think of including explanatory diagrams to communicate your hypothesis/goal or any uncommon methods. Also consider using timelines or other useful diagrams to depict your experimental design.

Deliberately include empty space. Reviewers are turned off by too much text, especially if you use a relatively small font size and minimal margins. Separate your sections (or even individual paragraphs) with spacing and reduce wordiness as much as possible so you can increase the size of your margins and make your proposal more readable.

Before: tedious layout



After: optimized layout to enhance communication



Summary: Don’ts and Dos

Don’t consider a research proposal to be a simple academic exercise.
Do recognize that each proposal you write is a request for a substantial sum of money.

Don’t write about scientific ideas and experiments without justifying their importance.
Do justify everything you describe in your proposal, including the importance of the problem, the novelty of your approach, the impact of your experiments, and your ability to ensure the project is a success.

Don’t begin writing without thoroughly reading the criteria that will be used by the reviewers who will evaluate your proposal.
Do ensure that you address every potential question your reviewers will ask in reference to each of the criteria they will use during the evaluation process.

Don’t write about a specific aim without conveying a sense of logical scientific thinking.
Do carefully consider all of the outcomes of your experiments and how you will logically interpret every possible result.

Don’t assume that visual layout doesn’t matter.
Do recognize that reviewers appreciate a clear, visual layout to better communicate ideas and increase readability.

Don’t forget about the use of diagrams as a way to communicate complex information to reviewers.
Do use as many diagrams as possible throughout your proposal to enhance the communication of your scientific ideas and experimental design.

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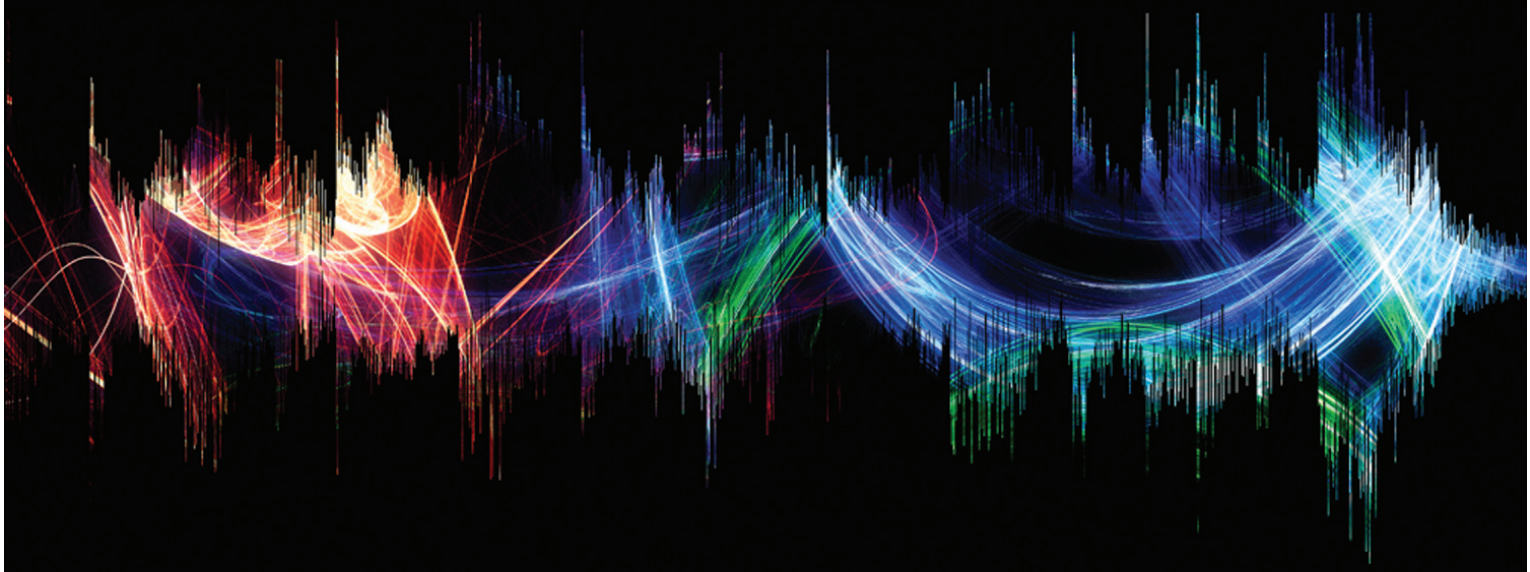
The Use of Slides in Oral Presentations

Slide presentations have become the most common way for scientists to share their work and ideas with others. Typical graduate students and postdocs publish 1–3 papers and present 5–10 posters during each stage of their training. In contrast, they deliver dozens of slide presentations. The frequency of talks only increases at the faculty level as principal investigators teach courses, present seminars on the lecture circuit, and speak at scientific meetings. With the use of slides so widespread, it is surprising that there is a general lack of training about their use in oral presentations. When used poorly, slides can mar a presentation, sabotage a speaker's message, and confuse an audience. However, when well designed, slides add tremendous impact to a talk, enriching the information an audience receives and enhancing the communication of scientific ideas.



Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00015-5

The Purpose of Slides as Presentation Tools

Slides are so ubiquitous in oral presentations that most people don't even consider the possibility of delivering a talk without them. Whether we realize it or not, using slides in our presentations is a deliberate choice, and we often have the freedom to present talks with oral delivery alone. Thinking as designers, it is worthwhile to ask: Why do we use slides in oral presentations at all? What benefit do they provide our audiences?

As discussed in earlier chapters, data are best conveyed visually in charts and tables. People don't just want to hear about the results of experiments, they want to visualize data so they can draw their own conclusions. Additionally, diagrams, illustrations, and photographs provide tremendous explanatory power. Therefore, visual aids are indispensible to good science presentations.

So why not use a handout instead of using slides?

The power of slides as presentation tools is that they allow you to show your audience *whatever* you want them to see, *whenever* you want them to see it. Unlike a paper, poster, or handout, it is *you* who controls the flow of information in a presentation.

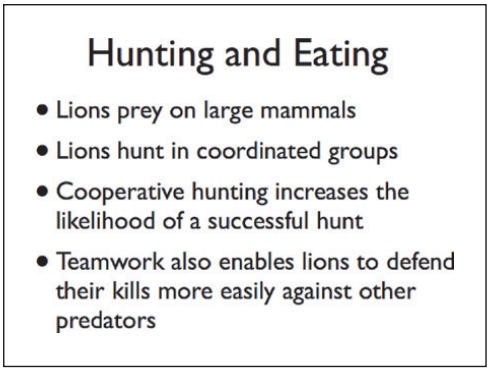
Without care and deliberation, the misuse of the power to control the flow of visual information to your audience can lead to confusing, unintelligible, and even annoying presentations. However, with care for your audience and attention to principles of good design, slides can offer much greater impact than your words alone.

Slides are for the Audience, Not the Speaker

Perhaps the most common mistake people make when creating slide presentations is to create slides for *themselves* rather than their audience. For example, they use slides as presentation notes so they know what to say during a talk and when to say it. They put visual elements on a slide that will remind them to explain a concept, instead of to help audience members understand a concept. They allow templates and default settings to structure a talk for them, without regard to the best narrative for their listeners.

Slides are tools to help you convey information, ideas, and emotions to your audience, not tools to save you time and effort making and delivering a presentation. If you feel you can't present without slides, you are probably using them for the wrong reason.

The proof of the dependency of some presenters on their slides occurs when a computer crashes or a projector fails and the speaker suddenly has to deliver a presentation without slides. Everyone in the audience feels bad for the speaker, instead of the other way around. If the speaker is a master of the content and has thoroughly thought through the needs of the audience, then he or she should be able to get through the presentation without slides. In fact, it should be the *presenter* who feels bad for the *audience* that they are denied a communication aid.



The slide on the left helps the speaker more than it helps the audience. All of this information can easily be conveyed orally without needing to be placed on a slide. Instead, the speaker probably intends to use the slide as personal lecture notes. In contrast, consider the immediate emotional impact of the slide on the right. With this slide the speaker can deliver the same information in a much more powerful way.

Design a Slide Presentation from an Audience's Perspective

We may not all consider ourselves experts at presenting science, but we are all expert audience members. After the hundreds, if not thousands, of slide presentations we have seen, we have many opinions about what we like and dislike in a talk. As a presenter, your goal is to consider your presentation from the point of view of your audience, providing the kinds of experiences you would want if you were attending your own talk.

What audiences want from

Presentation Design

- a scientific story with a beginning, middle, and end
- a rationale for the science
- an introduction that tells them what they need to know in order to understand the science
- clear, legible slides
- balance of data with the big picture
- information presented one piece at a time
- a chance to catch up if they lose attention
- a presentation that runs on time
- an indication of what to remember after the talk is over

What audiences want from

Presentation Delivery

- a clear, dynamic delivery
- a sense of expertise in the speaker
- interest and passion from the speaker
- a friendly, accessible speaker
- a speaker that can empathize with the general mood of the audience
- a flawless technical delivery and use of technology
- a sense of how much a talk has progressed (and how much remains)

An interesting exercise: Have you ever tried making a slide presentation in an empty lecture room? Literally sitting where your audience will sit can help you design a presentation from an audience's perspective. Try leaving your desk behind and getting a different point of view.

Know Your Audience

One of the most important factors that affects the success of a talk is a speaker's ability to connect with and understand his or her audience. Sometimes an otherwise excellent presentation fails because it doesn't conform to a particular group of people. There is no such thing as "the right talk for the wrong audience," because there is no such thing as "the wrong audience." It is *your* job to know your audience and to get your presentation right.

When designing the narrative of a slide presentation, you must consider who your audience will be and what relationship you want to establish with them.

Questions to ask about your audience

Who are they?
What do they care about? What are their interests? What do they find exciting and what is likely to bore them?

Why are they attending your talk?
Is their attendance required or voluntary? What will they be looking for in your presentation? What do they hope to receive?

What do they already know?
What background information is not necessary to present in detail because your audience is already likely to know it?

What do they need to know?
What background information is essential to present because your audience won't understand your talk without it?

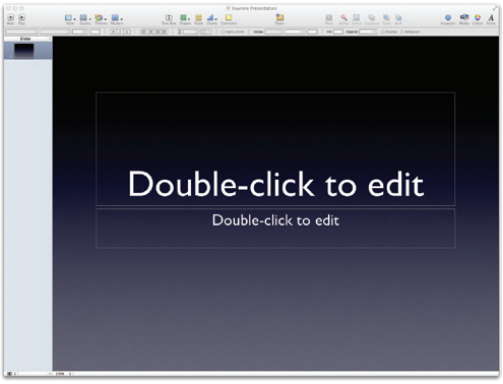
Do they hold any preconceptions or biases?
What opinions about your topic or field are they likely to have prior to the start of your talk? Why might they already object to information in your background or results?

What is their likely mood during your talk?
What time of day is your talk? Is your audience likely to be tired? Hungry? Anxious? Are they waiting for your talk to end so that they can go do something else?

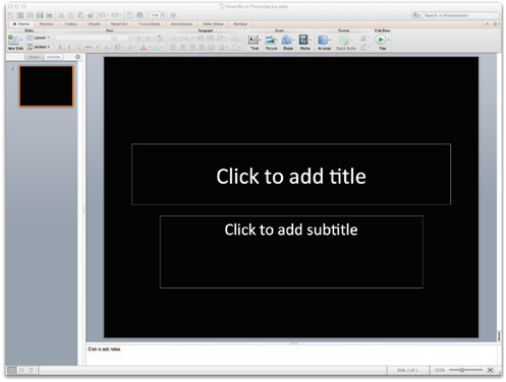
Connecting with your audience is more than just knowing who *they* are, you also have to consider who *you* are, and the roles you may play in addition to your role as speaker. Are you also a teacher? A mentor? A trainee seeking advice? Are you a salesperson, trying to convince your audience of an idea? A cheerleader, trying to raise hopes? Define your role carefully, because in order to connect with your audience you have to know the nature of your relationship.

Create Ideas, Not Slides

When using slide creation software, there is a natural tendency to focus on slides rather than on ideas. After all, when you first open these applications you see windows that look like this:



Apple Keynote user interface

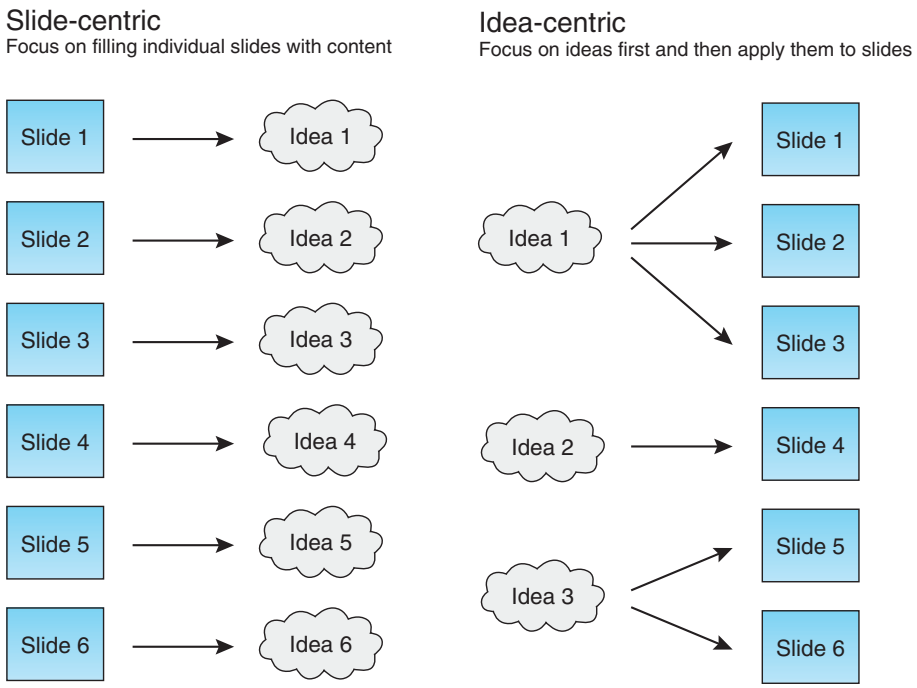


Microsoft PowerPoint user interface

Big, blank slides with long, empty slide columns almost seem to beg you to fill them up with stuff. It is easy to find yourself going from blank slide to blank slide, filling them up one at a time until eventually all of your content is represented within the slide show.

The problem with using blank slides as a starting point is that it changes your narrative style and the structure of your talk. Rather than focusing on your ideas and the best way to share them with an audience, you focus on slides as individual units, segmenting your information into bite-sized bits that may not be ideal for communication.

Instead of designing slides in a way that is slide-centric, design in a way that is idea-centric.



Before you even open a slide-making application, outline the structure of your presentation and organize the order and importance of your ideas. Concepts that you especially want to emphasize may take more than one slide to communicate.

Recommended reading: Anyone who cares about slides as a presentation tool will learn from a brief 32-page essay, *The Cognitive Style of PowerPoint: Pitching Out Corrupts Within*, by Edward Tufte, a pioneer in the field of data visualization and information design. This fascinating essay (available from any online bookseller) is critical of many of the properties and uses of slide presentations, especially in the way that slide software itself can change the way that people conceive of and deliver information.

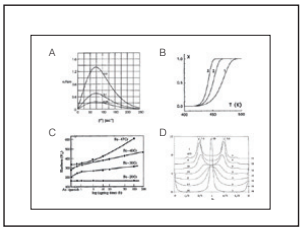
The Relationship Between Slides and Oral Delivery

During a slide presentation, audiences receive information from two different sources: your voice and your slides. When your narration and visuals complement each other, you achieve a great harmony that helps your audience understand your content. When narration and visuals contrast, your audience can become distracted and confused.

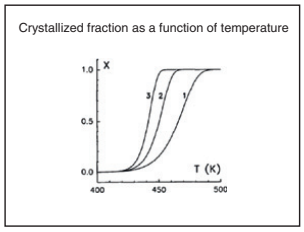
Your oral narration is what drives your presentation forward, and visual aids are always subservient to what you say. It is possible to give a talk without slides, but slides without oral delivery lack content and meaning.

Consequently, anything on a slide should be acknowledged in your oral delivery. *If you're not going to talk about it, get rid of it.*

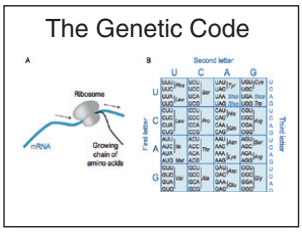
Before

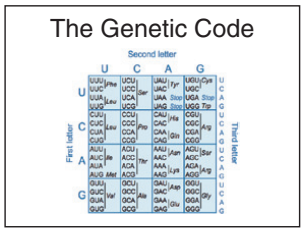


After



Only talking about Figure B? Then get rid of the other figures you aren't presenting.





Only discussing the figure on the right? Then get rid of the figure on the left.

However, everything you say doesn't need to be on a slide. Only show something on a slide if it will help your audience to understand your message.

Before

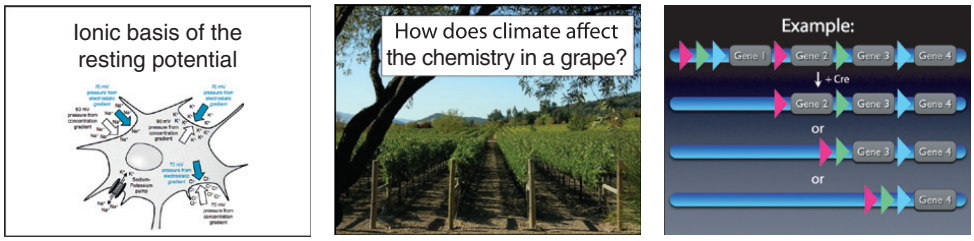
After

Just because you want to say it doesn't mean it has to be on your slide.

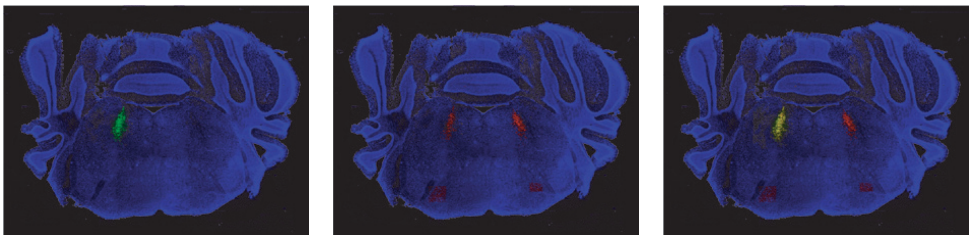
How Many Slides?

There is a common myth that you should make about one slide for every minute of a presentation. In reality, there is no formula that calculates the time your talk will take to deliver based on the number of slides in your presentation. How long you typically spend delivering slides depends on your delivery style and your content. Some excellent presenters use only 20 slides over the course of an hour-long talk and the audience is never bored. Others use hundreds of slides and the audience never feels rushed.

There is no golden rule about how many slides to use in a presentation except to know yourself and your own speaking style. The only way to truly know how long a presentation will last is to rehearse.



Depending on how the speaker presents the subject matter of these slides, each may take several minutes to explain and discuss.



These three slides, when presented in relatively rapid succession, make a point in seconds.

Exceptional Presentations Require Time and Effort

Making a mediocre slide presentation is really easy. All you have to do is wait until the day before a presentation is due, open a slide-making application, create a bunch of slides, and deliver them in front of an audience. If you're lucky, you won't have any obvious typos in your slide titles.

Designing a world-class slide presentation is hard work. Consider the amount of time you might spend:

Time estimates for designing a professional slide presentation

5–50 hours
Analyze data. Sort data in spreadsheets, perform quantitative and statistical analyses, etc.

5–20 hours
Design elegant tables, charts, diagrams, and photos. Optimize all visual elements for a slide presentation.

1–10 hours
Research relevant background information. Peruse the scientific literature to find key background papers, figures, etc. for your audience.

1–8 hours
Brainstorm and outline the narrative of the presentation. Organize your information into a scientific story and simultaneously translate your content into an oral delivery and slide presentation.

5–50 hours
Design slides. Use a presentation application to translate your ideas into a visual story.

1–5 hours
Edit slides. Proceed through your presentation, one slide at a time, optimizing visual elements, layout, and animations.

1–5 hours
Rehearse. Practice your delivery in whatever way works best for you: in front of a practice audience, by yourself, on your bike, etc.

1–2 hours
Test your slide show in a presentation room with a projector. Calibrate a laptop with projector settings and ensure that projected slides appear correctly.

Total: 20–150 hours

These time estimates assume you are creating a presentation completely from scratch. In reality, you may recycle much of one presentation for another, and some presentations are much shorter than others.

The amount of time you should dedicate to designing a presentation is proportional to the importance of the talk. Designing a presentation for a professional meeting, invited talk, job talk, thesis defense, etc. will require many hours, perhaps even a full week of work.

Even presentations that are less consequential (e.g., lab meetings, journal clubs) are important because they establish your reputation among your peers and colleagues. There is no such thing as a presentation that doesn't require time and effort.

Although it is possible to "get by" with a hastily crafted presentation, you diminish the impact you could have on your audience. Each presentation you give is a chance to showcase your content and develop your professional reputation. Make sure you dedicate enough time to prepare so that your talks aren't just adequate, but truly world class.

Summary: Don’ts and Dos

Don’t design slide presentations without routinely asking yourself how your slides are beneficial to your audience.
Do design slides deliberately to enhance communication with your audience.

Don’t become dependent on using slides to give a talk.
Do design slides purely for the benefit of your audience, and be able to speak about your science without needing your slides for assistance.

Don’t ignore what an audience needs when designing a talk.
Do ask yourself what you would want from a slide presentation if you were in the audience, and design a talk accordingly.

Don’t fail to consider the nature of your specific target audience.
Do consider who your target audience will be and what kind of relationship you want to establish with them.

Don’t be slide-centric, starting with blank slides and figuring out how to fill them with content.
Do be idea-centric, starting by first outlining your ideas and then applying them to slides.

Don’t include anything on a slide that you aren’t going to talk about.
Do use slides as a complement to what you say, only presenting visual information that supports your oral narration.

Don’t feel the need to put everything you talk about on a slide.
Do only show something on a slide if it helps emphasize a message.

Don’t make assumptions about how long your presentation will take to deliver based on how many slides you have.
Do rehearse your presentation so you know whether you adhere to time restrictions.

Don’t design a presentation at the last minute.
Do dedicate multiple hours to designing a talk that will, at the very least, influence your reputation with your audience.

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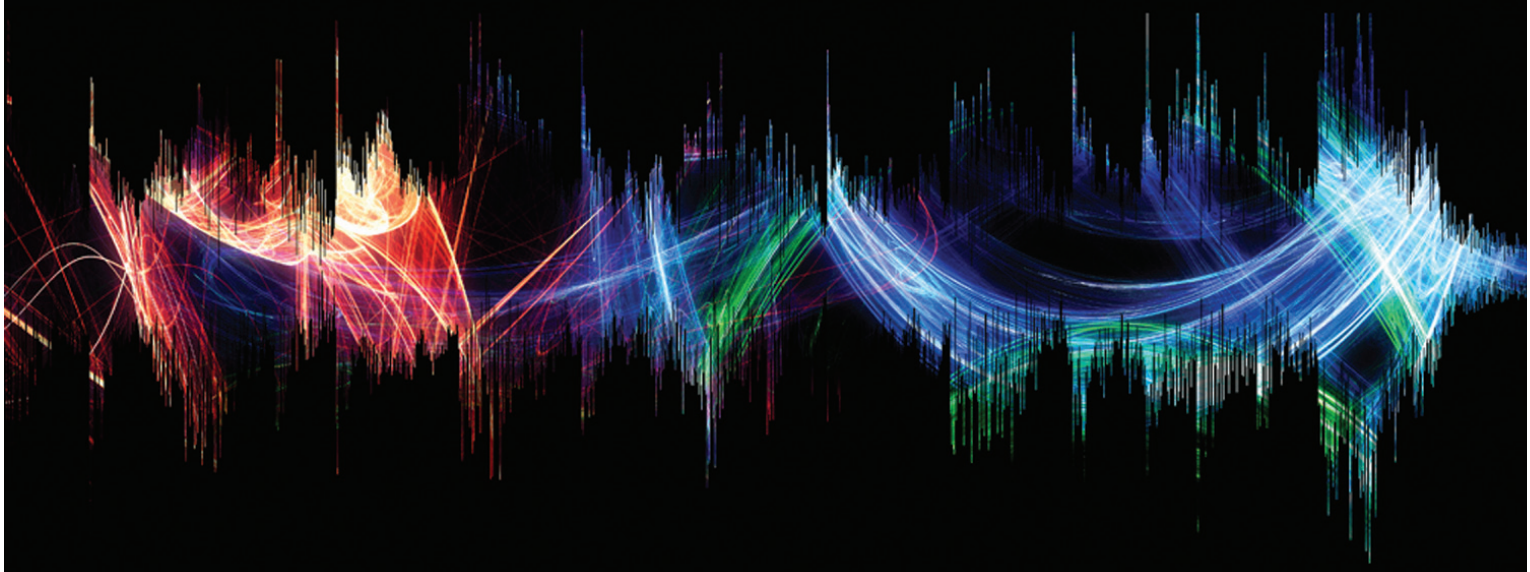
The Structure of a Slide Presentation

When most people think about designing a slide presentation, they focus on their content and what their slides will look like. Just as important, if not more so, is the *structure* of a presentation—the organization of ideas and concepts into a larger scientific story. Scientists that design well-structured talks not only communicate information better; they also create experiences for their audiences that increase attention, comprehension, and impact.



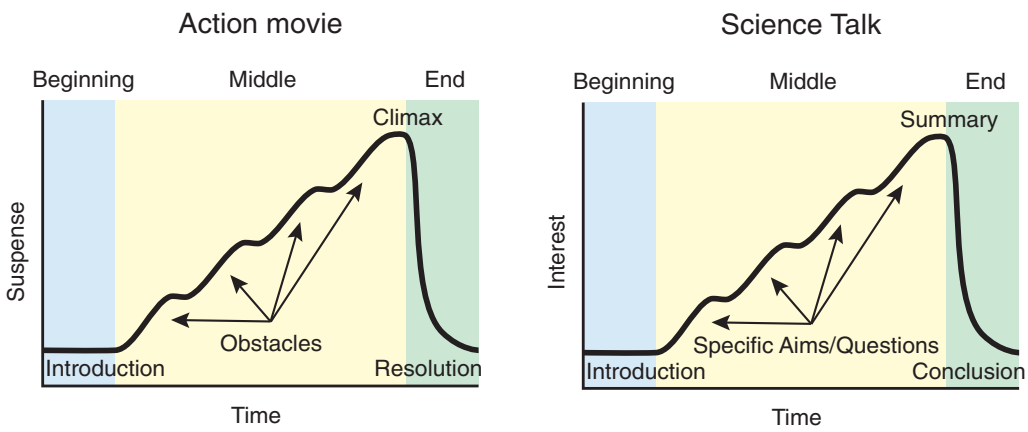
Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00016-7

A Good Scientific Talk Is a Good Scientific Story

A common problem with many science presentations is a narrow focus on experiments and data. While data and ideas are obviously the meat of any science talk, audiences can become uninterested and even confused if they have not been adequately prepared to interpret the data in a larger scientific context.

Audiences don't just want to see data, they want to hear a complete scientific story with a beginning, middle, and end. The beginning conveys a rationale, a sense of importance, and a clear goal. The middle contains the experiments, results, and conclusions. The end places your results in a larger scientific context and looks to the future.

In this respect, science presentations have a surprising amount in common with action movies. Nobody wants to see a thriller composed entirely of action scenes. Instead, movie audiences like a good beginning that introduces characters, conflict, and a sense of purpose. They also want a good ending that provides a resolution, a conclusion, and a hint of a bright future to come. Likewise, a good scientific talk is really a good scientific story. Take a lesson from your favorite movies and place your actions within a larger scientific context.



A typical plot diagram for a thriller is similar to a the narrative structure of a scientific presentation. Just as a protagonist overcomes obstacles through a series of action scenes, a scientist pursues scientific objectives through a series of experiments.

Set the Tone of Your Talk with a Title Slide

Your scientific story begins before you even begin speaking.

Title slides are more than just token beginnings to a slide show. They introduce details about yourself and set a tone for the rest of your presentation to follow. Because title slides are displayed as an audience enters a room, you can use these slides to communicate information without costing you time during the actual talk. Consider that your title slide will probably be the slide that your audience looks at for the longest amount of time.

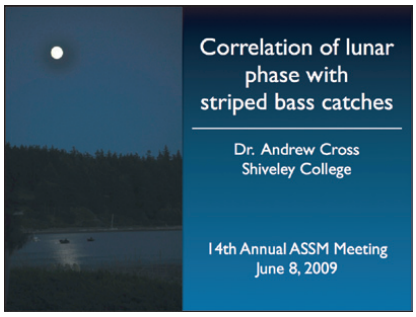
A good title slide contains:

A good title. A good slide show title informs the audience of what to expect from the talk.

Your name and affiliation. (This isn't necessary for internal talks in which everyone already knows you.)

The date and function of the talk. Writing the date and function will convey that you designed the talk specifically for *this* audience and *this* venue.

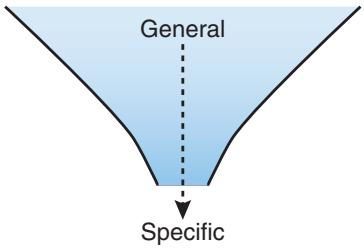
A picture or diagram that sets the tone. Including a picture or diagram will psychologically prepare your audience for the subject matter of your talk before you even say a word.



Start a Talk by Progressing from General Questions to Specific Goals

It is jarring for an audience when a speaker begins with highly detailed, specific information. Even people who are familiar with your work or research topic want to be gradually led from a broad question or problem to a specific scientific goal.

To attract the interest of everyone in your audience, always start a presentation with a statement or question that anyone from any discipline should be able to understand. Gradually focus your introduction toward your specific topic and research goal, defining specific terminology and concepts that people might not understand.



A good science talk starts with a general question and becomes progressively more and more specific until the speaker asks a unique scientific question.

General
Specific

How is the Earth's climate affected by global warming?

As the earth warms, some regions demonstrate anomalous cooling.

Is the decrease in Arctic sea ice in autumn linked to increases Northern Hemisphere snow in the winter?

General
Specific

What are the molecular mechanisms behind the aging process?

In sexual animals that don't self-replicate, telomere shortening correlates with cell senescence.

Is telomere maintenance different in sexual animals and asexual animals that do self-replicate?

General
Specific

How do chemicals cycle through the environment?

Isotopes of iodine play significant environmental roles.

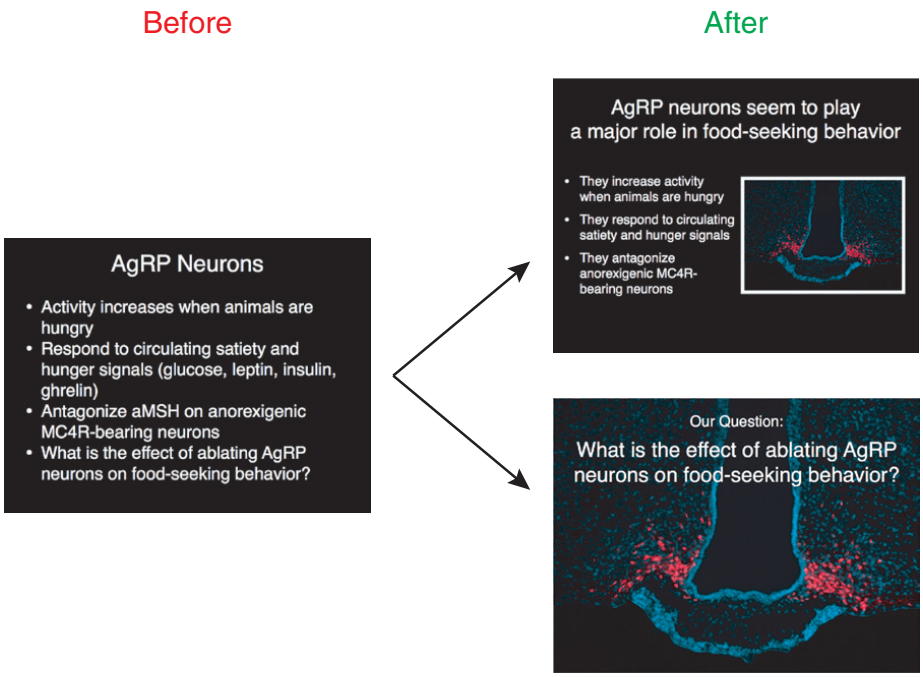
How does ^{131}I cycle throughout terrestrial ecosystems?

Clearly State Your Scientific Goal and Why It Is Worth Pursuing

Audiences want to know the answers to two important questions before learning about any specific experiments or results: what are you doing, and why are you doing it? In other words, what is your ultimate scientific goal, and why is reaching that goal important?

When speakers do not clearly articulate a question or goal that drives their research, their data and results lack context: the audience may understand specific experiments, but not how the results fit into the bigger picture. When speakers do not explain a rationale for their experiments, their results don't seem interesting: the audience may understand what the speaker did, but not why they should care.

Before presenting any data, clearly state and emphasize your overarching scientific goal and why reaching that goal is interesting. If you don't state your goal in the beginning, your audience won't know if you reached it at the end. And if you don't state your rationale in the beginning, your audience won't *care* if you reached it at the end.

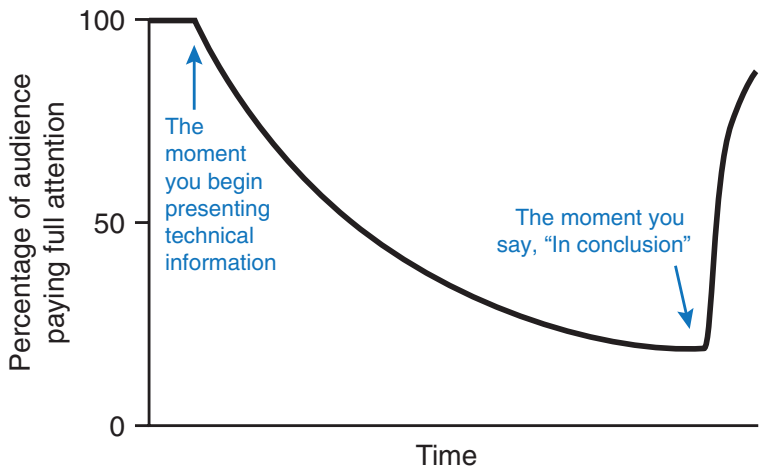


In the slide on the left, the major question that drives the entire research study is buried at the bottom of a text-heavy slide. Any audience member who is not paying full attention may miss that it was even mentioned. A better way to emphasize the research question is to separate it from the background information and place it on its own slide. Adding an attractive photograph or diagram increases audience attention so that everyone clearly understands the research question throughout the rest of the talk.

Prepare for Inevitable Shifts in Attention

Audiences rarely focus their complete attention on a science presentation throughout the entire talk. They may start out actively listening to what you say, but they inevitably become distracted and lose attention as your talk becomes more detailed. These distractions are natural—we are all human, and full concentration is difficult to maintain, especially for presentations that last an hour or more. Even the best presenters occasionally lose parts of their audience.

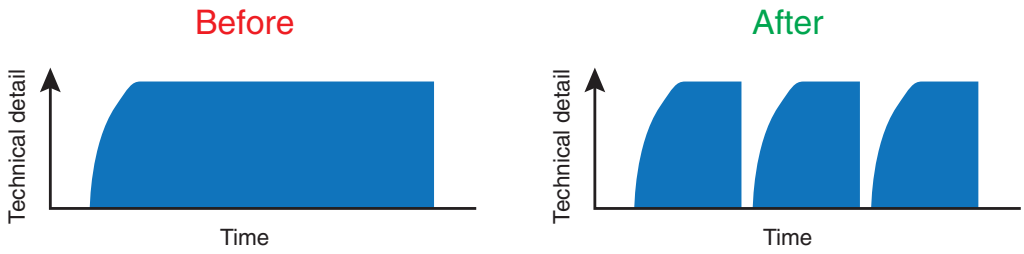
One of your goals in structuring a scientific talk is to prepare for the inevitable periods during which your audience is likely to become distracted.



Predict the moments during which people are likely to break concentration and deliberately structure your presentation so that you employ methods, described on the following pages, of maintaining and regaining their attention.

Organize the Presentation of Data into Individual Segments

After delivering background information to their audiences, most scientists usually present detailed scientific information (experiments, methods, results) in one long continuous section until they reach the end of their talk. During these long stretches of technical detail, audiences often become unfocused and gradually stop paying attention. In presentations that last longer than 10–15 minutes, scientists (even hard-core scientists) need mental breaks. Instead of presenting data all at once, organize your information into more manageable segments.



After each segment of data, give your audience a brief break—not a literal pause in your talk, but a pause in the presentation of detailed information. During this pause you can:

- Summarize what you just covered
- Ask if there are any questions
- Connect the details of your data with the larger scientific story
- Provide interesting examples/applications of what you just covered
- Tell a relevant anecdote or humorous story
- Show a video clip likely to recapture audience attention

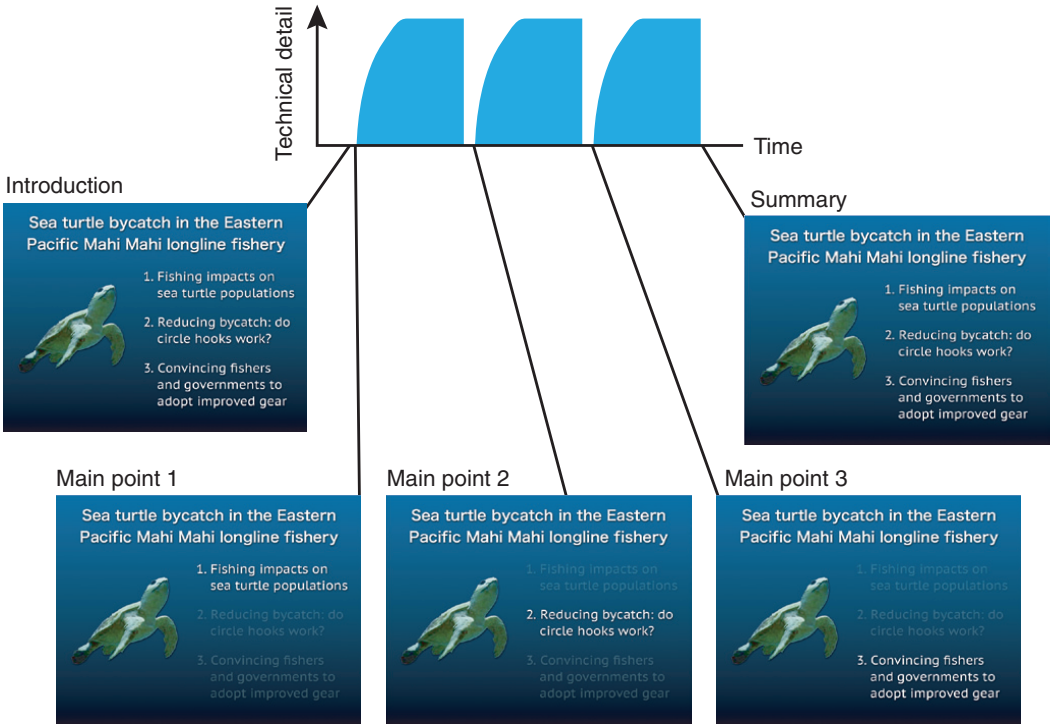
By providing these pauses in data, you not only allow your audience to firmly plant their feet on the ground after a stretch of detailed information, you also balance the details with the big picture, integrating the results of experiments with your overall scientific story.

Unite Sections of a Talk Using a "Home Slide"

When dividing a presentation into manageable segments, it can be helpful to your audience to provide an outline that follows the structure of your talk and tracks your progress throughout. This outline can be provided in the form of a home slide—a slide you return to throughout your talk to unite different segments into a cohesive whole.

A good home slide contains an outline of the different sections of your talk with a picture or unifying diagram that represents the big picture. Show this slide before you present your first segment of data and at the end of every section until the conclusion of your talk, using it to transition between sections and help increase audience attention and understanding. You can even return to your home slide at the end of your presentation to summarize all of the information you covered.

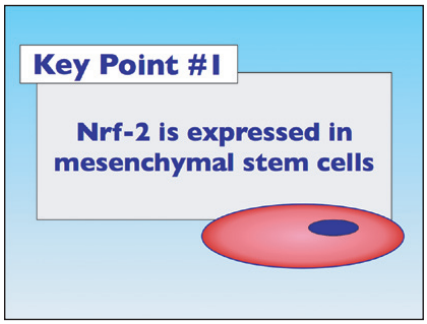
When does a home slide become too repetitive? A good rule of thumb is to show this slide no more than once every few minutes. For an hour-long talk, you might divide your data into two to four segments and use a home slide three to five times. While using this slide over and over may seem repetitive to you, your audience will appreciate the obvious exposition of structure.

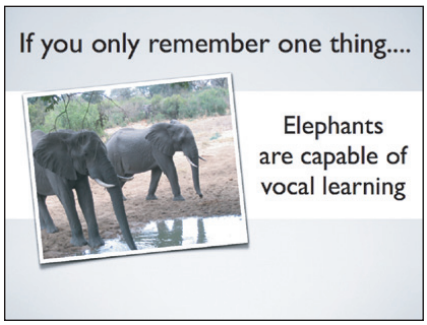


Deliberately Emphasize One to Three Take-Home Messages

Hours after a presentation ends, most audience members will forget all but a few details of your talk. While certain experiments or results may be especially interesting or important to you, your audience will probably blend all the details together into a single, general memory. Months after your talk, they may not even remember what your presentation was about.

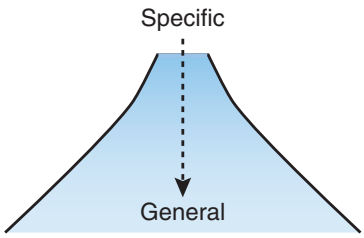
If you want your audience to remember one to three key aspects of your talk, deliberately highlight these items when they are most salient. Telling your audience what is important to you will make those items resonate long after your talk is over.





End a Talk by Transitioning from Specific Details to a Broader Scientific Context

Just as you begin a talk by transitioning from general ideas into your specific scientific story, end a presentation by transitioning from your experiments and results to broader conclusions and a larger scientific impact. Ending on a general note will remind your audience why your research interests you and why they should care.



A good science talk ends by progressing from specific conclusions to more and more general statements, placing results in a broader context.

Specific
General

We showed how ATP binding triggers activation of a P2X receptor.

This mechanism explains many experimental findings and provides insight for the future design of antagonists.

Our methods can be universally applied to other ion channels involved in various physiological processes.

Specific
General

We determined the three-dimensional structure of the IRES subdomain IIa in complex with a benzimidazole translation inhibitor.

Our findings will be a valuable starting point for structure-based designs of HCV inhibitors.

Such drugs may lead to the development of anti-HCV drugs for infected individuals worldwide.

Specific
General

We showed that hatchery pink salmon were larger and grew faster than wild pink salmon during the first summer at sea.

Differences in growth rate may indicate variable growing conditions or food consumption.

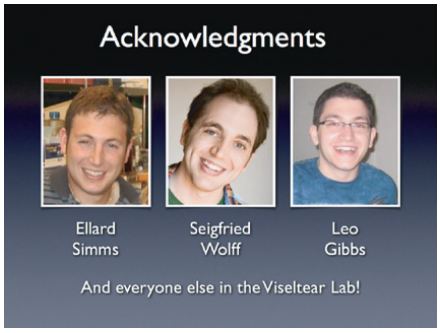
Evidence of competition could indicate that carrying capacity has been reached for the ecosystem.

Acknowledgments

Scientists often conclude their presentations with a slide that acknowledges the contributions of others. It is always important and considerate to acknowledge the people, organizations, and funders who helped make your science and presentation possible. However, consider that an acknowledgments slide typically doesn't hold much value for the audience. In fact, when a speaker displays an acknowledgments slide, most audience members immediately stop paying attention. This is not the way to end your presentation on a high note. Definitely acknowledge your colleagues, but try not to spend too long presenting long lists of names (which most people in your audience probably won't recognize).

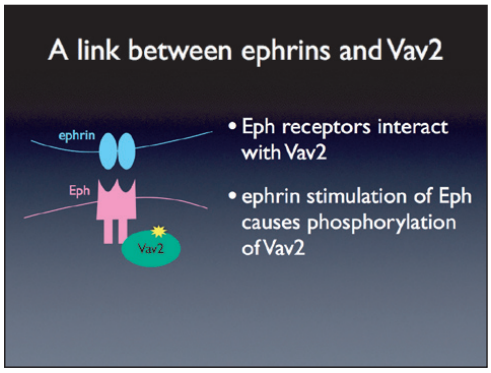
Tips for acknowledging your coworkers:

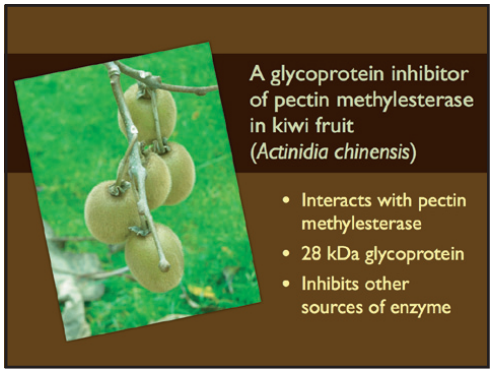
- Try not to spend more than 20–30 seconds on an acknowledgments slide.
- Display a photograph of your lab, the key individuals who contributed to your work, or the city/institution where you are located (photographs are more entertaining to look at than names).
- Don't read through long lists of names that most people probably won't recognize. Highlight a few key individuals, but don't read the names of everyone in your lab.
- Instead of acknowledging everyone at the end of your talk, acknowledge key individuals throughout your presentation, when appropriate.

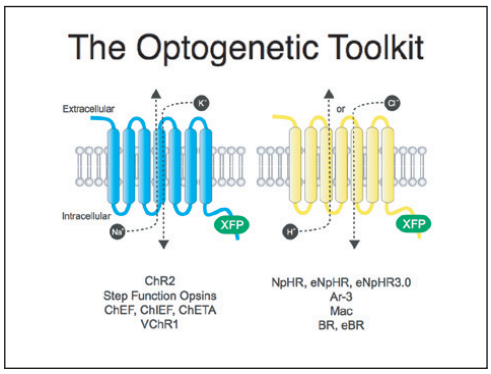


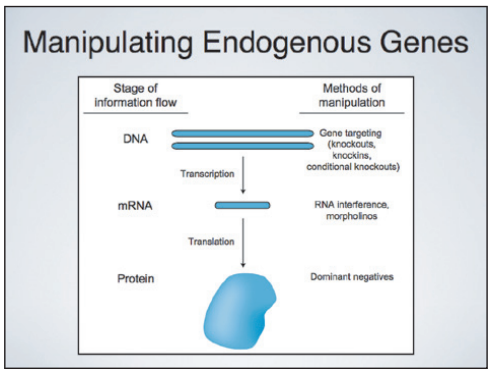
Answer Questions While Showing a Summary Diagram

Most talks typically end with a brief question-and-answer period. During this time, presenters usually either exit their slide shows or continue to display their acknowledgments slides. Consider a third option: while answering questions, display a slide that contains a simple summary of your talk. This slide can be your home slide, or perhaps an optimized version that displays the overall conclusion of your experiments. Showing a summary diagram at the end will help make your talk more memorable and also help your audience ask good questions because all the relevant information will be in front of them.





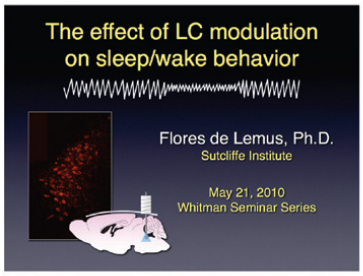




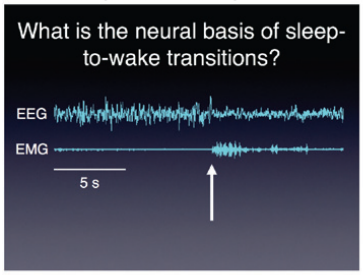
Outline of a Structured Scientific Talk

Here is an example of the structure you might use for a scientific talk. Each of the slides below could represent one or several slides that you create for an actual presentation. Don't let this outline make you think that a structured talk has to seem typical or routine. Remember that, just like the steps in a dance routine, structure provides the foundation for expression, innovation, and creativity.

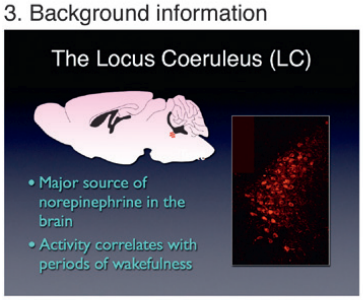
1. Title slide



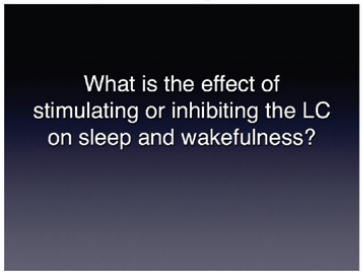
2. Broad question or topic



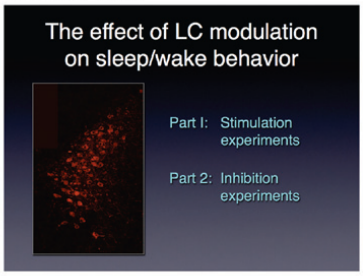
3. Background information



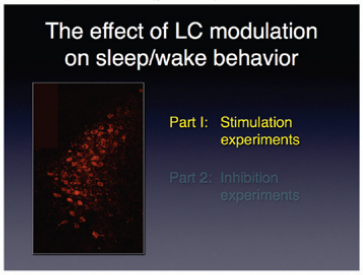
4. Main question or goal



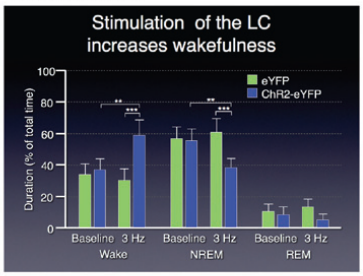
5. Home slide



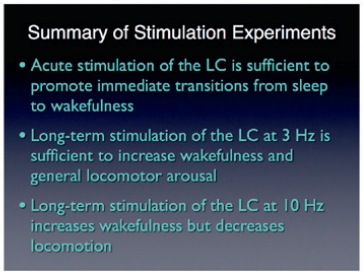
6. Home slide (part 1)



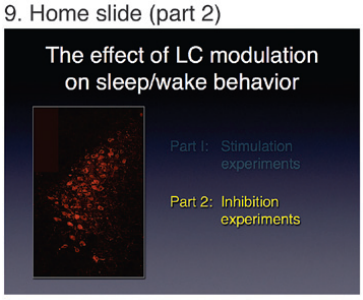
7. Data slides



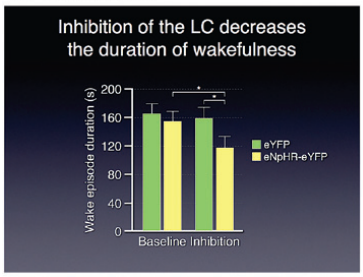
8. Summary of part 1



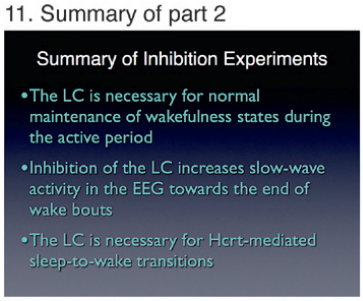
9. Home slide (part 2)



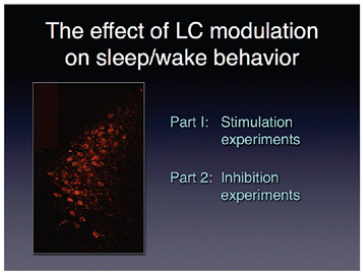
10. Data slides



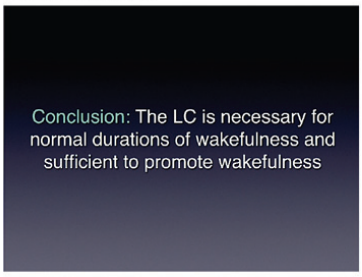
11. Summary of part 2



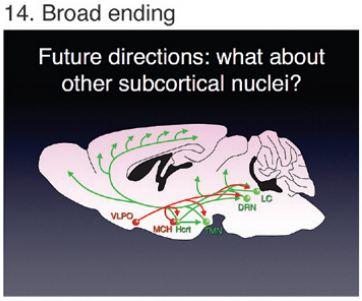
12. Home slide



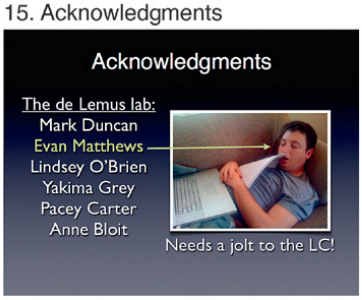
13. Conclusion



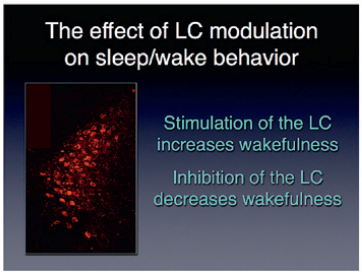
14. Broad ending



15. Acknowledgments



16. Question-and-answer



Summary: Don’ts and Dos

Don’t focus a talk exclusively on experiments and data.
Do tell a complete scientific story, with a beginning, middle, and end.

Don’t discount the value of a title slide.
Do use a title slide to set the tone of your presentation as your audience enters the venue.

Don’t start a talk with information that is too detailed or specific.
Do start a talk with general interests and questions and gradually transition to your specific content.

Don’t present any experiments or data without first clearly stating your scientific goal and why it is worth pursuing.
Do clearly articulate your goal and its importance early in your talk.

Don’t be ignorant of the fact that your audience is likely to become distracted throughout your talk.
Do help your audience by occasionally employing tactics to regain their attention.

Don’t present one long stretch of experimental data in the middle of your talk.
Do divide your talk into more manageable segments to let your audience take mental breaks.

Don’t divide a presentation into segments without using a home slide to unite your talk.
Do use a home slide throughout longer talks to provide your audience with a sense of structure.

Don’t expect your audience to remember important details of your talk on their own.
Do deliberately inform your audience the one to three points that are most important to you.

Don’t end a talk abruptly once you finish presenting your data.
Do transition from specific details to a broader scientific context.

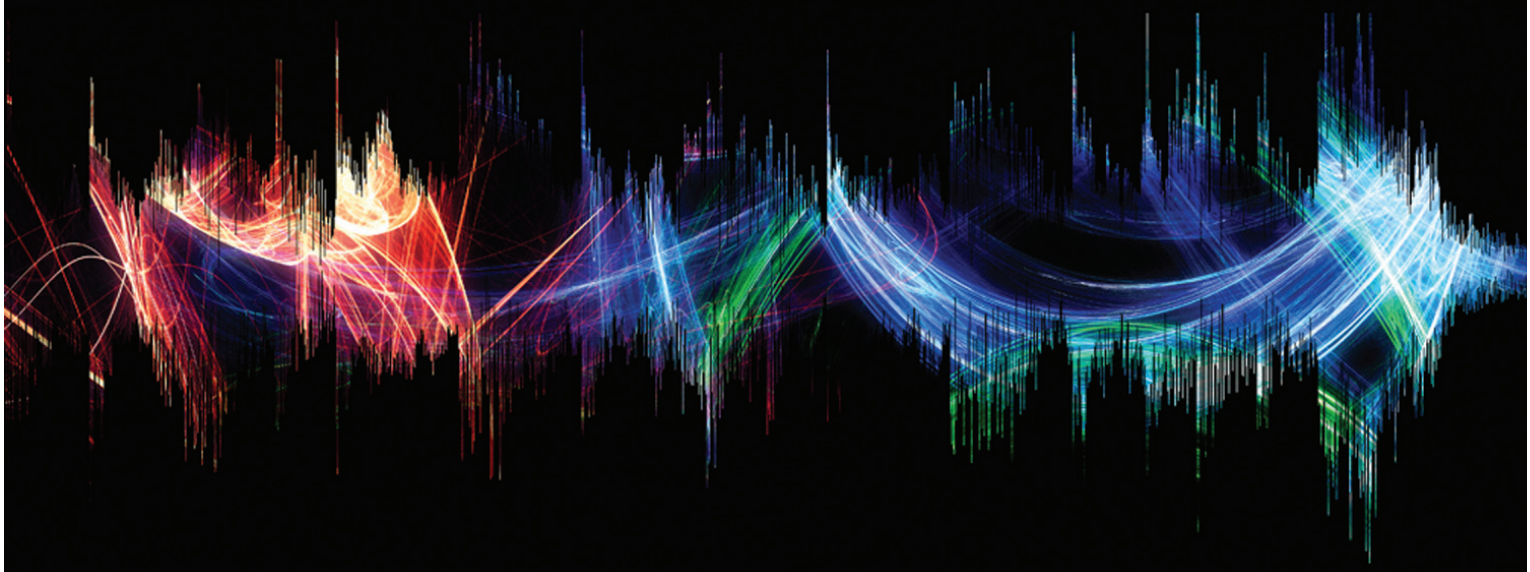
Don’t dwell on an acknowledgments section.
Do acknowledge key people gracefully but swiftly.

Don’t answer questions to a blank screen or an acknowledgments slide.
Do create a summary slide to help your audience during a question-and-answer session.

17

Visual Elements in Slide Presentations

Compared to a document or poster, the usable surface area of a presentation slide is relatively small. In a single slide you only have room to display a handful of visual elements: a background, a title, one or two figures, and some minimal text. Because the number of visual elements that can and should be used per slide is low, the design choices you make about each are highly important to the tone of your presentation and the clarity of your message.



Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00017-9

Visual Elements on Slides

There aren't many ingredients that make up a typical slide:

Background

Color

Century Gothic

Comic Sans

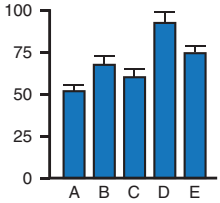
Helvetica

Myriad Pro

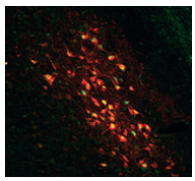
Text

	X	Y	Z
A	15.4	12.3	11.1
B	14.8	15.8	19.9
C	10.4	10.6	14.7
D	10.9	41.2	14.1
E	14.2	16.3	12.1

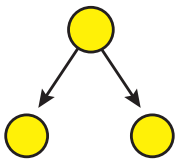
Tables



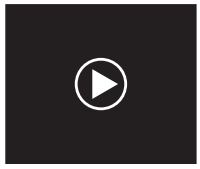
Charts



Photographs



Shapes and diagrams



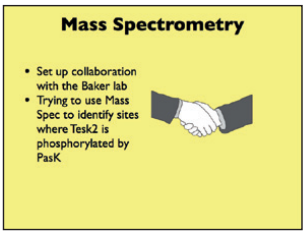
Video

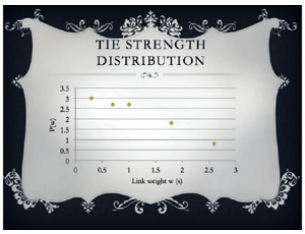
Because there are only a modest number of elements that constitute a slide, the selection and decisions you make about each can greatly affect the message and tone of your presentation.

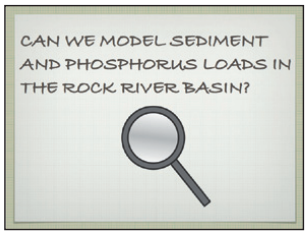
Optimizing visual elements for slides is kind of like choosing the best ingredients for a simple recipe: because you only use a few items, the quality of those ingredients has a tremendous impact on the final result. The more you use design principles to optimize visual elements, the better you communicate your slides, and the better you communicate information and emotion to an audience.

Add Design Instead of Decoration

When creating a presentation from scratch, the sight of a blank, new slide can sometimes cause us to fall into the trap of decorating rather than designing. We have a natural tendency to want to fill the slide with "stuff," adding visual elements so that the slide doesn't appear empty. Additionally, when we see a slide that seems too simple, we have an urge to add style, color, ornamentation, and special effects.



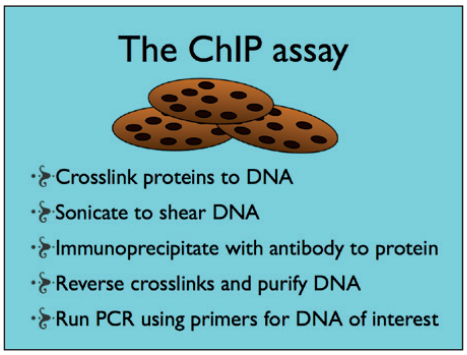




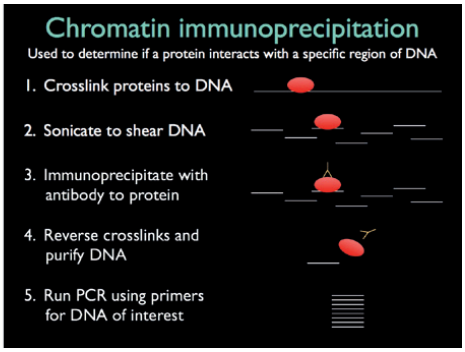
The problem with this way of thinking is that it ignores the entire purpose of creating a slide in the first place: to help communicate a message to an audience.

Instead of adding decoration to a slide, add design. Decoration may help fill a slide, but designing a slide to communicate with your audience adds meaning, value, and utility.

Before



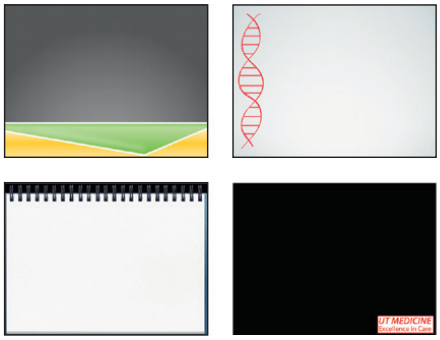
After



Backgrounds

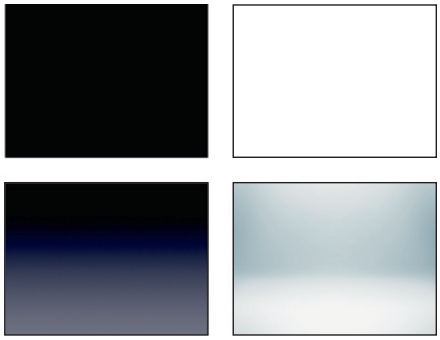
The best backgrounds are just that: backgrounds that, by themselves, lack visual content.

Before



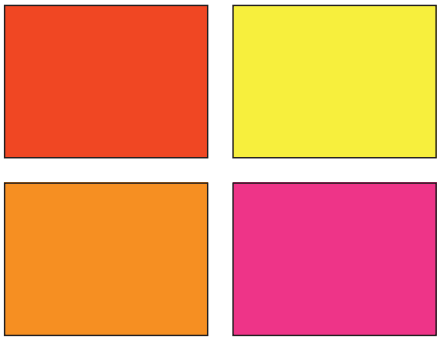
Slides with busy backgrounds reduce the amount of space you have for your own visual elements.

After



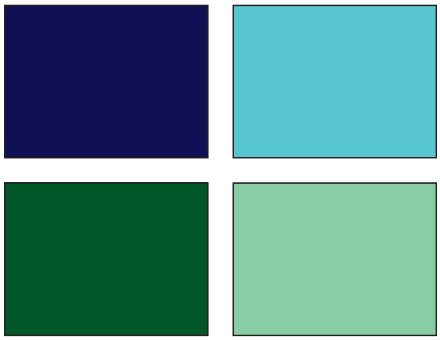
Slides with clear backgrounds allow you to fill the entire space with your own content.

Before



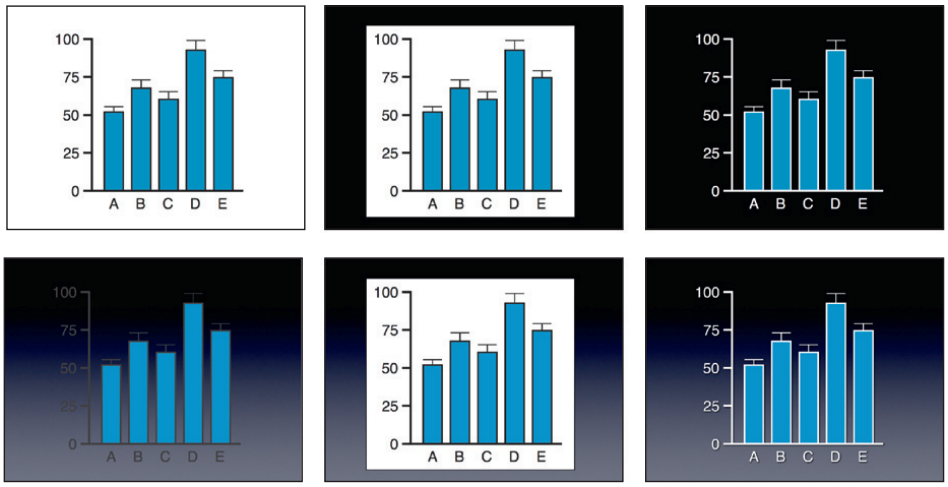
Backgrounds composed of warm, bright colors can be too intense on the eye.

After



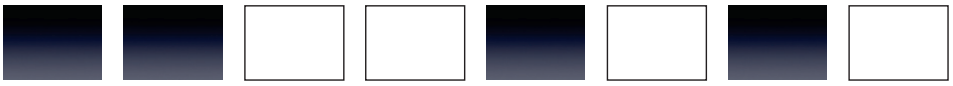
Backgrounds composed of cool tints or shades are comfortable to look at for long time periods.

When choosing a background, consider how your charts and photographs will appear when placed in the foreground.



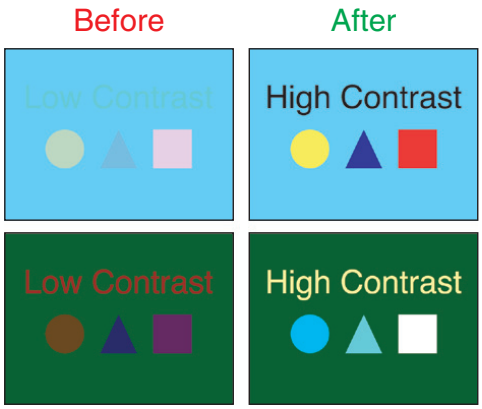
The same chart as depicted on backgrounds of black, white, and shades of gray. In some slides, a white square is placed beneath the chart so that it stands out more from the background; however, this white square introduces a non-essential visual element to the scene. In other slides, the line colors on the chart are inverted from black to white.

Whatever background you choose, be consistent throughout your presentation. Jumping back and forth between different backgrounds is distracting and hard on the eyes.

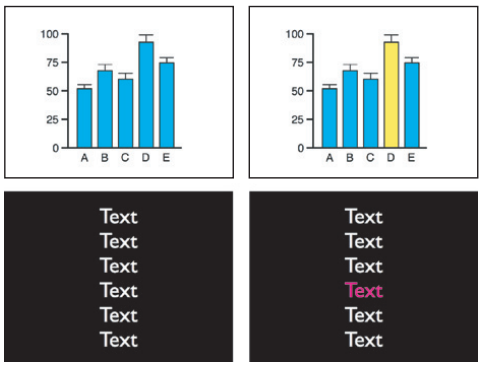


Color Considerations for Slides

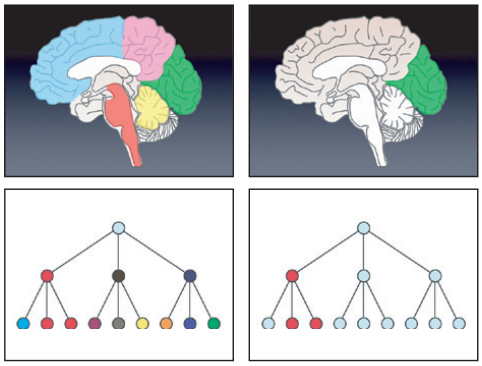
Color was discussed in Chapter 4. Remember that color should always be used judiciously, either to emphasize a message or to set a tone.



Ensure there is high contrast between your foreground and background colors.



Use color to emphasize important information.

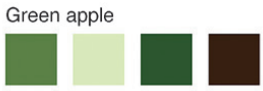


Use color sparingly so the audience knows what to look at.

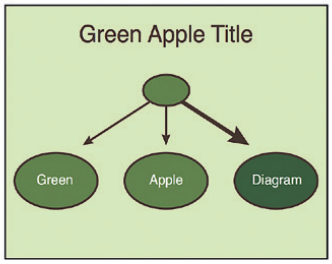
Assemble a Unifying Tone Using a Color Palette

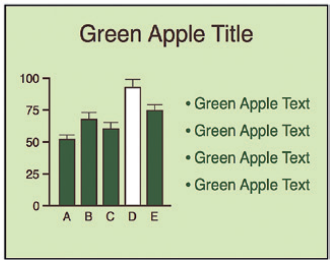
Depending on the occasion of your talk, you often have the freedom to use a greater combination of colors than you would for a more formal written or poster presentation. Different color combinations (called "color palettes") can set a unifying tone for your presentation while affecting the atmosphere and mood of your talk. There are hundreds of color palettes embedded in many software applications (such as Photoshop and Illustrator), as well as thousands online. To find great color palettes on the Internet, simply type "color palette" into your favorite search engine.

You can also design your own color palettes from one of your own photographs or a photo you find online. When choosing colors for your palette, identify a range of colors from light to dark so that you can create optimal foreground/background combinations. Whichever color palette you choose, make sure you are consistent across your presentation to unify your talk and create a stable tone.



The photograph on the left was used to produce this custom-made color palette. The slides could have been made on a dark background with light green foreground, but here they are presented with the lightest color of the palette as the background. This color scheme is used consistently throughout the entire presentation.





Fonts Must Be Legible

Fonts and typography were discussed in Chapter 5. The most important consideration when choosing fonts is legibility.

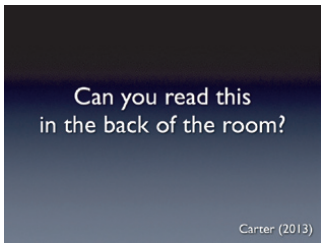
Choose a sans serif font instead of a serif font. Sans serif fonts are easier to read across a room.

Calibri
Century Gothic
Gill Sans
Helvetica
Myriad Pro
Tahoma
Verdana

Don't use overly complex fonts.

Brush Script is hard to read
Lucida Handwriting is too
Don't even think about Edwardian Script

The font size should be large enough to be seen in the back of the presentation room. This is typically at least 20–36 pts, depending on the font. It is okay to use a relatively smaller font size for citations and footnotes, which can be placed in an inconspicuous location on the bottom of the slide. However, these references should still be legible in the back row.

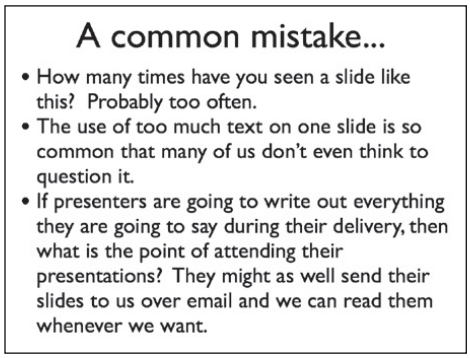


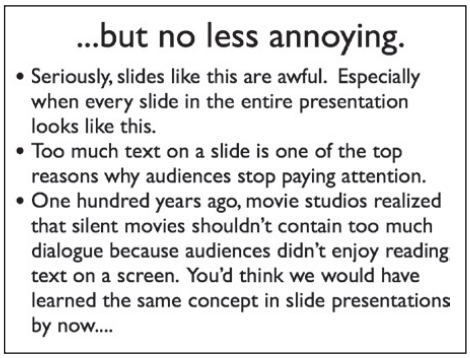
On a slide, it is harder to read underlined words or words in ALL CAPS

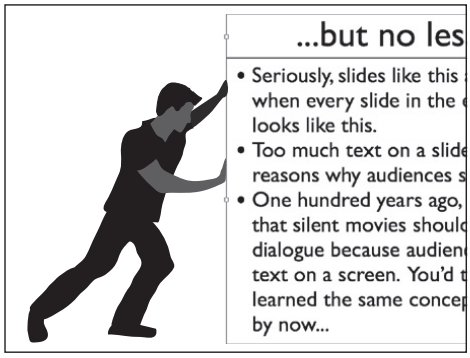
If you want to emphasize a word, use **bold letters** or *italics*

Keep Text to a Minimum

Probably the most common design problem in most slide presentations is too much text on one slide. If you find yourself filling up an entire slide with text, realize that you are not really creating a slide—you are creating a document.





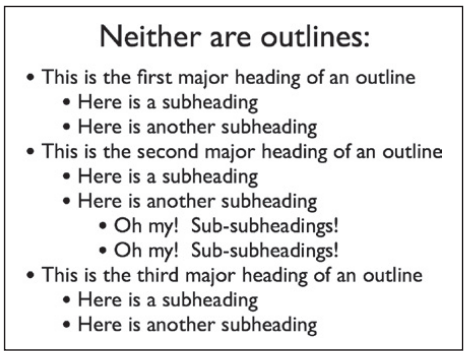


Try to limit yourself to only two lines of text for any single title, bullet point, or statement on a slide. And limit the total amount of text to only about one-fourth the total area of the slide…one-half when you are in extreme need.

Minimize the Use of Lists and Outlines

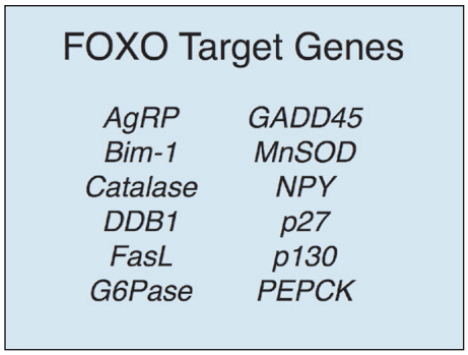
Scientists have many reasons to use lists in presentations: to present a set of facts, to describe the results of multiple published studies, to write steps in a process or procedure, to show all the outcomes of an experiment, etc. Outlines are a special category of lists with headings and subheadings (and sometimes sub-subheadings) that organize and sort information into logical groups.

The problem with lists and outlines on slides is that they are boring to look at.

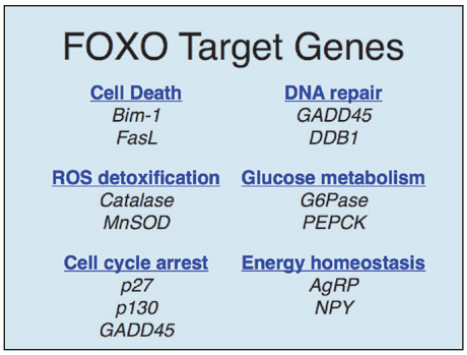


Try your best to minimize the use of lists in slide presentations, and try not to use outlines altogether. Instead of listing multiple facts or background studies on the same slide, consider breaking them up into several slides. Instead of presenting multiple items in one long list, consider splitting them up into different categories.

Before



After

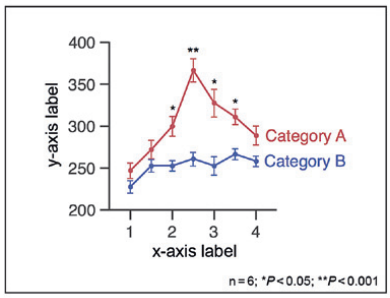


Try to limit the number of items in a list to four or five. If you need to present more than five items, try splitting a single list into different categories.

Use Slide Titles to Make a Point

Most people place titles on the top of their slides because slide creation applications seem to insist upon it. From a designer's point of view, we must think about the purpose of a slide title. Instead of making a title, make a point. Emphasize the message contained in your slide with brief text that conveys an unmistakable conclusion.

Before



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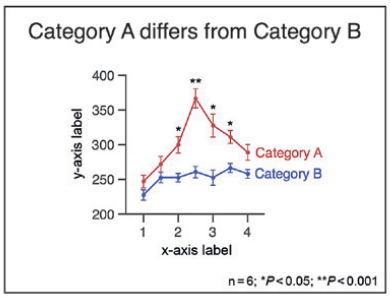
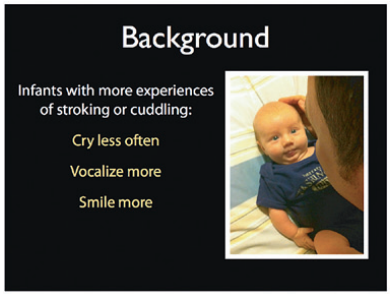
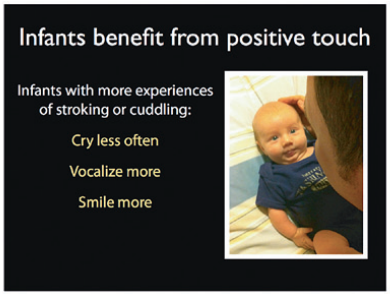


Use a title to make a point, such as when presenting results, background information, ideas, etc.





Don't use generic words or phrases like "Background," "Results," or "Conclusion." Instead, try to be specific about the larger point you want to emphasize.

Don't use a title when the contents of a slide are obvious and you don't need to emphasize a point.

Optimize Tables and Charts for Slides

A usual practice among scientists concerning figures with data is to optimize tables and charts for written presentations and then re-use these figures in slides. However, slides are a different medium than documents and have different needs.

Before

Too much data for the audience to perceive at once

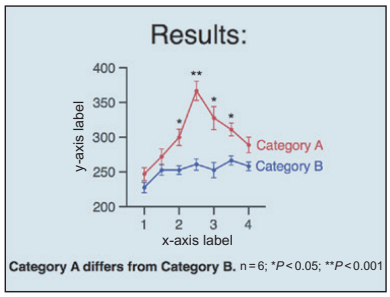
Name	Data	Data	Data	Data
Item A	2.3	1.9	8.7	9.0
Item B	4.0	7.2	9.1	5.5
Item C	0.4	0.8	5.2	0.6
Item D	8.0	9.4	1.0	4.2
Item E	6.3	3.5	8.0	6.0
Item F	0.5	1.7	3.8	0.9
Item G	7.0	1.4	9.2	8.7
Item H	1.6	0.3	8.1	9.7
Item I	4.7	9.2	3.5	0.6
Item J	9.1	4.8	3.2	1.2
Item K	7.1	4.2	3.3	5.4
Item L	8.0	2.8	4.7	9.3

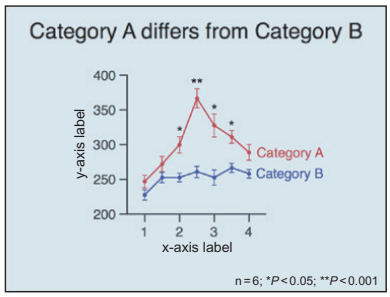
After

Appropriate amount of data for an audience to comprehend

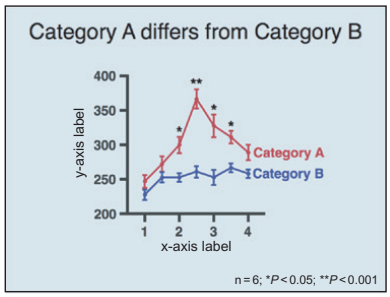
Name	Data	Data	Data	Data
Item A	2.3	1.9	8.7	9.0
Item B	4.0	7.2	9.1	5.5
Item C	0.4	0.8	5.2	0.6

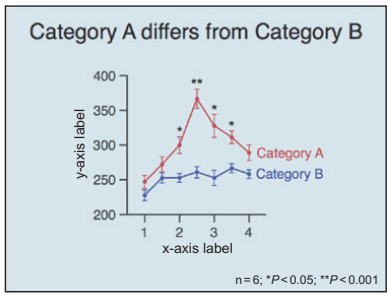
Only include data in tables that you will actively show or discuss. Adding gridlines to tables in slide presentations is helpful for audiences who must examine data from a distance.



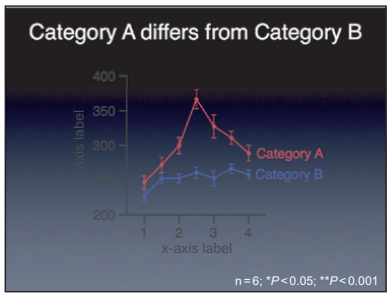


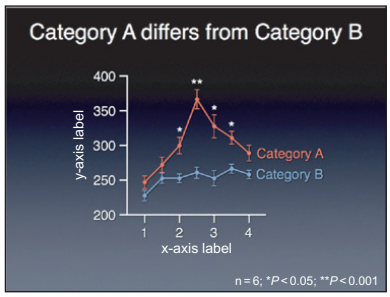
Place titles of tables and charts at the top of a slide and footnotes at the bottom. The best title of a data slide is the result of the experiment, not simply the word "Results."





Sometimes when importing figures from other software programs into a slide presentation, the default line weights are too thick. Optimize the weights of lines that make up gridlines and axes in tables and charts.



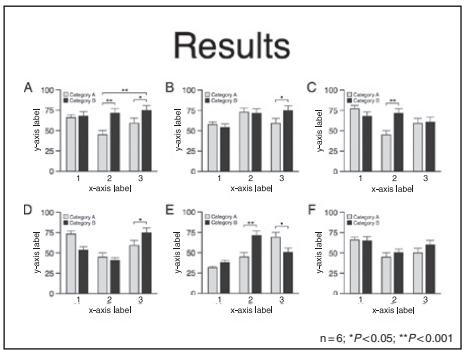


Optimize figures depending on your background. Coordinate color schemes, and change the colors of text, lines, and shapes accordingly.

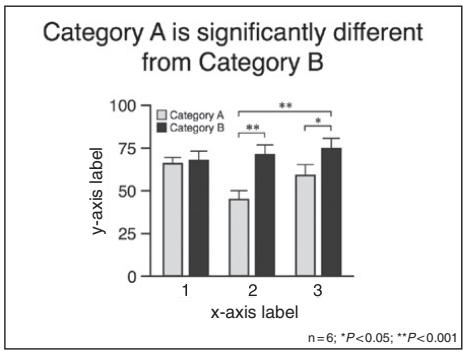
Try to Only Present One Table or Chart per Slide

Audiences can only reflect meaningfully on one piece of information at a time. Therefore, try only to show one chart or figure per slide unless you have a good reason not to do so.

Before

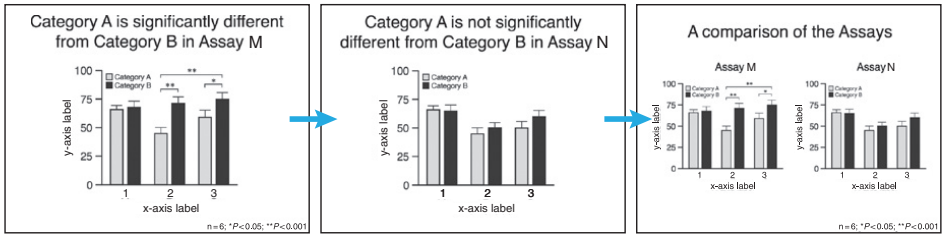


After



Many presenters intend to discuss only one figure at a time, but nevertheless display multiple figures on the same slide, addressing each sequentially. The problem with this strategy is that (1) each chart is much smaller than it needs to be, and (2) audiences always break their focus and look at whatever figure catches their eye, no matter which figure the speaker presents. There is no reason to distract an audience with visual elements that aren't currently being discussed.

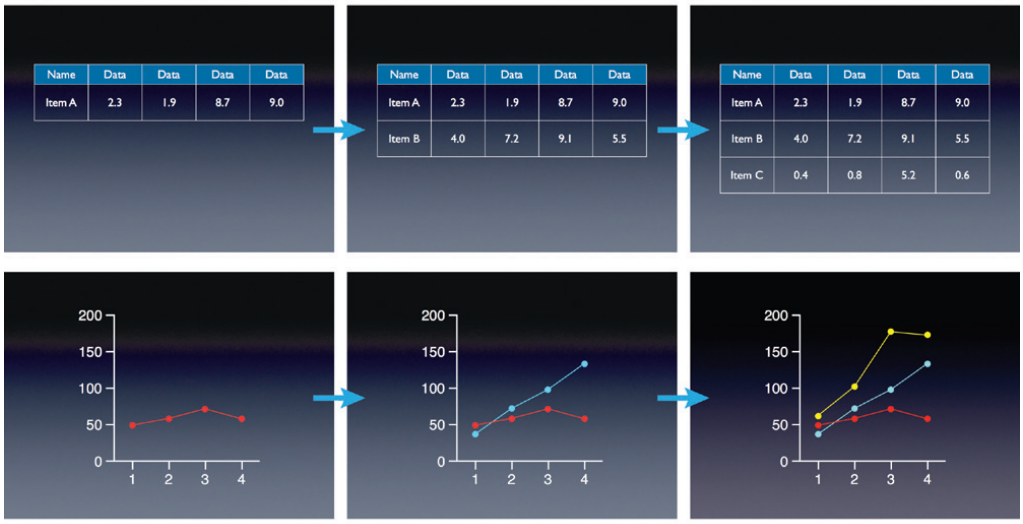
If you want to present two or more figures side-by-side for comparison or discussion, consider presenting them individually at first and then grouping them together afterwards.



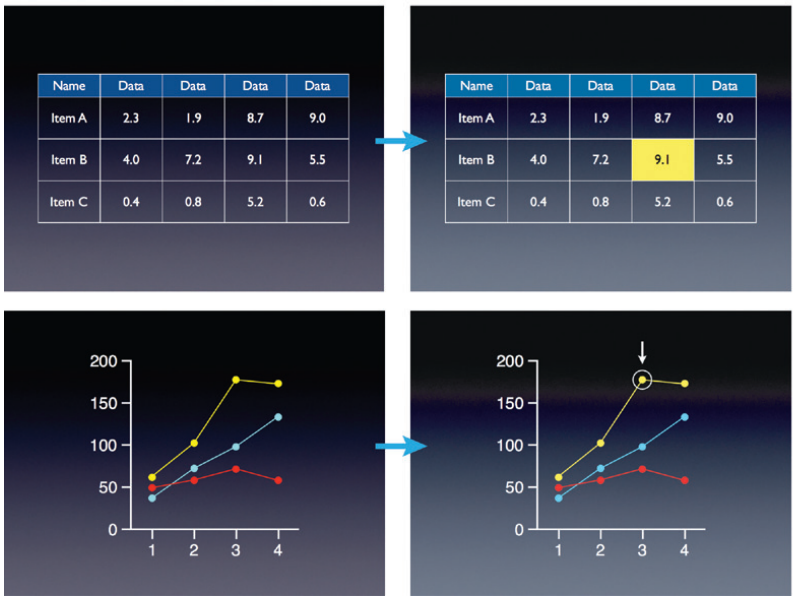
Animate Information in Tables and Charts for Maximum Impact

One of the advantages of slide presentations compared with any other science presentation format is your ability to emphasize information in tables and charts using simple animation techniques. Doing so allows you to highlight specific datasets or even specific data points at a time of your choosing.

Animate the entrance of data to emphasize each category, one at a time.



Animate with color and shapes to highlight individual data points.



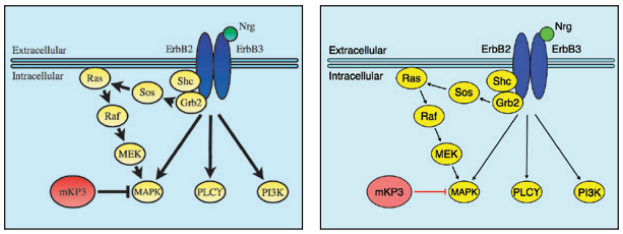
Diagrams in Slides

Diagrams were discussed in Chapter 9, and all guidelines mentioned there are certainly applicable to the use of diagrams in slides. In contrast with research articles and poster presentations, you can use as many explanatory diagrams as you would like in a slide presentation. Because they are so helpful to audiences, use them whenever they convey information better than words or photographs alone.

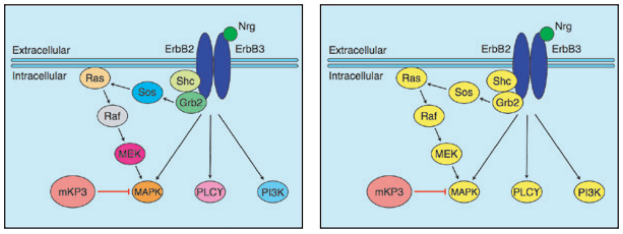
Diagrams are relatively easy to create in slide creation applications because of how simple it is to draw shapes, lines, and arrows. In fact, many scientists create their diagrams in PowerPoint or Keynote and then export them for use in written or poster presentations.

Before After

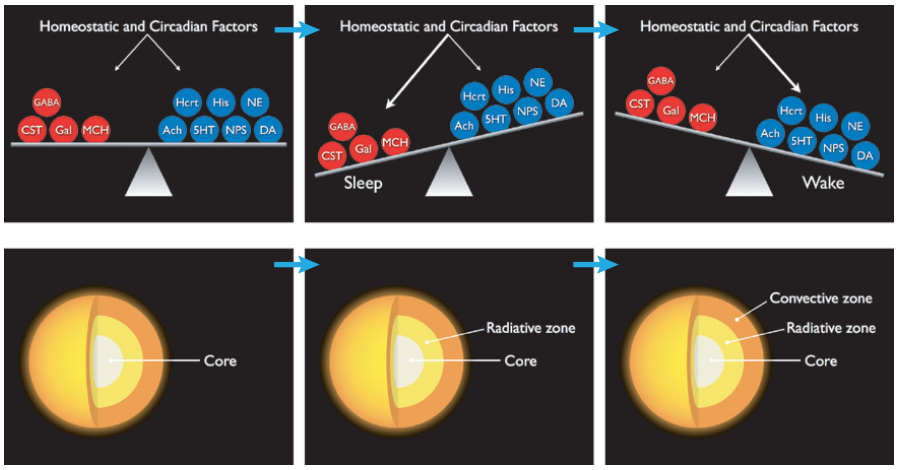
Pay attention to default settings such as the fonts, colors, and thickness of lines. Deliberately adjust each until your diagram is optimal.



Avoid the temptation to fill each item with a different color. Use color minimally, only to emphasize the most important aspect of your diagram (which in this case is "mKP3").



As with tables and charts, another major advantage of slide presentations is the ability to animate diagrams to enhance communication with an audience.



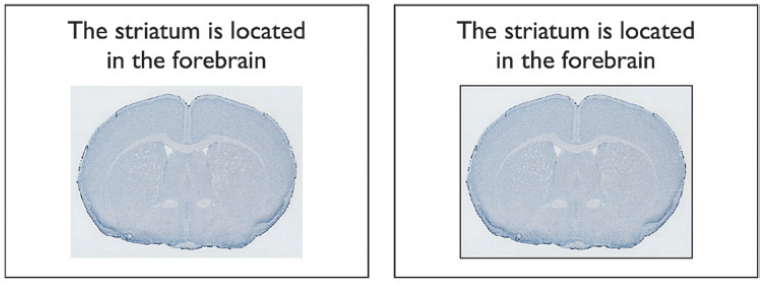
Photographs in Slides

Photographs were described in Chapter 10. Because slide presentations are not as formal or space-limited as written or poster presentations, they are an ideal opportunity to use photographs, both to show data and to enhance atmosphere and tone.

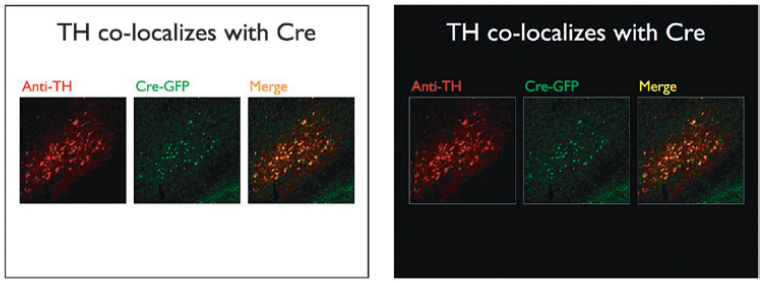
Before | After

If the photograph is of a high enough resolution, consider enlarging the photo to fill the entire slide to increase the impact.

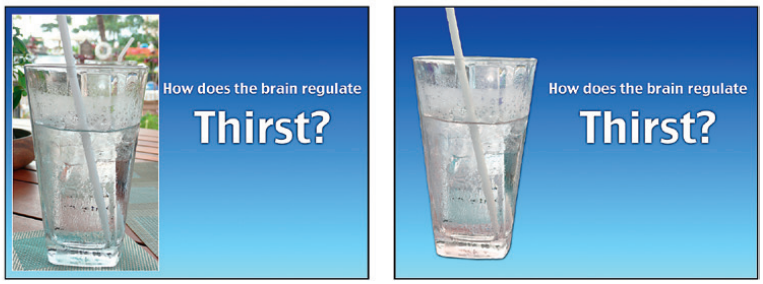
If a photograph does not fill the entire slide, place it within a minimal frame so that it stands out from the background.



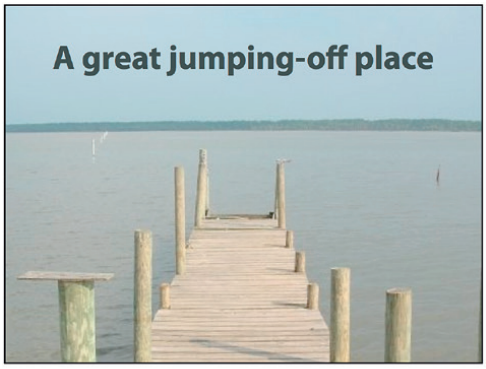
When presenting fluorescent images, use a dark background so that the fluorescent signal is the brightest aspect of the visual scene.

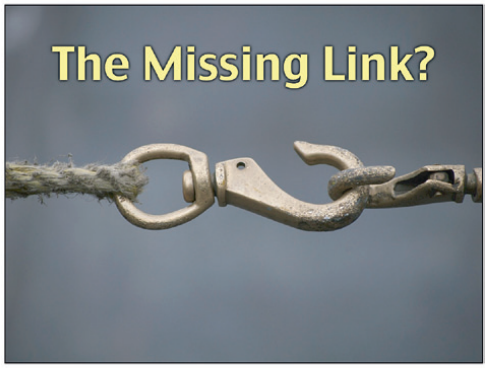


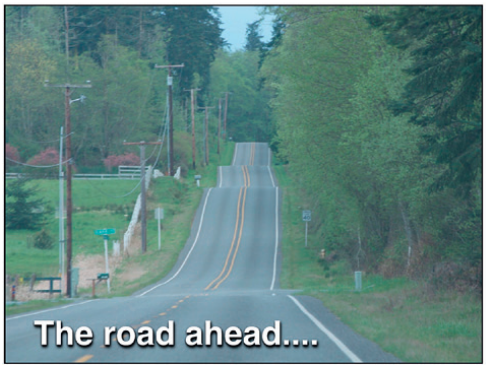
If possible, extract objects from their photographic backgrounds so that they blend in better with your slide background.



When appropriate, use a striking photograph to instantly convey an emotional tone. Make sure that the photograph fits in with the overall style and theme of your presentation.







Video: The Ultimate Presentation Tool

Videos are one of the best tools you can add to a slide presentation. Not only do they dramatically show data or ideas in way that static images or words alone cannot, they also function as something like an "audience reset button," immediately increasing attention and enthusiasm in anyone who may have lost focus. The moment a speaker says, "Let me play you a quick movie…," every single audience member immediately looks attentively at the screen. It's like magic.

However, only show videos when they help communicate your data or ideas to your audience:

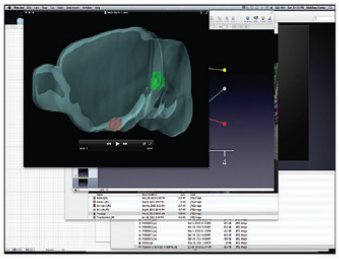
- Show dramatic changes that occur over time, such as an animated map of the United States that shows obesity trends over the past 50 years.
- Show the rotation of a three-dimensional object so your audience has a better perspective—for example, a three-dimensional rotation of the anatomy of an organ.
- Show a case study, such as a brief movie of a patient who suffers from a specific disease that you address in your presentation.
- Show a single trial of an experiment.
- Show a clip from a popular TV show or movie that helps illustrate a point—for example, a relevant news clip or joke from a late night program that addresses your research topic.

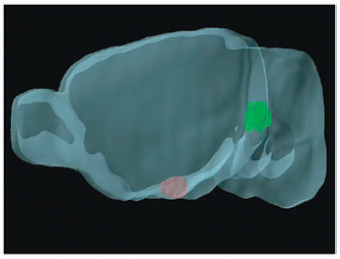
Add a video when relevant to your presentation, but also consider adding a quick clip during moments when you think your audience may need a break (see Chapter 16 about particularly good moments). Using a video can simultaneously communicate information, increase attention, and provide the audience with a mental break after a long stretch of data.

Key Tip: You can find many great movies to add to your science presentations by searching video sites like YouTube or Google Video; however, many of the best scientific movies can be found as supplementary videos in scientific papers. To find these movies, type the subject of your search plus the words "supplementary movie" into your favorite Internet search engine. For example, if looking for movies about octopus behavior, type "octopus supplementary movie" into a search engine. You'll be surprised how many great movies you can find this way.

Before | After

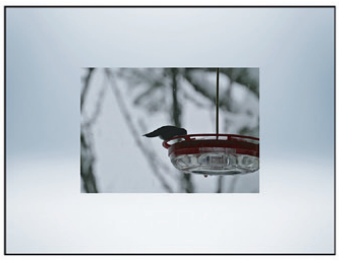
Embed a movie within your presentation. It is distracting when a presenter leaves a slide show to play a separate file. You can find free, downloadable software that allows you to save YouTube videos as files that you can embed in your presentations.



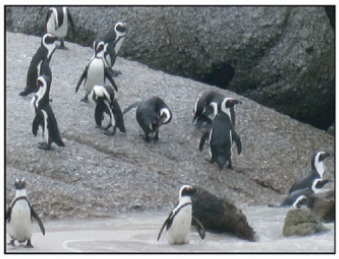


If the resolution is good enough, enlarge the video so it fills the entire screen.

If your video doesn't fill the entire screen, make sure it stands out from the background. Consider framing it within a box or other graphic.



Add animation on top of a video to help show your audience what is important.



Use a movie in a title slide to create an atmosphere and immediately engage your audience as they enter the room. Loop your video so that it plays continuously until you advance to the next slide. In this example, the stunning video of rush hour in Vietnam communicates a powerful tone.

Summary: Don’ts and Dos

Don’t fill a slide with meaningless decoration.
Do add design.

Don’t choose a background that is distracting to look at.
Do choose a neutral background that emphasizes the visual elements in the foreground.

Don’t choose colors randomly to decorate.
Do choose colors judiciously and use a consistent color palette.

Don’t choose a serif or fancy font that is hard to read.
Do choose a sans serif font in a size that is legible in the back of the presentation room.

Don’t use too much text in a slide or include long lists or outlines.
Do minimize text as much as possible and reduce lists to four or five items.

Don’t add meaningless slide titles that don’t convey information.
Do add titles to make a point.

Don’t reuse tables and charts without optimizing them for a slide presentation.
Do minimize the amount of data in tables and coordinate figures with your backgrounds and color schemes.

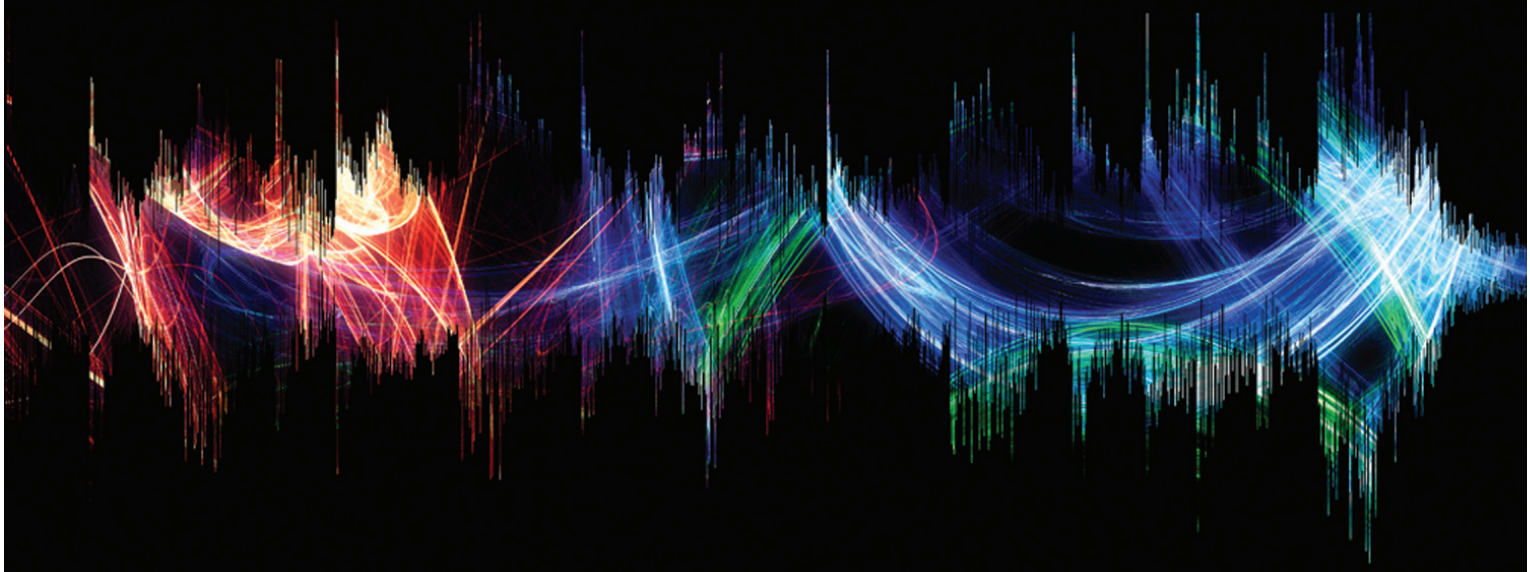
Don’t present more than one table or chart per slide.
Do only present one piece of information at a time and consider animating datasets for maximum impact.

Don’t add photographs or videos to slides without making decisions about sizing and framing.
Do optimize the impact of photographs and videos by enlarging them or making them stand out from the background.

18

Slide Layout

When designing the layout of a scientific poster or arranging the figures for a written presentation, you have flexibility in how you arrange visual information but are also confined by the traditional structure of these formats. In contrast, when designing a slide presentation you have virtually total freedom to arrange visual elements however you want. Slide layout has a tremendous impact on your ability to communicate ideas with your audience. Poor layout can obscure the meaning of visual elements, even elements that, by themselves, are well designed. However, a good layout helps to convey the meaning and importance of information, making the impact of a slide much more than the sum of its parts.



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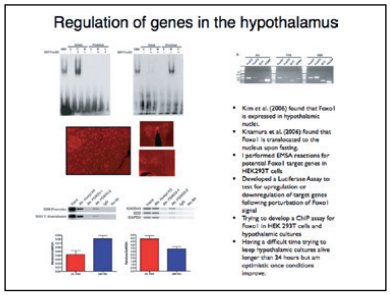
The Importance of Slide Layout

Designing a slide is not only about optimizing individual visual elements. Perhaps even more important, one must deliberately arrange these elements in a logical way to help the audience perceive and process information.

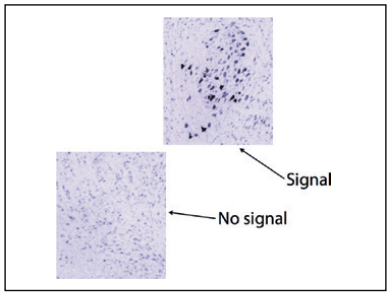
Arranging visual elements on a slide is much more consequential than simply making a slide "look nice." Slide layout is about adding meaning to your content, controlling the flow of information to your audience, and emphasizing what is most important.

When a scientist creates a slide without designing an optimal layout, the meaning of visual elements can become obscured, and the slides themselves can seem overwhelming, random, and yes, even ugly.

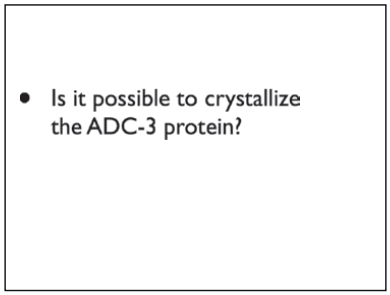
Slides that could use a good layout tune-up:



Too busy and overwhelming



Too random and chaotic



Too sparse and asymmetric (and a terrible use of a bullet!)

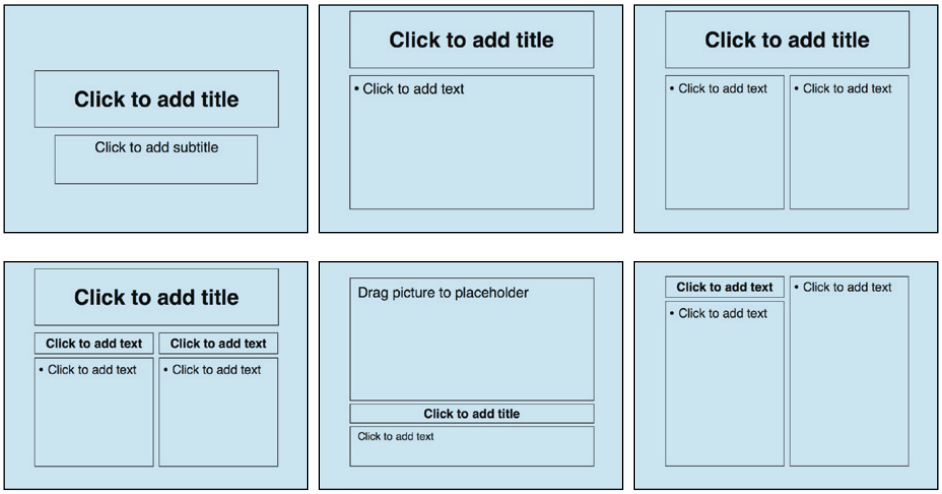
Avoid Universal Slide Templates

All slide creation applications come with about a dozen templates—master slides with a prearranged layout that users can fill with their own content. These master slides can be useful for anyone new to creating slide shows because they quickly teach users how to add and arrange content on a slide.

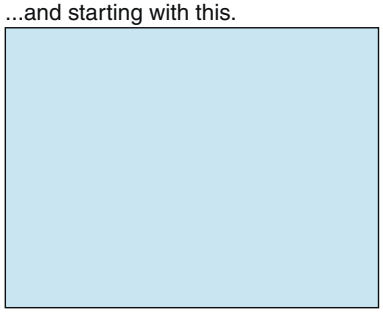
The problem with templates is that they are not specific to your own content. The software engineers who created these templates deliberately designed them to be universal and applicable to any kind of visual information. Although these templates may present your content adequately, they are certainly not designed to communicate specific messages optimally.

This is *your* presentation. Instead of using templates, start with a blank canvas and intentionally arrange your content in the way that best communicates your message.

Consider ditching these...



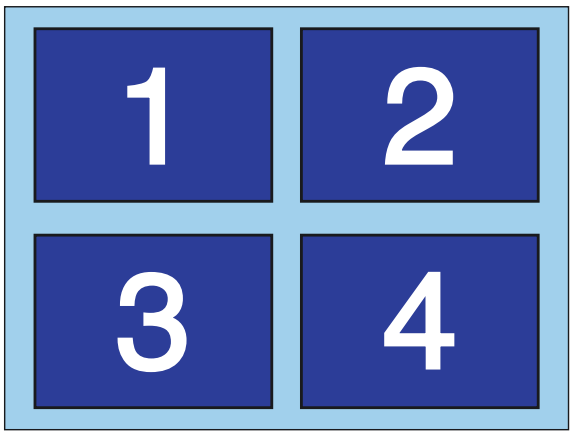
...and starting with this.



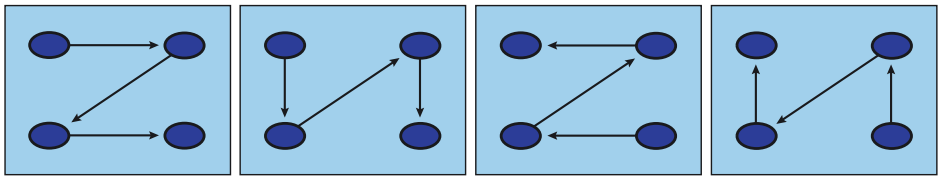
A blank slide may be intimidating to start out with, but your end result will be deliberate and intentional.

Design a Natural Flow of Information

Each time you advance to a new slide in your presentation, your audience immediately begins scanning the slide for information. Help them intuitively know what to examine first by organizing visual content in a logical way.

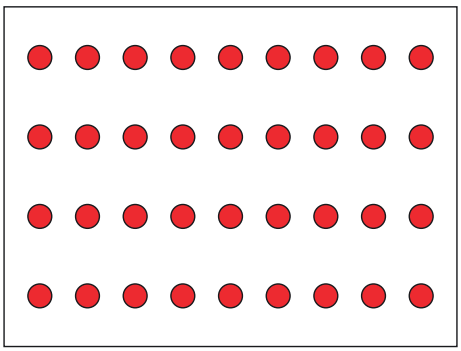


When people view a slide for the first time, they have a natural tendency to read the slide as they would read a book: in Western cultures, we start by gazing from top left to top right and finish by gazing from bottom left to bottom right. Therefore, to provide your audience with a flow of information that seems natural and intuitive, try laying out your content in accordance with this "book reading" paradigm.

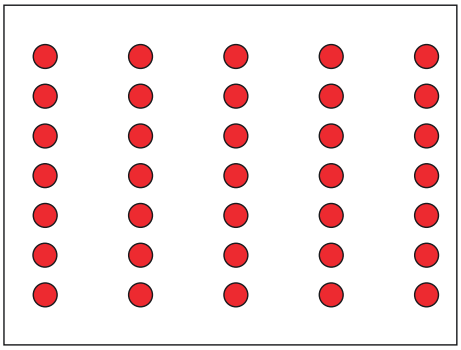


Best layout ····· Worst layout

Without thinking about it, audiences should know immediately whether information is grouped in rows or in columns.

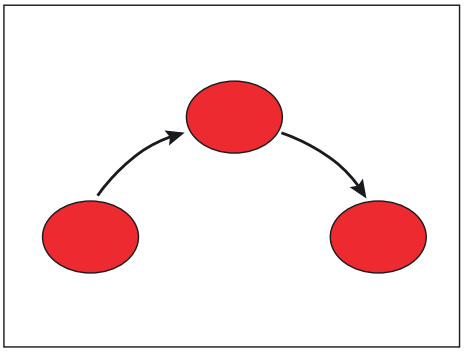


Audiences will process information grouped into rows by reading each row left to right and descending top to bottom.

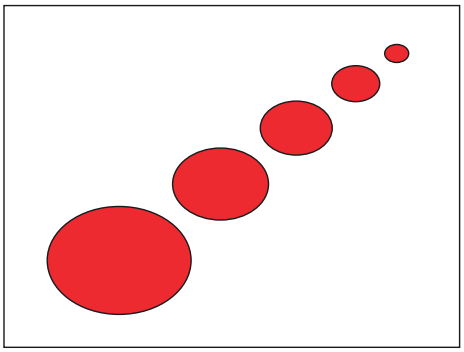


Audiences will process information grouped into columns by reading each column top to bottom and proceeding left to right.

If it is necessary to organize the flow of visual information in a way that is different from a natural reading style, guide the audience with arrows or by varying the size of visual elements.



Arrows immediately convey the proper flow of information to an audience. Even if you use arrows, try to organize information from left to right or top to bottom to create a natural reading experience.

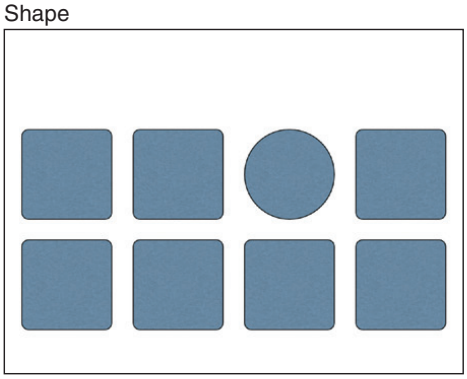


In the absence of arrows or other visual cues, audiences tend to perceive bigger objects as the foreground and will scan visual elements biggest to smallest.

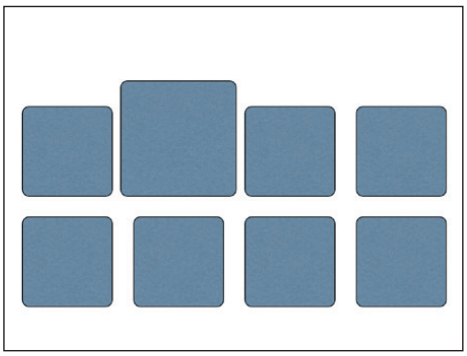
Emphasize Important Elements

Just as with diagrams, it is possible to emphasize visual elements within a slide by varying simple parameters.

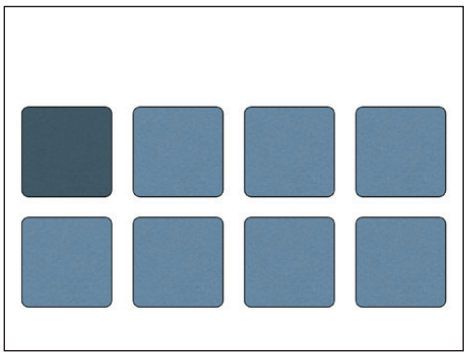
Shape



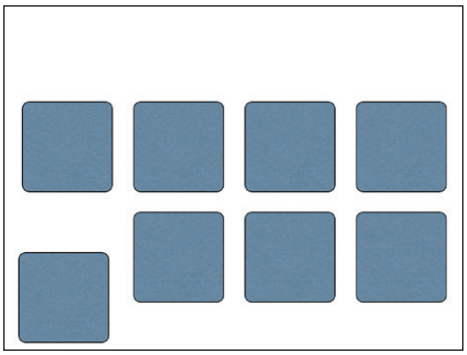
Size



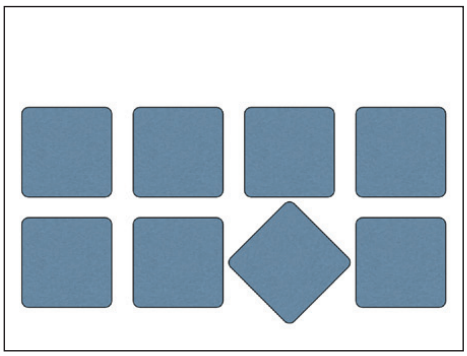
Shade



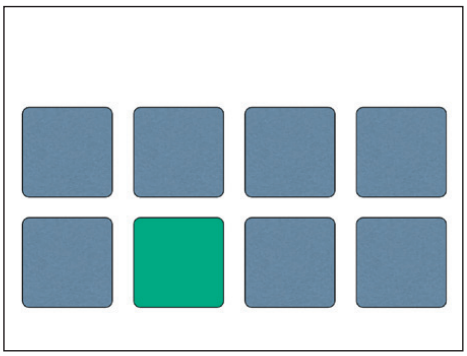
Location



Orientation

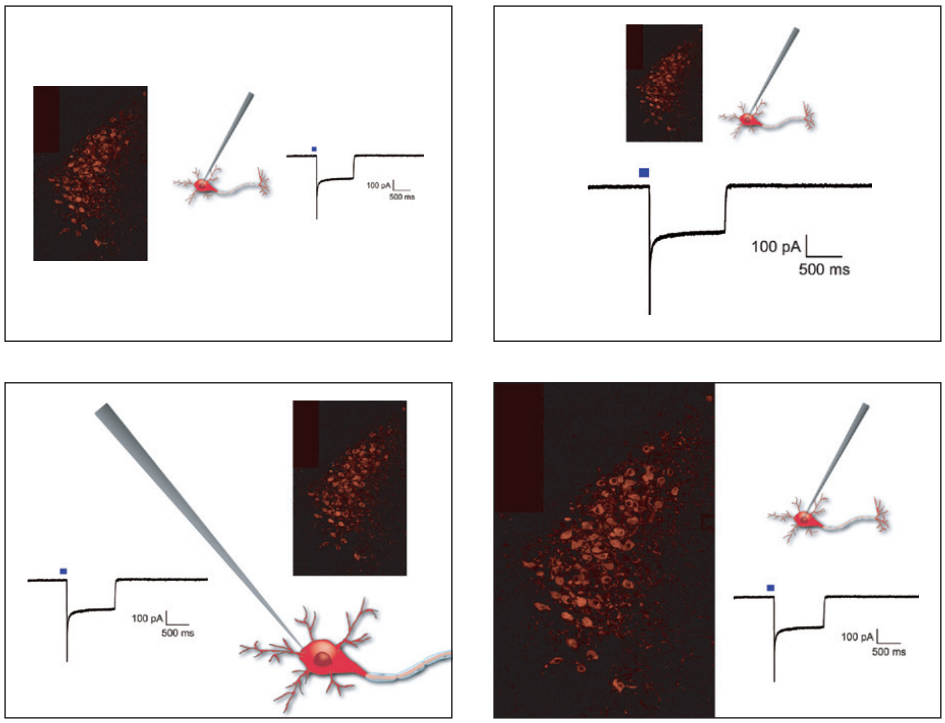


Color



Each time you arrange elements on a slide, you make a statement about their relative importance. Even if you don't explicitly state what you find most important, the audience will make conclusions about what you are trying to emphasize based on your slide layout. Be deliberate about arranging your elements so that your most crucial information is emphasized the most.

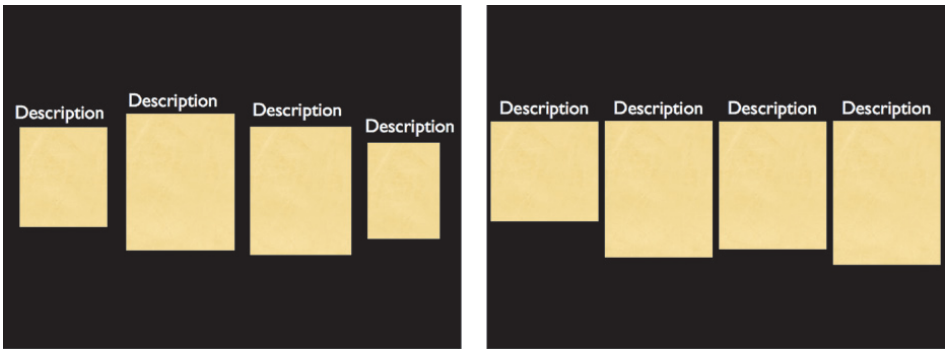
All of these slides present the same information but emphasize different figures. Make sure you are deliberate about which figures you highlight as particularly important.



Align Visual Elements for Harmony

The human eye is remarkably good at perceiving the proper alignment of visual elements. When objects are not aligned properly, audiences become distracted and the meaning of the elements becomes obscured.

In contrast, when visual elements are aligned evenly on a slide, your arrangement conveys a sense of order and harmony. Your audience members probably won't be aware of it, but they will pay more attention to your presentation because your slides will be easy to look at.



In the slide on the left, the four images are slightly disjointed and not evenly spaced horizontally. The descriptions above the images are not aligned and sometimes spill off the edge on the right-hand side. The slide on the right is much more balanced because the image sizes have been adjusted so they are all the same width. Even though they are different heights, there is a sense of harmony because they all descend from the same imaginary horizontal line. The descriptions are centered above the images and no spill-off occurs.

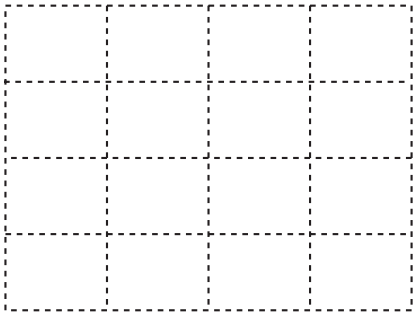
In the slide on the left, the bottom left image stands out even though the right image is much larger. If this is intentional, kudos to the author for using design principles to deliberately emphasize the bottom left image. However, if this is unintentional, enlarge the images on the top left and right until the widths and heights of the total image achieve a sense of balance.

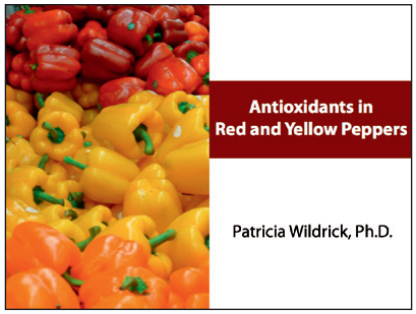
Align Elements Using a Grid

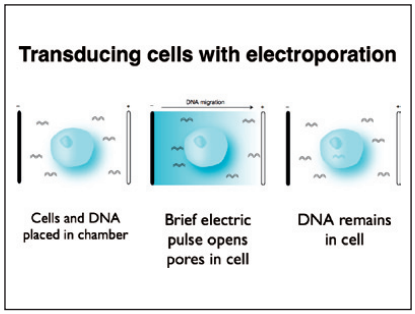
When arranging elements on a slide, it can be helpful to imagine an invisible grid (or use a grid included in your slide creation software) to aid in good alignment. A grid with three rows and three columns follows the principle of the Rule of Thirds (discussed in Chapter 10). Aligning objects along these lines or at their intersections creates a harmonious scene with a remarkable simplicity. In addition to the Rule of Thirds, you can design a grid with however many rows and columns as you would like. In slides, creating a 4×3 or a 4×4 grid can also achieve excellent results.

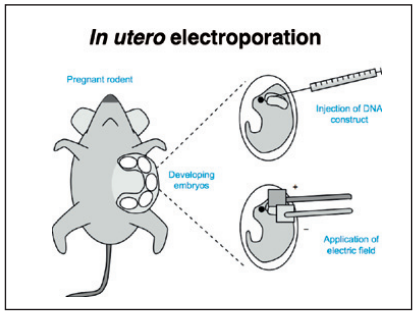
Three column

Four column





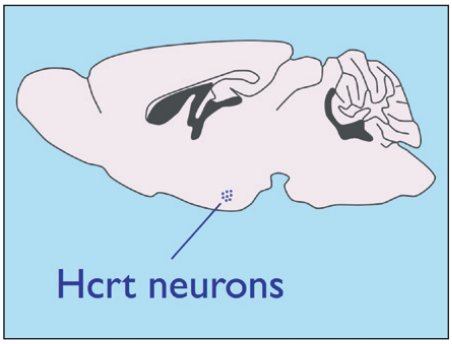




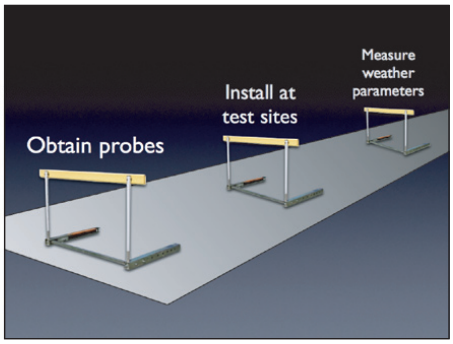
Embrace Simplicity

Visual elements on slides are like people in an elevator: you can theoretically fit a maximum capacity into a tiny space, but it's nice to have some breathing room.

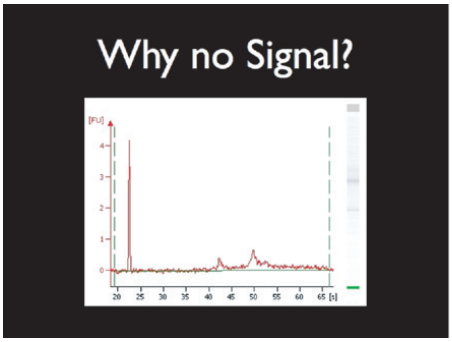
People new to making slide presentations often feel the need to fill their slides with too many visual elements. In reality, the old maxim "less is more" truly holds for slides. Putting less on a slide adds greater impact to the information that you choose to show, increasing the clarity of your message and simplicity of your delivery.

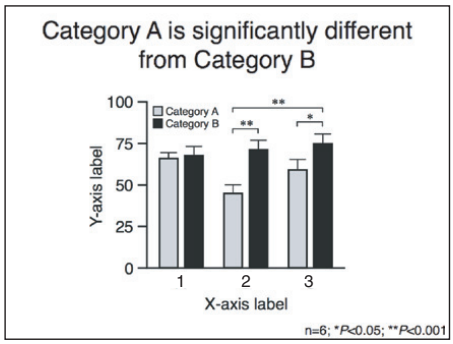


This slide embraces simplicity and empty space by showing only what is important.



A simple metaphor of jumping hurdles to describe the methods of a research project. Although slightly cheesy, this slide easily conveys a sense of order and procedure. Minimal use of words and images allow for a balanced, uncluttered visual scene.

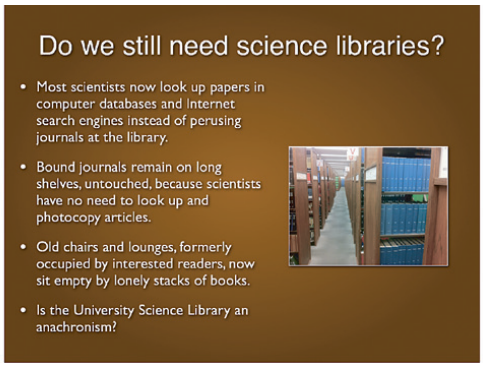




When presenting data, avoid the temptation to fill a slide with too many figures, footnotes, keys, photographs, and explanatory information. Let the data speak for themselves by placing a single chart or photograph front and center. Minimize any text surrounding the data so it can be perceived with maximal impact.

Split Busy Slides into Many Slides

The best slides are clear, simple, and only convey a single idea. If you find yourself creating a slide that contains too much information (such as a slide with several bullet points), consider splitting your slide into three to five separate slides. Don't believe the myth that each slide takes a minute to present...in reality, it will probably take you *less* time to present five ideas on five slides compared with five ideas on one slide because your presentation will be more clear and easier for your audience to understand.



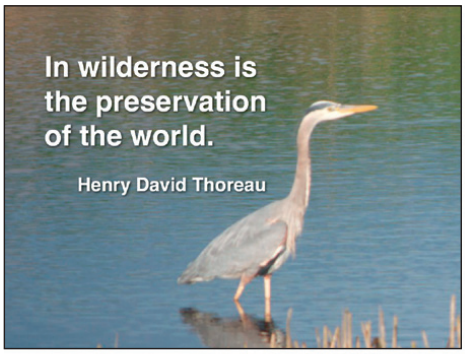
This slide is typical of many that you've probably seen in science presentations: dense text, maybe a token picture, and definitely too many ideas for one slide. You can imagine a slide like this presenting background information for a project, a summary of methods, a list of future directions, etc. What would happen if we divided the information contained in the bullet points into separate slides?

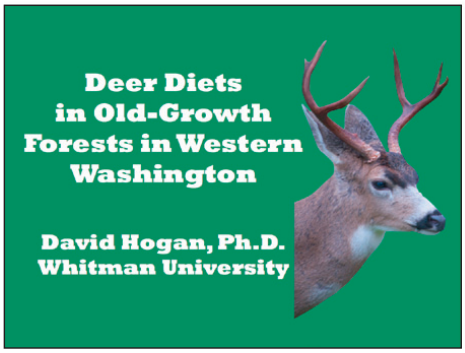
Breaking up one busy slide into several separate slides greatly improves the presentation of your content. Each idea is emphasized on its own for maximal impact. Audience members can better process the information, one piece at a time.

Achieve Harmony with Photographs

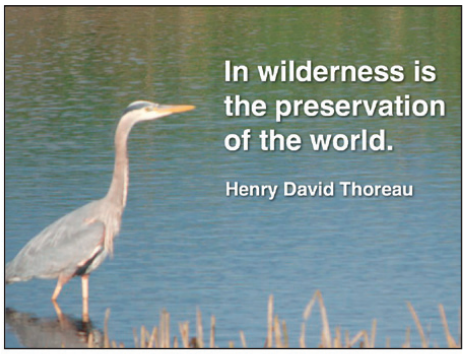
When including photos of dynamic or conscious subjects, arrange the photos so they are an active part of the visual scene. Subjects that seem to be moving or staring away from your visual scene can disrupt the harmony of your slide and distract from your message. Use simple photo flipping or rotating techniques to make sure that all of your visual elements are congruent with each other.

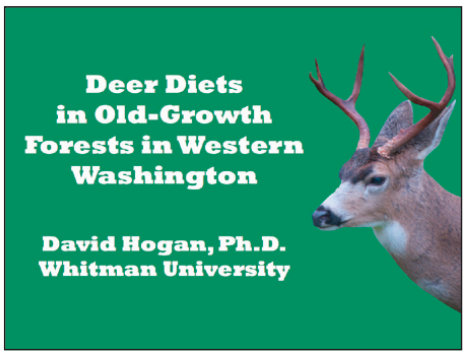
Before





After





Summary: Don’ts and Dos

Don’t trust predesigned slide templates to optimally lay out your content for you.
Do design your own layout, emphasizing the elements you find most important.

Don’t randomly place visual elements on a slide.
Do use design principles to create a logical flow of information and emphasize salient details.

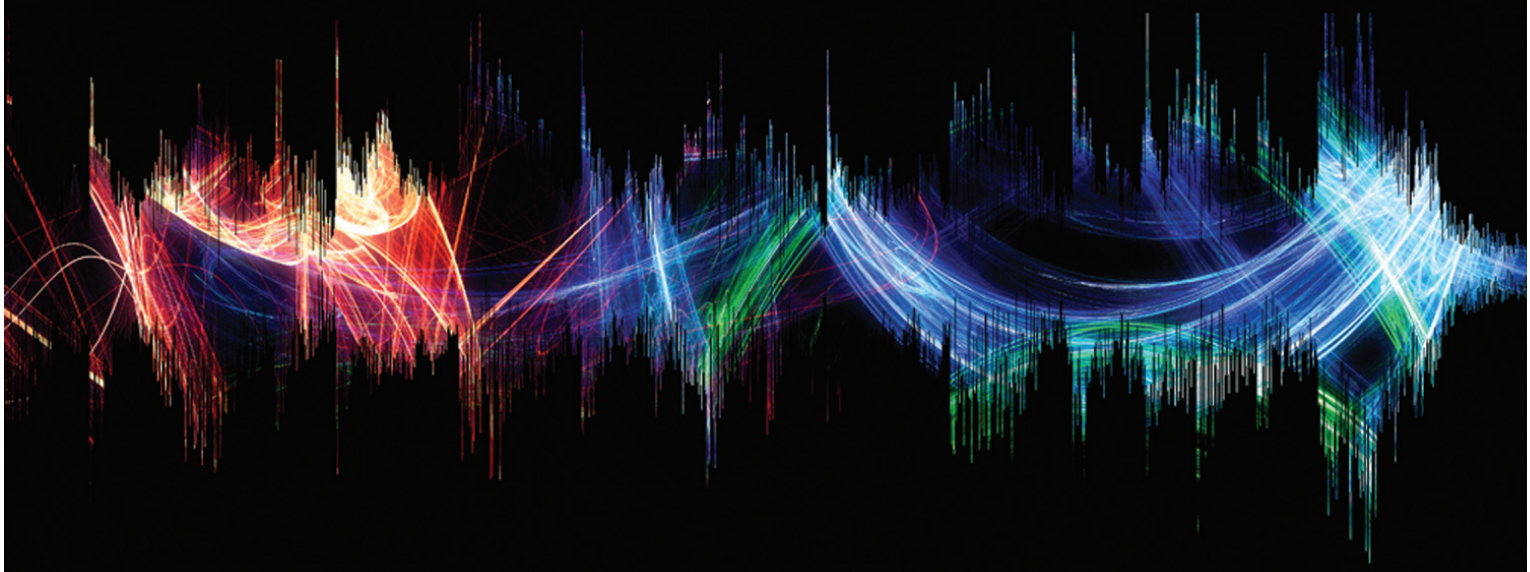
Don’t ignore how visual elements are aligned on a slide.
Do carefully ensure that objects are aligned harmoniously.

Don’t fill a slide with too much content.
Do embrace simplicity and try to only convey one idea per slide.

19

Slide Animations and Transitions

Slide animation effects allow you to make visual elements appear, disappear, and move around the screen whenever you want during a presentation. Transitions allow you to advance from one slide to the next with a variety of two- and three-dimensional effects. Everyone who explores the possibility of using these effects thinks they are fun to play with and usually look cool. However, as designers, we must ask what value these effects add to a presentation. When are they beneficial and when are they decorative? When are they meaningful and when are they distracting? As with all other presentation tools, animation and transition effects can be used well or used poorly depending on the design decisions that we make.



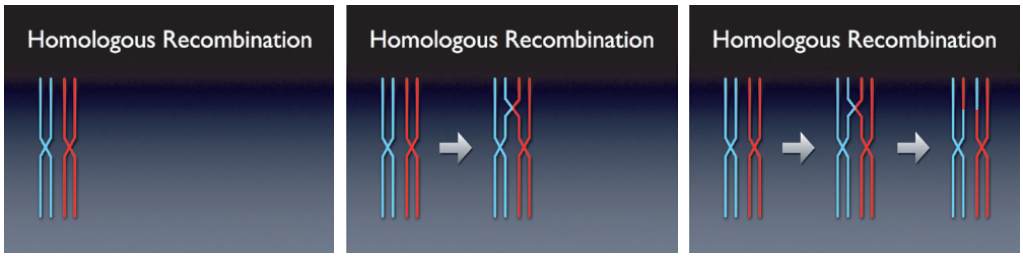
Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00019-2

The Benefits of Using Slide Animation Effects

A wonderful feature of digital slide show applications that did not exist with old-fashioned manual slide projectors is the ability to add animation and transition effects. Twenty years ago, slides could only show static visual scenes. The only way a presenter could add an animation effect was to advance to a slightly different slide, which was cost-prohibitive because each slide was expensive to produce. Modern slide applications allow you to use many kinds of animation techniques that can increase your ability to highlight information and communicate a message to an audience.

There are many reasons why you might want to add animation to your slide presentation:

- To make individual visual elements appear only when you want your audience to see them
- To remove visual elements when they are no longer relevant to your message
- To direct an audience's visual attention
- To increase understanding about how a process works by showing how individual components dynamically interact



A simple animation effect designed to add information only when the presenter chooses to do so.

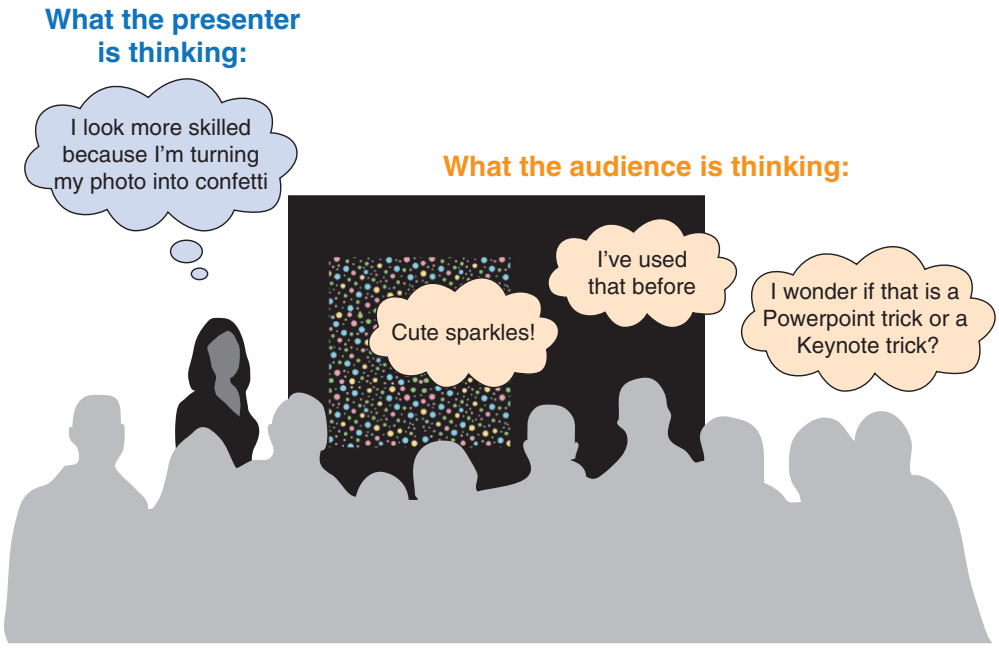
Don't use animation effects when they don't add value or meaning to your message. For example, if presenting an image of a pipette injecting liquid into a solution, would it add any value to animate the loss of liquid in the pipette tip? Do you want your audience's attention focused on the pipette, or on the methodology you are trying to communicate? Effects that don't add meaning are a waste of your time to create and a potential distraction for your audience.

Don't Be an Animation Show-Off

Using animation effects in presentations is a privilege that can easily be abused. When creating slides, it can be fun to explore your slide-making software and play with cool special effects; however, during an actual presentation, make sure that these effects actually add value to your ability to communicate a message to your audience.

Good design never calls attention to itself. Presentation effects should always be used in service of your science and not in service of the cool things you know how to do with your computer.

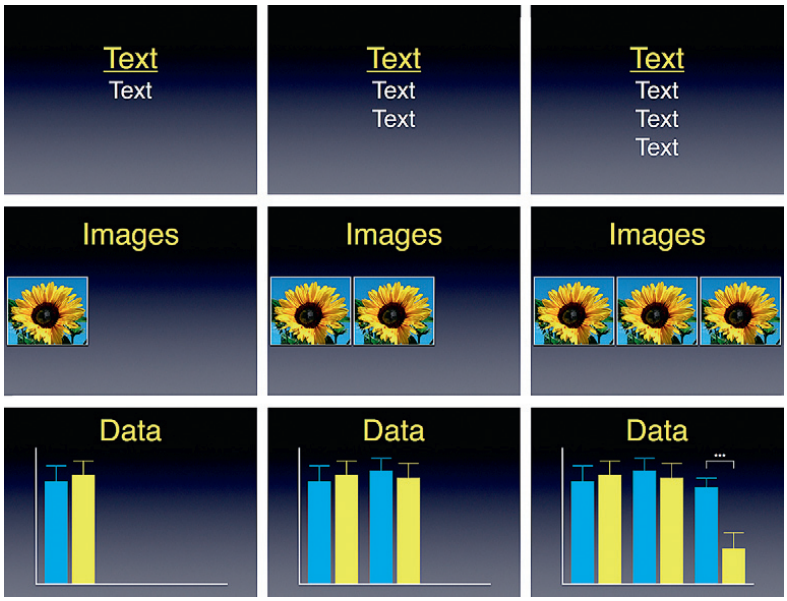
Although your software may provide you with the power to bounce text around your slide, turn your diagrams into smoke, or explode photographs into a burst of flame, always ask yourself whether such techniques add value to your presentation. Days after your talk is over, will your audience remember your silly three-dimensional explosion effects or will they remember your science?



What the audience is *not* thinking about: **your message**

Use Animation to Introduce Concepts at a Time of Your Choosing

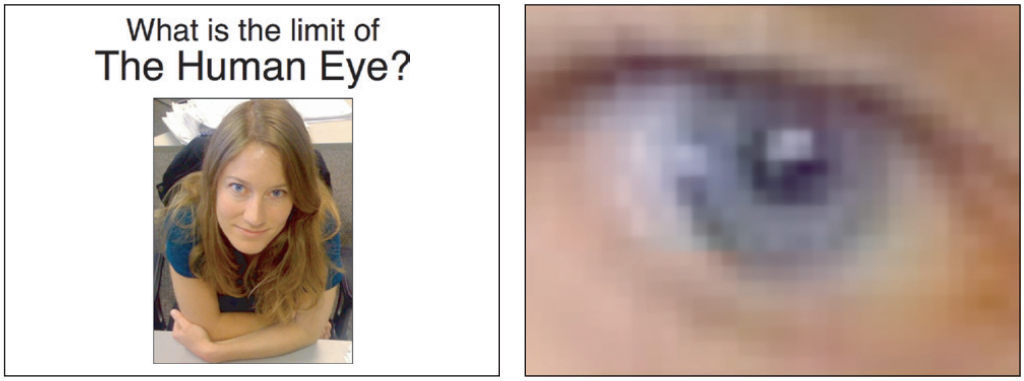
One of the advantages of slide shows compared with other presentation formats is the ability to show whatever you want, whenever you want. Animation effects let you control precisely when your audience will see specific visual elements.



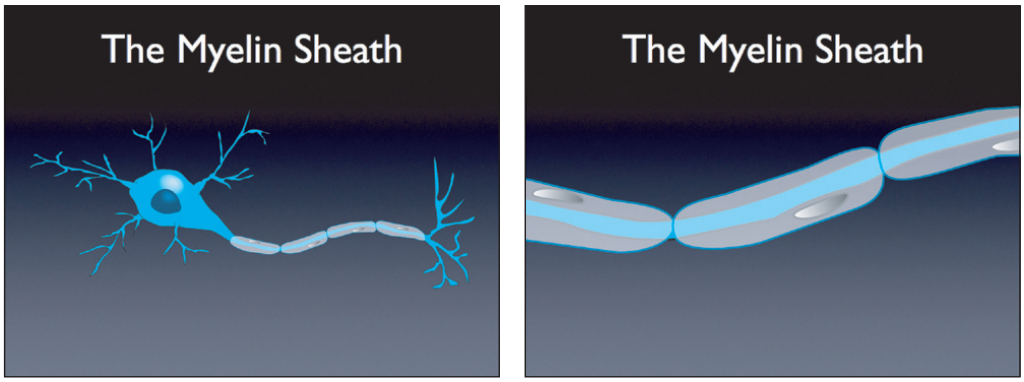
Keep in mind that when a single visual element appears in the top or left-hand side of the screen, your audience is primed to expect more. Don't keep them in suspense for long. If you are too slow to introduce subsequent text or images, your audience will become distracted.

Use Animation to Relate the Big and the Small

Using "scale" or "zoom" animation features, you can make visual elements much bigger or smaller during your presentation. These techniques are useful for showing how an object might literally shrink or enlarge during a process—for example, in a slide about how a star expands as it grows old. Additionally, you can scale an object to demonstrate how an individual component of a system relates to a larger whole. In doing so, you can focus on a constituent part of a process while also showing a larger, global perspective.



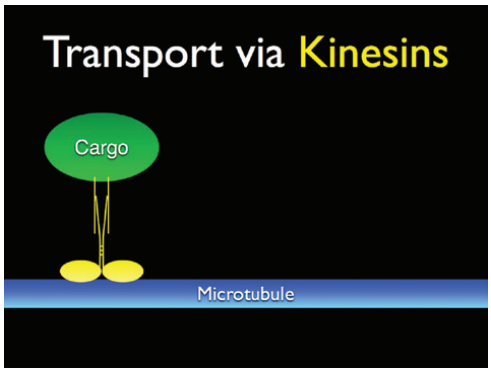
In this slide, a zoom animation effect is applied to the photograph until the eye fills the entire screen. This has a powerful effect, not only because the subject matter is about the human eye, but also because it is a perfect validation of the fact that the pixellated photograph looks perfectly clear in a normally-sized photo, demonstrating to everyone in the audience the limitations of their own eyes.

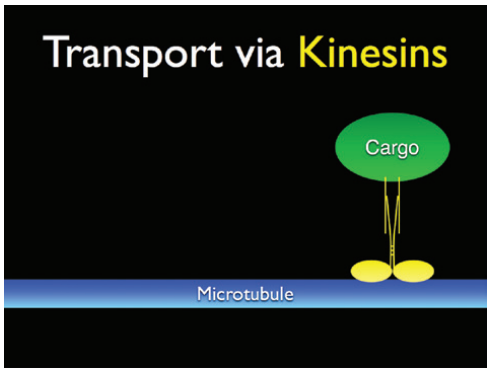


This slide starts with a global pictorial diagram of a neuron before zooming in to focus on the myelin sheath. The advantage of starting out with an entire neuron is that the audience has an understanding of the complete object, always remembering that the specific component under investigation is one of several parts. At the end of the talk, the speaker could zoom back out to remind the audience of the bigger picture.

Animate Movements Naturally

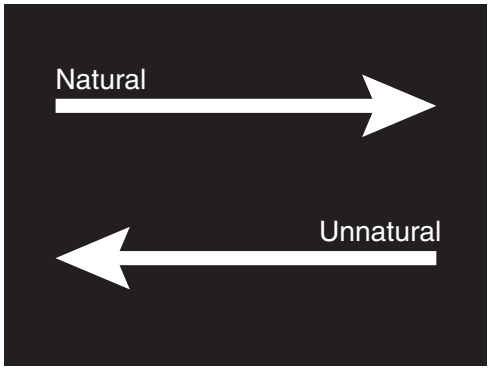
Animation techniques are great for showing movement and how objects interact with each other.



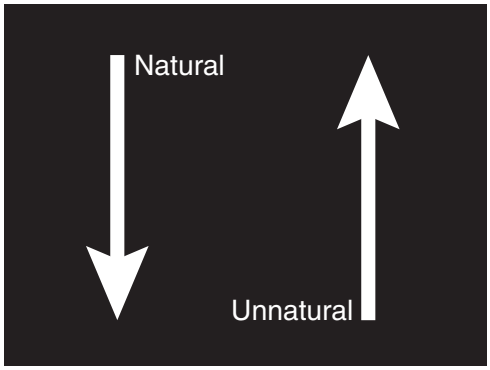


A simple animation effect moves cartoon biomolecules from left to right across a depiction of a microtubule. Instead of animating this movement quickly, a presenter could adjust the settings to move the object over a period of 30–40 seconds while he or she orally describes the phenomenon.

If you apply movement to visual elements on your slide, animate them in a direction that is natural and intuitive to your audience. Otherwise, your animations may seem distracting or jarring.



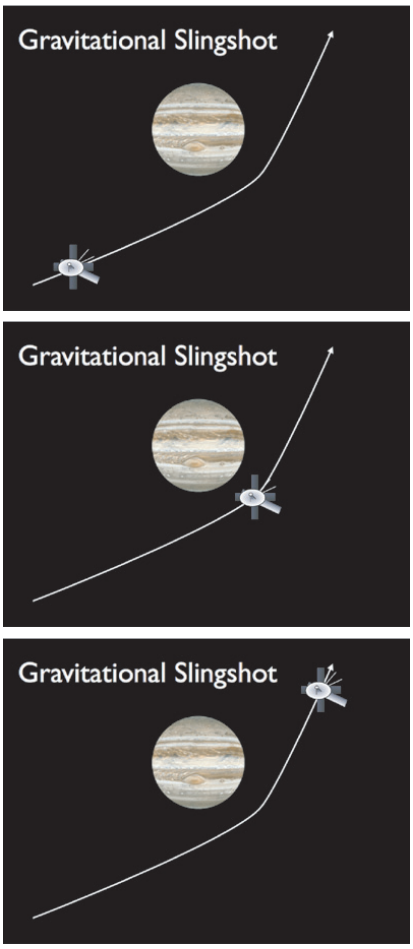
Because of how we are used to reading, it is more comfortable to experience movement going from left to right than right to left.



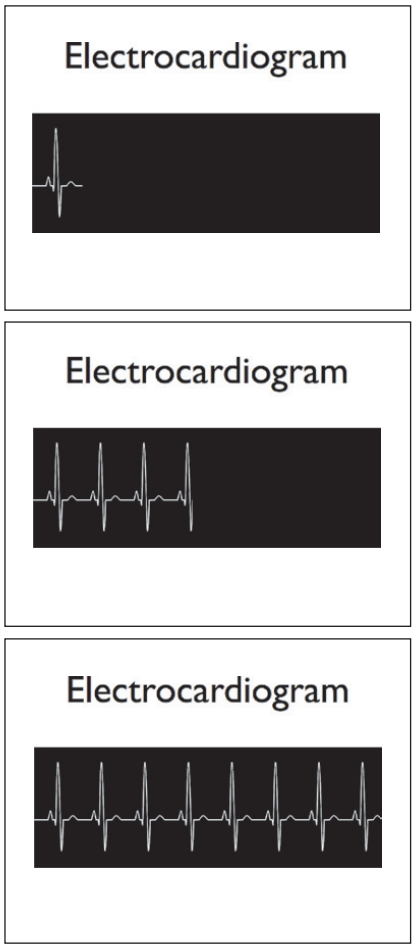
Because of our intuition of gravity, it is more comfortable to see objects descend than rise vertically.

Animate Diagrams to Bring Dynamic Processes to Life

A good static diagram can quickly inform an audience about the steps in a process or technological procedure. Simple animations can add meaning and visual impact to these diagrams, bringing processes to life in a way that static diagrams cannot.



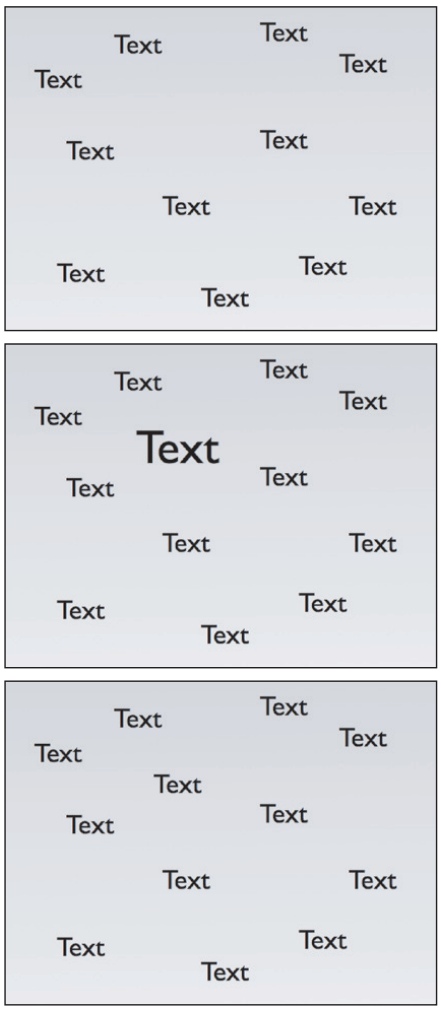
This slide conveys the gravitational assist experienced by a space probe passing a planet. In the animation, the probe approaches Jupiter, then the animation speeds up to demonstrate the increase in velocity.



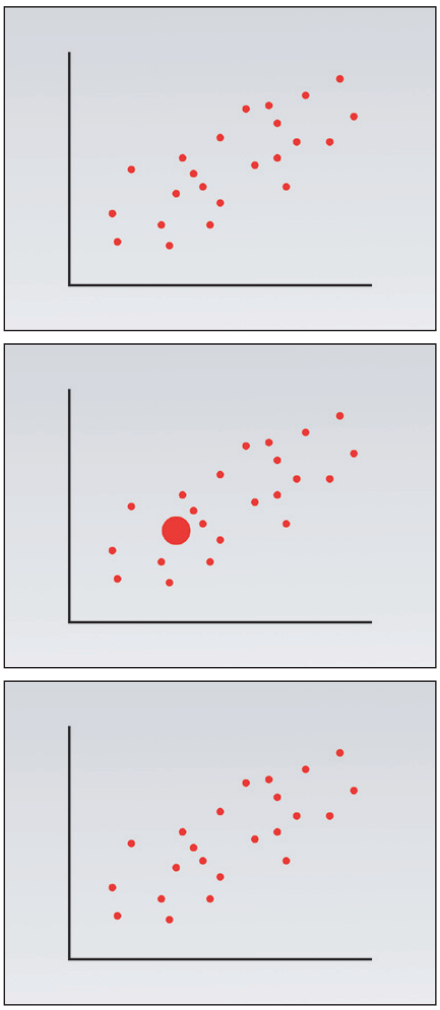
This slide presents an animated electrocardiogram. A black rectangle is placed in front of an EKG trace, and a simple "wipe" animation removes the black to create the illusion of a real-time EKG recording. This animation can be looped several times as the presenter conveys information orally. If used for no reason, such an animation could be distracting; however, in this case, the presenter wants to recreate the impression of observing a real-time recording in a clinical setting.

Use Animation to Direct the Audience's Attention

When the human eye perceives motion within a static visual scene, it immediately focuses on the moving object. Therefore, one way to direct an audience's attention to a particularly important feature is to animate the visual element with a brief subtle motion. This animation can be applied to a visual element as it appears on a slide, or to an object already present on a slide.



To introduce text or another visual element to a slide that already has many visual elements, use a pop or scaling effect so that the new object is momentarily visually salient.



To highlight a visual element among many other elements, briefly "pulse" the object in size as you describe the object's meaning.

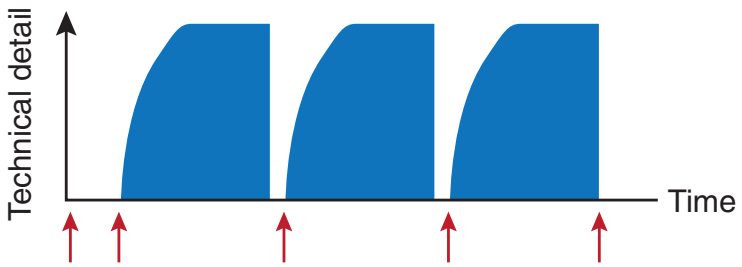
Use Slide Transitions Minimally for Emphasis

The default slide transition on all slide shows simply takes you from one slide to the next. These transitions, along with other peaceful effects like "fade in/out", are usually never consciously perceived by an audience.

However, modern slide applications come bundled with a variety of exciting two- or three-dimensional transition effects that, while fun to look at, have the potential to divert your audience's attention. Like animating objects within slides, transitions should never distract from your main point. People who use gimmicky effects for each transition risk distracting their audience every time they advance to the next slide.

A benefit of more complicated transition effects is that, when used sparingly, they can refocus audience attention towards the screen. Like video, the movement of a slide transition causes your audience to look at the screen, even if only for a moment. If you use these effects constantly, your audience will stop attending to them; however, if only used three to five times during a presentation, they can be terrific tools to non-verbally inform your audience that you are transitioning from one major section of a talk to another.

In Chapter 15, we divided the sections of a scientific talk into discrete segments of data. Perhaps the best occasion to use a transition effect is immediately before a new section of your talk. By momentarily regaining your audience's visual attention, you establish a new opportunity to engage them in your presentation.

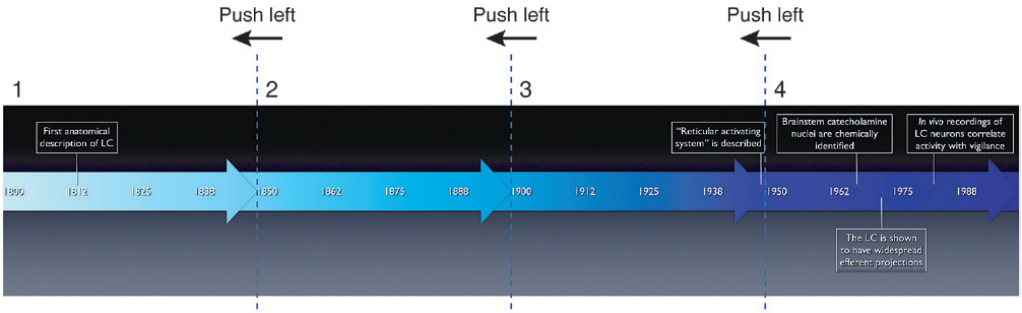


Potentially good moments for an animated slide transition

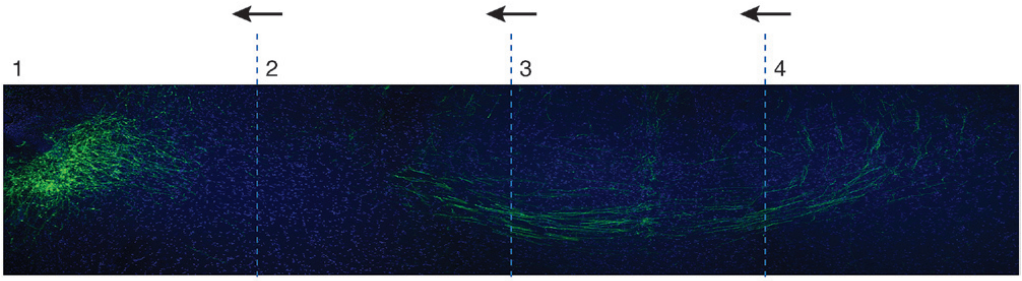
Use Transitions to Create Scenes and Panoramas

Slide transitions can be used as more than just a cute way to get from one slide to the next. Using the "push" transition, you can actually create impactful scenes that create the illusion of extending one slide into a longer landscape.

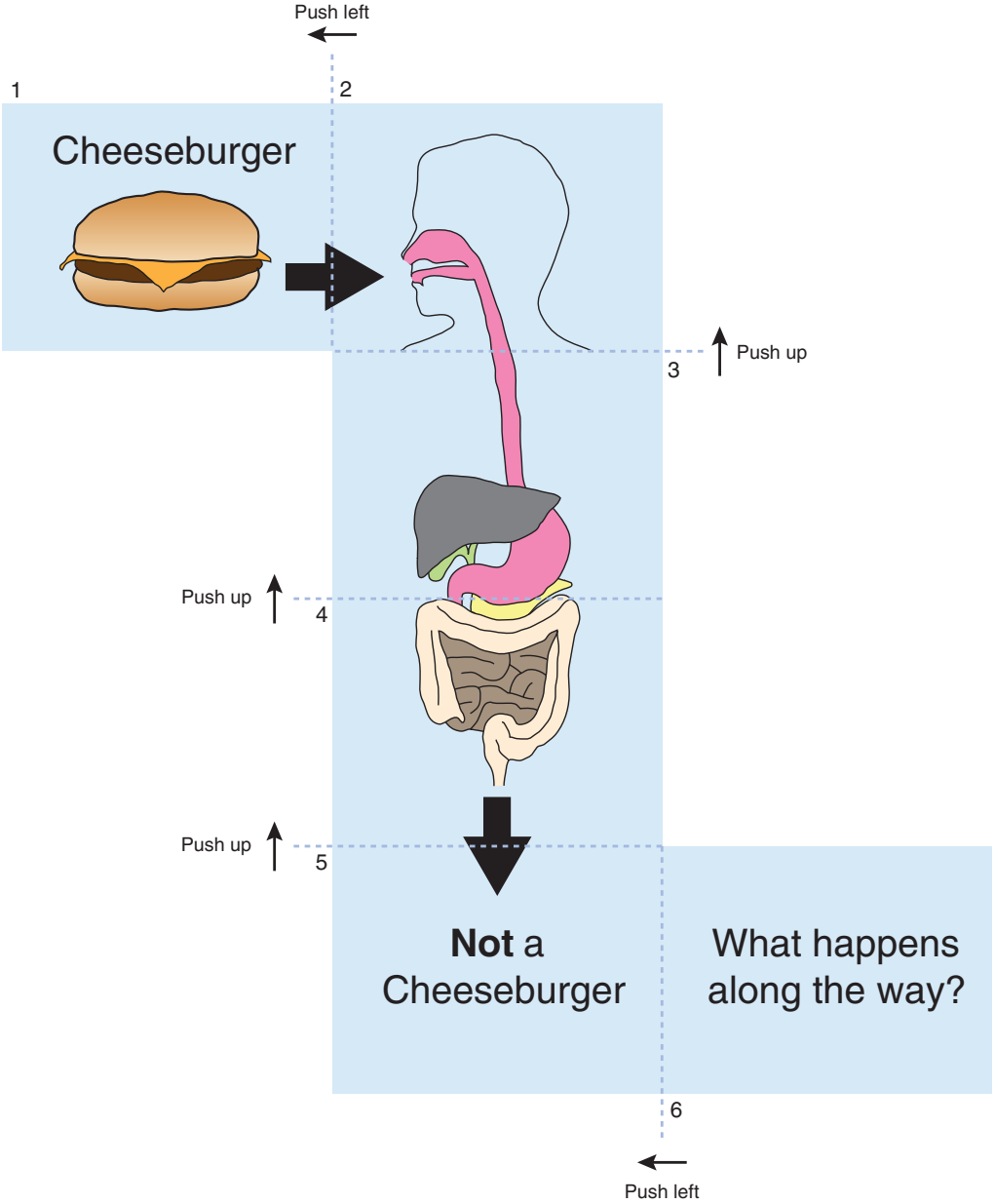
When using this technique, make sure to keep your slides as simple as possible and remove any background images, logos, slide numbers, etc. Adjust the settings so that each push lasts at least 2–3 seconds.



This series of four slides presents a 200-year timeline of the history of the study of a biological structure.



This series of four slides starts with a group of neurons and follows their projections across a brain.


Push left
1
2
Cheeseburger
Push up
3
Push up
4
Push up
5
Not a Cheeseburger
What happens along the way?
6
Push left

Summary: Don’ts and Dos

Don’t use slide animation or transition effects because you think they look cool and exciting.
Do use animation effects deliberately to introduce concepts when you feel they should be introduced, to capture your audience’s attention, or to better communicate a message to your audience.

Don’t animate objects in slides without considering the direction of movement and what is most comfortable for your audience to experience.
Do animate objects in a way that is natural for your audience, either left to right or top to bottom.

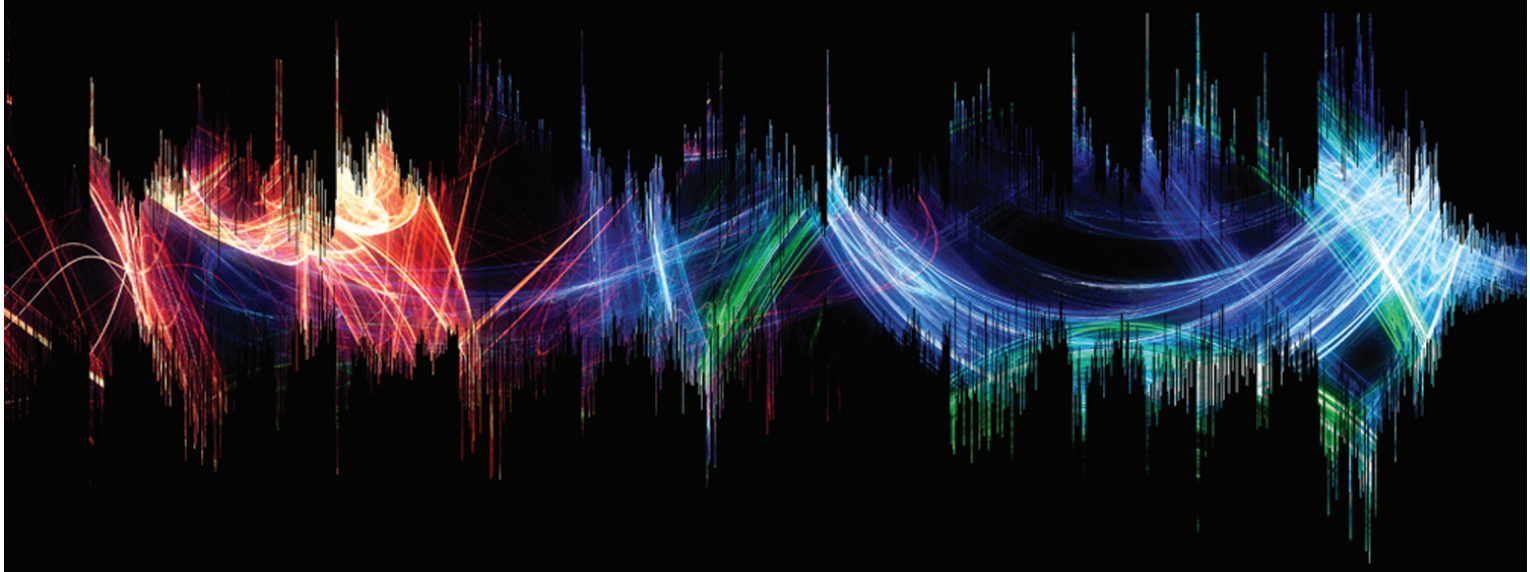
Don’t introduce visual elements one at a time in a way that causes your audience to grow impatient, waiting for subsequent elements.
Do animate the entrance of objects fairly rapidly so that your audience does not grow restless.

Don’t use slide transitions constantly throughout a presentation.
Do use slide transitions minimally, only to indicate to an audience that you are starting a new section of your talk.

20

Delivering a Slide Presentation

Many scientists assume that delivering a slide presentation is a talent that cannot be improved over time. Perhaps this misconception is due to the fact that great presenters work hard to make their delivery seem easy and natural. In reality, a great delivery is rarely easy, and requires forethought, planning, and rehearsal. Scientists who don't have strong presentation skills don't lack talent as much as they lack effort. Science presentation skills can be improved with practice, as long as you have the desire.



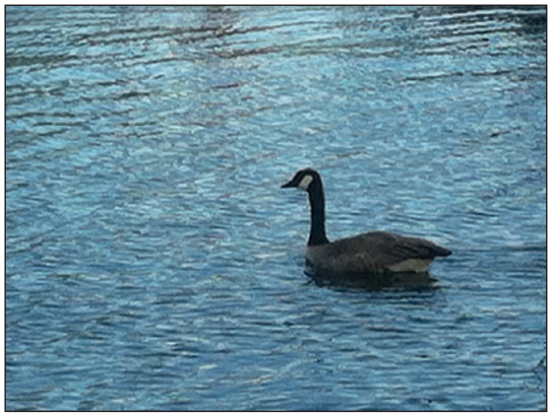
Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00020-9

To Seem Like a Natural, Design and Rehearse

Every now and then you come across a scientific speaker who makes delivering an exceptional talk look incredibly easy and natural. These speakers communicate complicated messages to audiences in a way that captivates everyone in the room, yet they look like they are hardly working at all. In reality, these presenters work harder than anyone else.

There is no such thing as a natural exceptional presenter. What distinguishes "naturals" from others is the degree to which they design and rehearse talks until they can communicate their message as effectively as possible.

Rehearsing means different things to different people. Some like to rehearse by actually delivering a mock presentation to an empty room while projecting slides on a screen. Others like to rehearse mentally: at their desks, while riding their bicycles, or in the shower. Rehearse however you feel most comfortable. Just make sure to work so hard that your audience doesn't perceive you working at all.



An exceptional scientific presenter is like a bird on the water: moving forward seems easy and natural, yet below the surface a great deal of effort is necessary to stay afloat and move ahead.

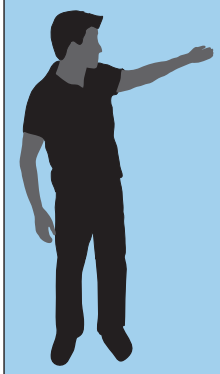
Be Present

You have probably attended many scientific talks in which the speaker seemed to lack an accurate impression of the extent to which he or she was effectively communicating with the audience. You may have thought to yourself that some aspect of the presentation wasn't quite ideal, yet whether it was because of the speaker's delivery, the audience's level of comprehension, or the presentation room itself, the speaker didn't seem to notice. By failing to accurately gauge the atmosphere while delivering the presentation, the speaker failed to adequately communicate ideas with the audience.

Designing a presentation for your audience members is not only about predicting and accounting for their needs while designing your talk, but also about continuously monitoring your communication during the actual delivery. This awareness requires that you are completely present in your environment while speaking, and constantly assessing your connection with your audience.

To be completely present as a speaker means to have a clear understanding of yourself, your audience, and your environment during your real-time delivery.

Be aware of...



Yourself:

Are you talking too slow, too fast, too quiet, too loud, or too monotonously?

How is your posture?

Is anxiety causing you to perform a nervous, repetitive movement?

Your audience:

Is your audience showing signs of confusion, boredom, or impatience?

Where is your audience maintaining eye contact?

Is your audience distracted by something else in the room?

Your environment:

Is the lighting optimal for viewing slides and keeping the audience awake?

Is the temperature too hot or cold?

Are there visual or audible distractions?

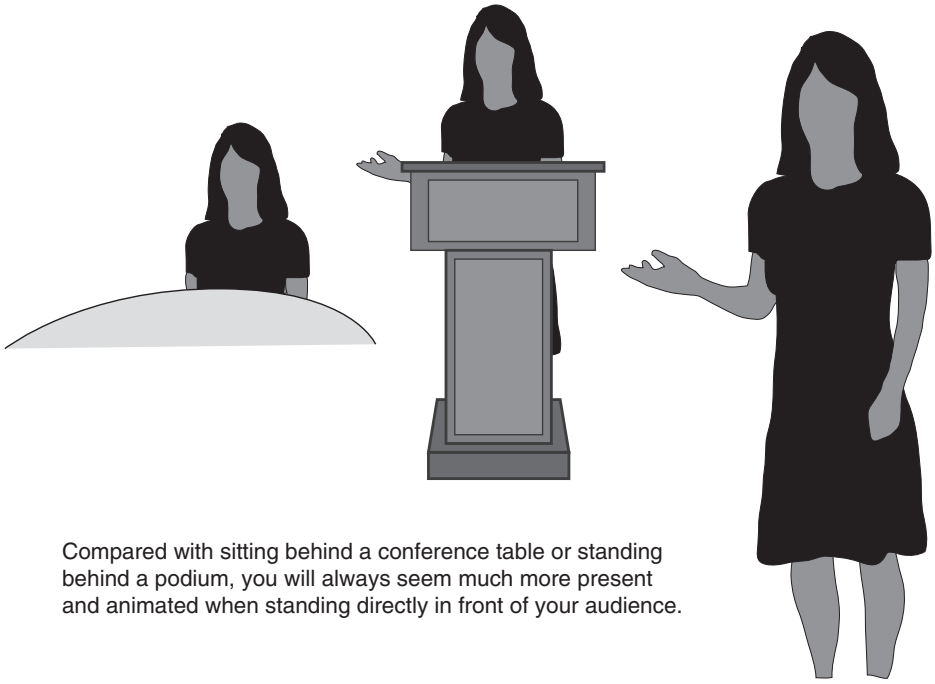
Being present is a skill that requires active practice and experience. The more presentations you give, the better you will be.

Be Visible and Audible

The audience members attending your scientific talk don't only want to see your slides, they want to see and hear *you*. Don't just strive to be visible and audible in the minimal sense—try to fully engage your audience with your presence and voice. By increasing the degree to which your audience can see and hear you throughout your talk, you increase the passion you convey as well as the likelihood that your audience will pay attention.

Increase your presence during a talk in three easy ways:

- **Leave the lights on.** Never turn the lights off all the way unless you need to temporarily shut them off for a specific slide (e.g., a fluorescent microscopy picture).
- **Make sure your voice projects throughout the room.** Do a quick sound check before the start of your talk. If delivering in a large room, practice using the microphone to ensure that your voice can be effortlessly heard throughout the entire room without booming. Speakers who are able to project a strong voice throughout their presentations are more likely to maintain audience attention.
- **Don't sit at a table or hide behind a lectern.** If possible, use a remote slide advancer (see Chapter 21) so you can leave your computer and walk around the entire presentation space.



Compared with sitting behind a conference table or standing behind a podium, you will always seem much more present and animated when standing directly in front of your audience.

Cater to a Specific Audience

You can establish an immediate emotional connection with your audience members by addressing them specifically at the start of your talk, commenting on what you appreciate about them, how they are likely to feel, or what they are likely to want to hear from you. By addressing your audience members directly, you form an instant relationship that makes them feel emotionally invested in your talk and more likely to pay attention.

Comment on who they are:

"It is a real pleasure to be speaking at the University of Washington again. I always love visiting here because you have so many of the world's best neuroscientists all in the same place. It has been a true pleasure to meet with so many of you throughout the day and I hope to visit with more of you after my talk."

"Thank you for inviting me to speak at your lab meeting! Obviously we are interested in similar topics and this lab has inspired many of the experiments I performed in the past. This is a great opportunity for me to share what I've been working on lately and get your feedback, and it would be great if any collaborations develop because of our mutual interests."

Comment on how they are likely to feel:

"First of all, thank you very much for attending my talk at 8:00 in the morning…especially on the fourth day of a 4-day conference. I know some of you were up late last night because, well, frankly, I was with some of you… So I know many of you are tired and I'm so appreciative you woke up to be here. I promise to make it worth your while."

"How are you guys holding up? I know it's the middle of midterm season and I hear that anyone taking general chemistry or organic chemistry just had a big exam yesterday. You must be tired. Well, at least it's a Friday today, so hopefully you can sleep in tomorrow."

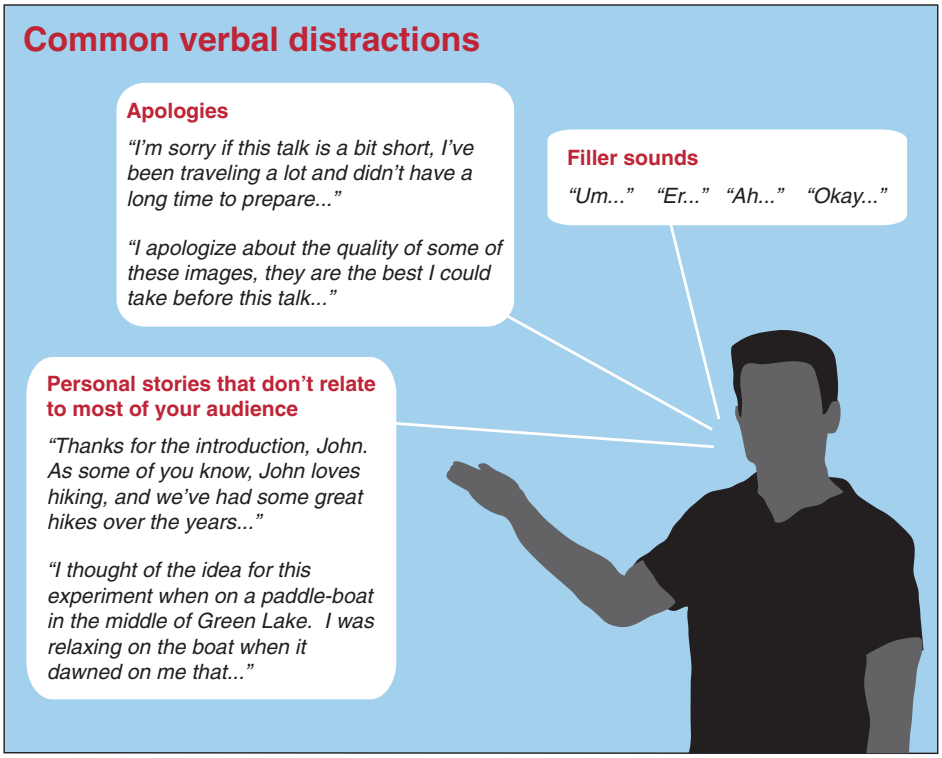
Comment on what they are likely to want to hear from you:

"I picked this journal club paper not only because it is a great paper, but because the authors addressed a scientific problem that is similar to a lot of the problems we address in our lab. I think that the strategies that these authors used could be potentially adapted by many of you to achieve your own goals."

"I'm sure that you not only came to hear my talk because of my own research topic, but because you might also be interested in doing experiments with optoproteomics. Today, in addition to talking about my own work, I'll be sure to talk about the development and application of this technology so that you can apply it to your own labs."

Eliminate Verbal Distractions

Just as you should remove clutter from your slides and eliminate any visual elements that don't communicate meaningful information, you should also try to eliminate wordiness and verbal elements that don't communicate meaningful information. In general, the most common verbal distractions include meaningless apologies, filler sounds, and personal stories that aren't relevant or interesting to your audience.



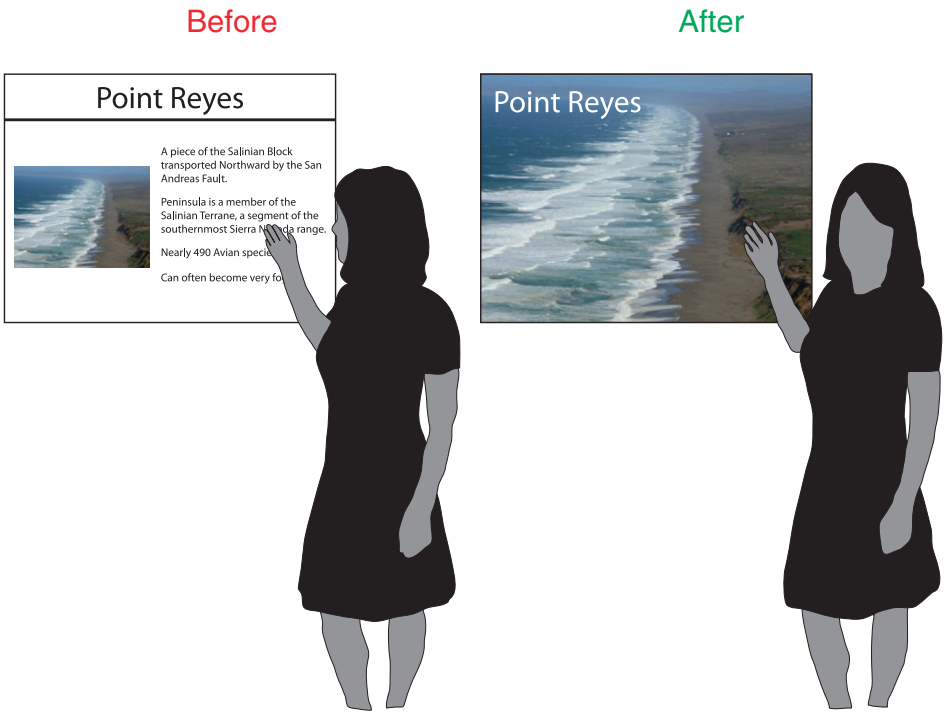
Sometimes presentation anxiety causes you to say things you don't intend to say. If you find yourself often succumbing to one of the verbal distractions above, you can eliminate these bad habits with practice. Each time you present a talk, make it your goal to deliberately avoid the verbal clutter that plagues you the most. With time, bad habits can disappear.

Don't Use Slides as Presentation Notes

Unfortunately, most scientists add too much text to their slides and then use their slides as presentation notes during their delivery, reading the text verbatim. This bad habit occurs so often that most scientists don't even recognize it as a bad habit.

The problems with using slides as notes are that: (1) you design boring slides; (2) you look at the slides rather than maintaining eye contact with your audience; and (3) you reduce your ability to be present and attentive to the real-time needs of your audience.

Slides are not presentation notes. Don't design slides as presentation notes, and don't use slides as presentation notes.



The best presenters rehearse to the point that they no longer need presentation notes. If necessary, they bring along a brief page of key points in case they forget a quick fact. Slides should never serve this purpose, and should exist purely as a visual aid for your audience's benefit.

Soliciting and Answering Audience Questions

After your talk is over, your final job is to ask for questions from the audience. During this period, make it a habit to smile and seem receptive to all questions so that you look happy to discuss aspects of your research with others.

If you are speaking at a formal venue, such as a scientific meeting or symposium, consider rephrasing each question you receive in your own words before providing an answer. Doing so ensures that you correctly interpret the specific question that was asked, as well making sure that everyone in the audience hears and understands the question.

Prepare for the possibility that you may face difficult questions from the audience, not necessarily because the questions are hard to answer, but because of the nature of the questioners. Difficult audience members commonly show up in a few different forms:

The critic. You may encounter an audience member who has something critical to say about every aspect of your research. Feedback is obviously good, but an unusually negative response from a single person will not only bring you down but also distract other audience members. The best way to deal with a critic is to avoid debate. Certainly comment on the rationale of your work and why you performed experiments in a certain way, but don't get into a scientific argument during your actual talk. Thank your critic for his or her criticism, acknowledge that you appreciate different points of view, and offer to discuss aspects of the science after the talk is over.

The time guzzler. Sometimes a single audience member will try to ask questions and discuss your research with you as if no one else was in the room. It's great to talk with someone who is so enthusiastic about your work, but you should try to address questions from as many audience members as possible. The best way to deal with a time guzzler is to suggest a specific time to talk later: "Make sure to find me at the reception and we'll talk about this further."

The science 101 student. Someone might start asking questions that will make you question whether they have taken a high school science course. There really isn't such a thing as a dumb question, but if someone starts asking you what a cell is, you'll lose visitors who want to discuss more sophisticated aspects of your research. Just like the time guzzler, set up a specific time to talk after the question and answer session. Say something like, "It's great that you want to know more about this… Let's talk in more detail during the reception."

Dealing with Anxiety

Contrary to popular belief, there is no correlation between how nervous a speaker is before or during a talk and how well he or she delivers a presentation. Some people always become nervous before a talk, while others always remain calm. Some people are only anxious in front of large audiences, others are only anxious in front of small audiences. Consider the possibility that the presenter who seems the least nervous and most comfortable when presenting could actually be the most nervous of all.

Practice and preparation distinguish presenters who don't seem nervous from presenters who let anxiety overcome their delivery.

The keys to dealing with presentation anxiety are to anticipate it and develop strategies to transform anxiety into positive energy:

Rehearse for the 5 minutes before your presentation begins. Speakers usually become most nervous just before their talks begin, yet few scientists actively prepare for dealing with their anxiety during this period. Anticipate the sights and sounds of the minutes before the start of your talk, especially the sounds of the gathering audience. (A trick you can perform with modern smartphone technology: the next time you attend a talk, record 5–10 minutes of audience chatter, then listen to these sounds over and over again so that you become accustomed to them.)

Memorize and rehearse the first 1–2 minutes of your talk. Most speakers agree that once they get through the first minute of their presentation, anxiety begins to fade. Therefore, memorize and rehearse the first minute so you feel more in control and your anxiety doesn't prevent you from making a good first impression.

Walk around your presentation space. Although it's tempting to hide behind the lectern, slowly walking around your available presentation space will not only help your audience pay attention but will also help to calm your nerves and give you the perception that you are having a conversation with colleagues. Use a remote slide advancer (see Chapter 21) so that you are free to leave your computer and speak from wherever you feel most comfortable.

Bring a water bottle. Presentation anxiety can easily cause a dry mouth due to the physiological response to stress. Elevated heart rate, breathing rate, body temperature, and sweating can all lead to acute dehydration, even if you drank water immediately beforehand. A quick drink of water during your talk can help you feel better physically. (But do so only if it helps you—taking too many sips of water can also be distracting for your audience.)

Summary: Don’ts and Dos

Don’t consider exceptional presenters as “naturals” who can deliver great presentations without effort or rehearsal.
Do realize that anyone can seem like a natural if they work hard to design and rehearse a quality presentation.

Don’t ignore the state of your audience during your delivery.
Do be fully present throughout your delivery, accurately gauging yourself, the emotions of your audience, and the environment in which you are presenting.

Don’t sit at a desk or hide behind a presentation lectern.
Do move to a visible location during your talk and make sure you are as audible as possible.

Don’t deliver a presentation without acknowledging your audience.
Do cater to your specific audience and introduce your talk while speaking specifically to them.

Don’t use your slides as presentation notes during your talk.
Do rehearse your presentation so that you don’t need to rely on your slides for guidance during your talk.

Don’t assume you can’t overcome presentation anxiety.
Do practice methods for dealing with anxiety that can transform nervousness into positive energy.

Don’t include verbal distractions in your delivery.
Do eliminate unnecessary apologizes, nervous fillers, and personal stories unlikely to interest your audience.

21

Using Technology to Present Like a Professional

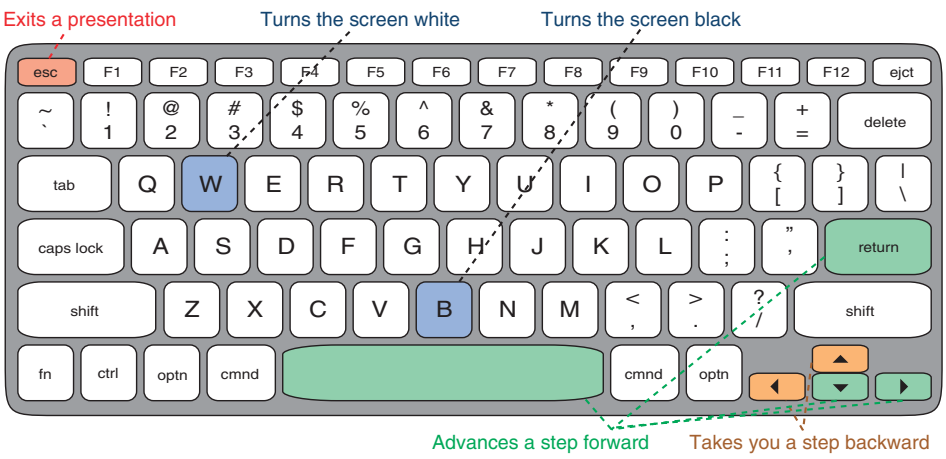
Consider the following scenario. A scientist has spent time and effort designing a beautiful presentation, and rehearsed to ensure he will have a dynamic, fluid delivery. However, when it is time to present, he has a difficult time connecting his laptop to the projector. Then the slides appear too dark and, during the talk, fluorescent images are barely perceptible. The scientist tries to turn down the lights, can't find the correct switch, and becomes so anxious that his laser pointer nervously shakes around the screen. Although the audience members understand the content, they are distracted by all of the technological mishaps, and the scientist comes across as not being in control. Audiences associate good presentation technology skills with professionalism in general. Therefore, mastering presentation technology will help enhance your reputation as a scientist and ensure you deliver a world-class presentation.

Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00021-0

Know How to Control Your Presentation

All slide creation applications have keyboard commands that let you control your slides during your presentation. Some commands are software-specific, but many are common throughout the various programs. To advance through your presentation, hit the space bar, the right or down arrow keys, the return/enter key, or your mouse button. The best choice is often the space bar, as it is the largest key and easy to spot. To go back a slide, hit the left or up arrow keys. To quit your presentation, hit escape.

Two underutilized controls are the B and W keys, which turn the screen black or white, respectively. These keys can be very useful during a pause in the middle of a presentation. For example, if someone asks you a question and you want to draw an answer, press the B key and switch to the blackboard or whiteboard.

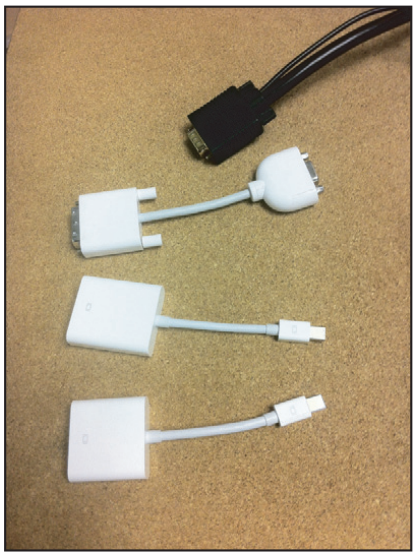


These keys are consistent across all presentation software applications. However, there are many more commands you can choose to use; for example, you can use the keyboard to display the cursor on the screen or to control audio and video clips in real time. See the instructions for your presentation software to learn more about the specific ways you can control your presentation during a talk.

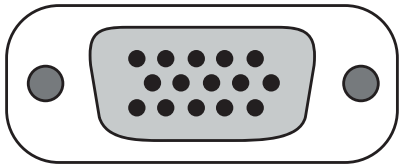
Bring Your Own Power and Projection Cords

Every computer comes with its own cord for connecting to a power outlet, and many, especially Macs, have unique cords for connecting with a digital projector (PCs often connect to the projector directly without the need for an adaptor cord). In fact, the same manufacturer can vary their cords across computer models and years. If you plan on using your laptop during a talk, it is your responsibility to bring your own cords to the presentation venue.

You won't come across as professional if you have to ask around for a cord, especially because you may have to ask several people before finding the correct one.

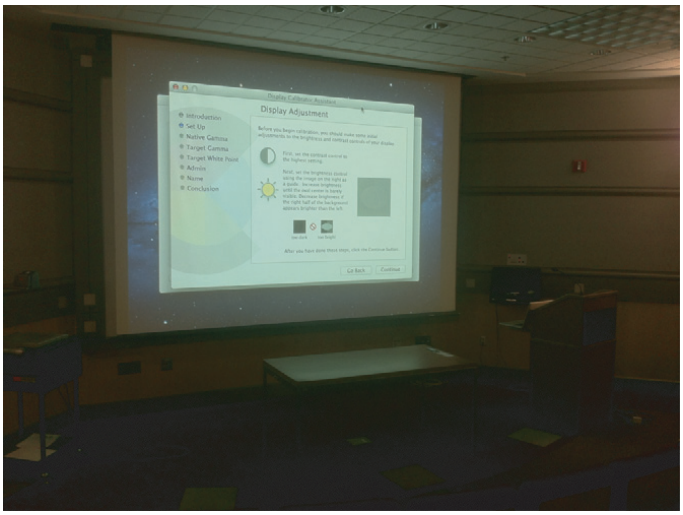


At left, a black cord that connects a laptop with a projector, along with a few white connector cables accumulated throughout the years. The correct cable will connect with your computer on one end and connect with a 15-pin VGA cable on the other end. Your laptop or connection cable should contain 15 holes to accept the pins (below).



Calibrating a Laptop with a Projector

Just because you can successfully connect your computer to a projector doesn't ensure that the projector will faithfully display your slides with the same brightness, contrast, and colors you see on your screen. In fact, sometimes a projector will not even align graphics on your slides in the same way that they are aligned on your screen. Fortunately, most laptop operating systems contain projector calibration tools that help you match your personal display with what is projected to the audience.

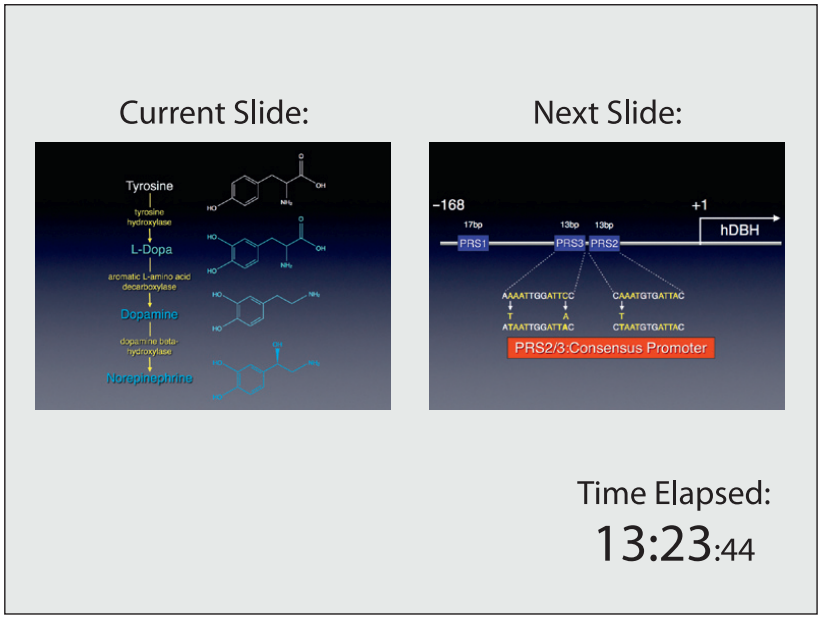


This is the display calibration system used in Apple laptops. As soon as you connect your computer to the projector, you can calibrate the display within minutes to ensure that your settings are optimal so your slides look their best.

Alternate Display Settings

Most slide presentation applications include a special mode that allows you to see something different on your personal display from what is displayed to the audience. This personal display might include a preview of the next slide, a clock timing the length of your talk, and your presentation notes.

While it is usually not a good idea to read presentation notes directly off your screen, a quick peripheral glance at your screen can provide you with real-time information that will help you improve your transitions between slides and keep track of time.



Adjust your settings so that your personal display shows you your next slide and the amount of time that has elapsed.

Learn the Light Switch

The piece of technology that often causes the most problems during a talk isn't the computer or projector—it's the lights. Many scientists like to show photographs or videos that look better when the lights are off, but few scientists take the time before their talk to learn where the light controls are and how to use them.

While it may not be the most embarrassing experience to have to ask someone to turn off the lights for you during a talk, it is distracting to an audience and conveys that you aren't in control.

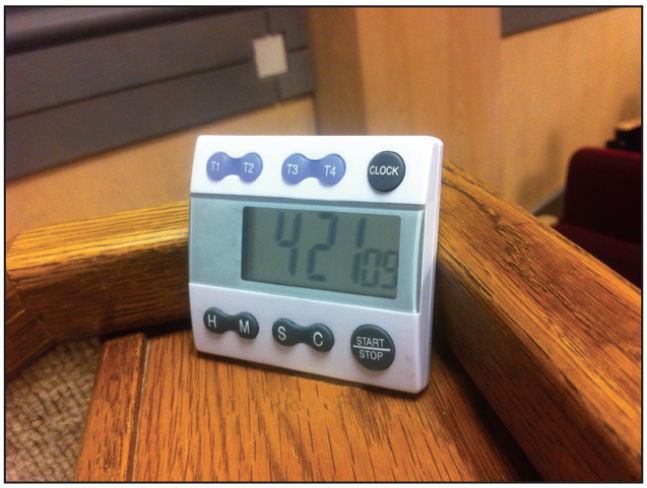
In contrast, if you can immediately turn on/off the lights without pausing your delivery, you will seem in total command of your presentation.

Whether the light controls in your presentation room are fancy (top) or resemble any common light switch (bottom), learn how to adjust them before your presentation begins.

Keeping Track of Time

Even if you have rehearsed the length of your presentation, you should have a method for tracking time during your actual delivery. Sometimes the anxiety of talking in front of an audience can make a speaker talk too quickly or too slowly. Depending on the format, audience members may also interrupt your talk with questions, adding time to your presentation. Check out the venue ahead of time to find out if there will be a clock facing you. If one doesn't exist, presentation software often allows you to display a timer on your personal display during the slide show. You can even bring a small digital clock to face you during your talk. Just never use your watch… Overtly checking the time in the middle of your talk seems rude, as if you're counting down the moments until you are done.

It is also a good idea to identify one or two benchmark slides that you would like to be at by a particular time. If you find you are too far behind or too far ahead, you can subtly speed up or slow down your delivery just a bit. If pressed for time, you can also start telling audience members who have questions that you would like to address questions at the end.



If you don't see an obvious clock in your presentation room, place a lab timer in the corner of the lectern (or another inconspicuous location) so you can always know how much time has passed during your talk.

Using a Laser Pointer

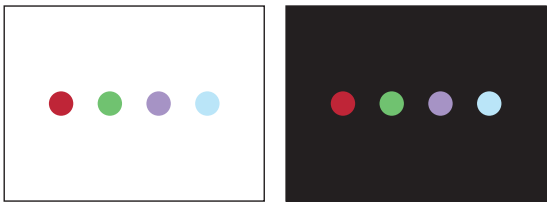
The purpose of a laser pointer is to direct the audience's visual attention to a particular location on a slide. A momentary bright, moving dot is a very salient visual feature that can cause the entire audience to focus on exactly what you want them to see.

Some general advice:

- **Use a laser pointer sparingly.** Just like any highlighting tool, the more you use it, the less your highlighted material stands out. Try to *not* use the pointer as much as possible so that you only highlight the information you truly want to emphasize.
- **Don't turn the laser on until it is aimed at the screen.** You only want your audience to look at the screen, not a spot on the floor or wall.
- **Don't highlight text.** It is annoying when a presenter reads sentences off a slide while using a laser pointer to highlight each word. If you want to highlight a word, say it.
- **Never aim a laser pointer at the audience.** Even if the pointer isn't on, audiences become nervous at the potential to be blinded at any minute. Consider a laser pointer to be like a loaded gun and only aim it at the screen.
- **Try to leave your pointer on for just a few seconds at most.** Direct your audience's attention toward what you want to highlight, then turn the pointer off. If you leave your pointer on for too long, your audience will stop listening to your message and will continue to monitor the dot on the screen.
- **If you are nervous, rest the hand holding the laser pointer on your other hand.** This support will prevent your laser dot from nervously shaking around the screen.

Don't depend on anyone else to provide you with a laser pointer during your delivery. Buy your own, and make sure you bring extra batteries, just in case.

What color laser pointer is best? Pointers are available in red, green, light purple, and light blue (blue pointers are currently the most expensive—usually $200 or more). In general, green pointers seem to stand out the best against any background.

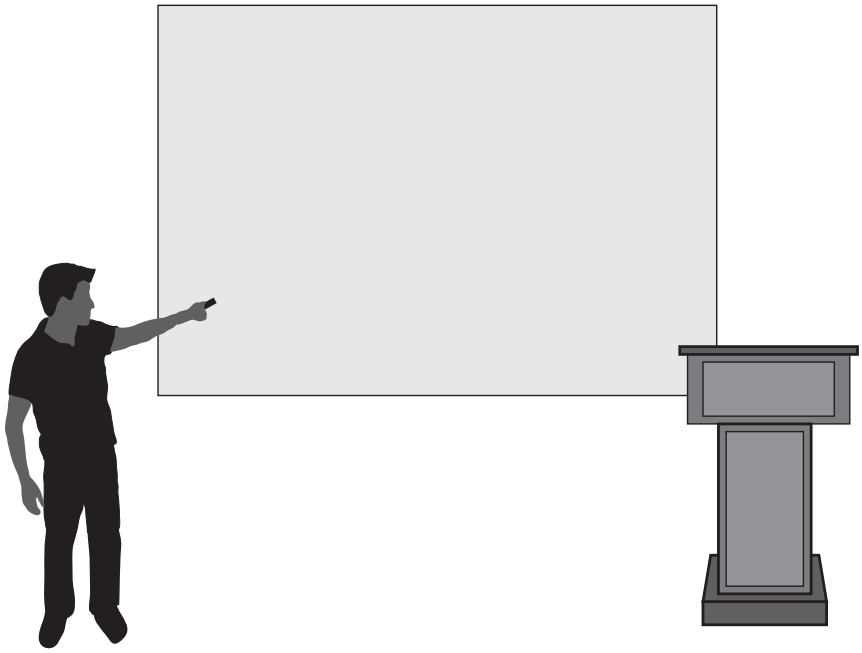


Although red has the highest contrast against a white background and light blue has the highest contrast against a black background, green always has the greatest overall contrast with any background, light or dark.

Using a Remote Slide Advancer

One of the best investments you can make is to purchase a remote slide advancer—a handheld device capable of advancing slides when you are several feet away from your computer. These devices cost anywhere from $20 to $100, and most come with built-in laser pointers (so you don't need to carry two items).

Remote slide advancers liberate you from your computer, allowing you to move freely about the presentation space and interact better with your audience. They also remove the need to constantly look at your computer keyboard each time you want to advance a slide or play an animation; instead of making intermittent eye contact with your computer keyboard, remotes allow you to make eye contact with your audience throughout the entire presentation. People who use remotes for the first time often feel like some sort of artificial barrier has been removed between them and the audience, and some even feel that the freedom to walk around the presentation space calms their anxiety.



Considerations for Presenting While Traveling

Giving a talk while traveling presents you with the challenge of adapting to a novel presentation space, often in the few minutes before your presentation begins. In these situations, it is still possible to bring your own computer cords and your own laser pointer or slide advancer, but you'll have to face the difficulty of quickly adapting to the new space.

If possible, ask your host about the venue ahead of time. Tell your host you would appreciate arriving in your presentation room 10–15 minutes before your audience to ensure that you can connect to the projector and calibrate your display settings. (If this catches your host off guard, it will only make you look more professional compared with other scientists.) Once you've set up your slide show, find a clock (or set up your own), learn to use the lighting, and settle in to your presentation space you so feel comfortable.

Considerations for Presenting with Someone Else's Computer

There are often situations when you need to present using someone else's computer (such as a symposium during which all speakers use the same laptop). In this situation, make sure that you preview every single slide before the actual presentation. If you use any uncommon fonts, they are likely not to show up properly. Also check that all of your media files are present—these files are often not embedded within a presentation itself but linked from a different source on your computer, so they may not show up at all. Be sure to bring a back-up of all of your media files on a memory stick that you can quickly reinsert into your presentation, just in case.

Prepare for the Worst

Presenters who are skilled with technology know that technology often fails, usually at the worst possible moment. There are three key ways you can prepare for the inevitable moments when technology fails:

1. Bring a back-up of your talk, along with all media files, on a USB memory stick.
2. Bring spare batteries for your laser pointer, or even a second laser pointer.
3. Plan a story to tell the audience if you have to pause your presentation while dealing with a technology failure. Nobody likes the nervous energy of a silent room as people try to solve a problem, so if you can tell, for example, a humorous story about something that happened to you or someone you know while giving a talk, it will lighten the atmosphere. Your calm will make others feel calm, and you will seem totally in control.

Summary: Don’ts and Dos

Don’t assume that scientists don’t need to be skilled at using presentation technology.
Do realize that skill with technology makes you seem more professional and in control.

Don’t be unaware of the basic keyboard commands that can be used to control a presentation.
Do learn the basic controls to advance back and forth within your presentation, exit your presentation, and turn the screen black or white.

Don’t assume that someone else can supply you with a power or projector cord for your laptop.
Do consider your cords as valuable to the success of your presentation and keep them in a safe place along with your computer.

Don’t accept that the display you see after connecting your laptop to a projector is automatically the most optimized.
Do use your computer’s display calibration settings to ensure an optimal brightness, contrast, and range of colors.

Don’t wait until your presentation has begun to learn how to turn up or down the lights.
Do learn the lighting controls before your audience arrives, to prepare for moments when you would like to adjust the room lighting.

Don’t depend on anyone else to keep track of time for you during a presentation.
Do find a way to keep track of time yourself, by locating a clock in the back of the room, setting a clock on your display, or bringing a small clock to place on the presentation lectern.

Don’t be confined to the lectern or desk where your laptop is placed.
Do use a remote slide advancer so that you can walk around your presentation space.

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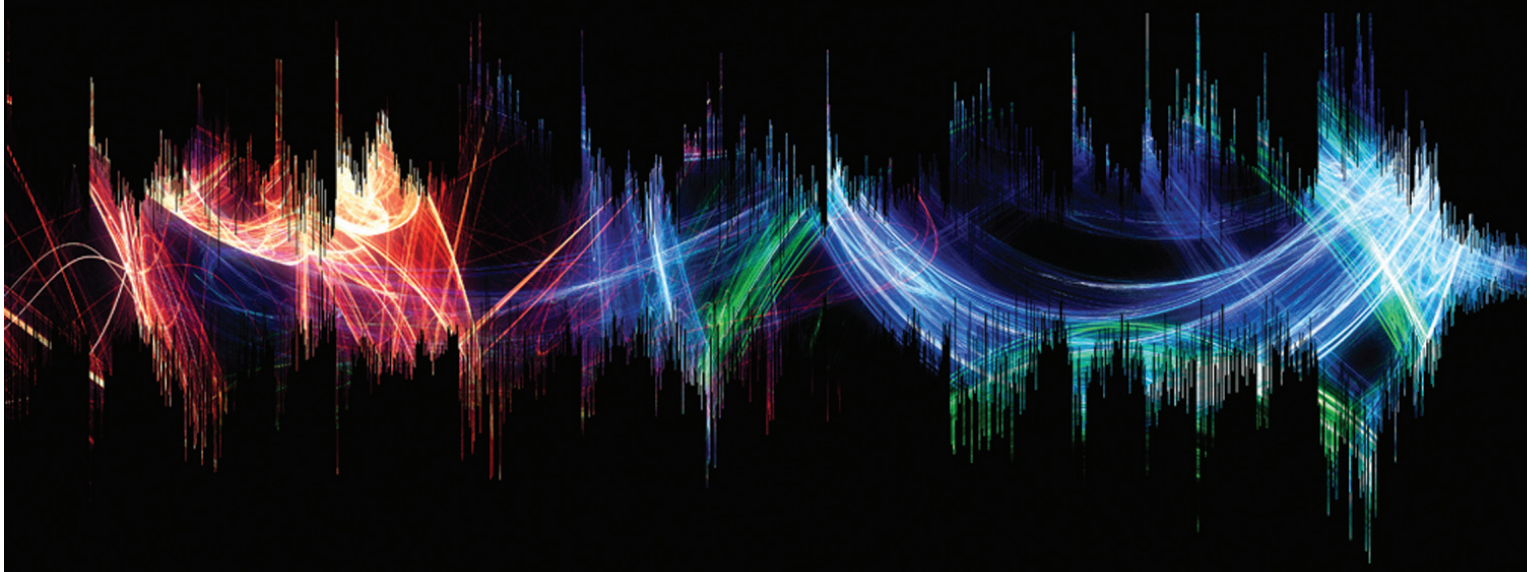
Considerations for Different Categories of Slide Presentations

Just as different categories of written presentations each have different formats and goals, different categories of slide presentations also have different purposes, target audiences, optimal methods of communication, and inherent structures. Sometimes the commonly assumed goals of slide presentations are different from what you should actually strive to achieve. Before designing a presentation for any one category, consider your primary and secondary goals and how you ultimately want to impact your audience.



Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00022-2

The Research Seminar

What it is: An opportunity to share your recent scientific work with colleagues. Research seminars are probably the most formal category of all scientific talks, and include invited presentations, keynote lectures, job talks, thesis defenses, etc. The talk typically represents a full scientific story with a clear scientific question, multiple experiments, and a solid conclusion.

Length: 45–60 minutes (with 5–10 minutes for questions at the end).

Stated goal: To share your recent work with other scientists and briefly describe work in progress. For a job talk, you will also describe how your previous work leads to your future directions.

Unstated goal: To establish your reputation as a scientist and make yourself and your work known among the scientific community. Because you can add photographs, videos, stories, and anecdotes to a slide show that you can't to a formal research article, you can also represent your science in a broader context and amalgamate the results of multiple studies.

Considerations: Because seminars are usually invited by others or required for a job or promotion, they are ultimately the most important category of slide presentations that you will give. If you need to design and build a new presentation from scratch, dedicate dozens of hours to ensure that every aspect of your talk comes across as polished and professional.

When you deliver a seminar presentation, you not only present your science, you also present yourself. Seminars help establish your reputation as a scientist and convey your way of approaching scientific problems and finding solutions. If you are a faculty member, your talk may attract future graduate students or postdoctoral fellows to your lab. If you are a graduate student or postdoc, a seminar may earn you a future invitation to apply for a job. No matter what your position, if you deliver an excellent presentation you are more likely to be invited to speak again in the future, providing you with yet another opportunity to meet other scientists and strengthen your reputation.

The Symposium Talk

What it is: A relatively brief talk grouped with presentations from other scientists about a similar topic. Symposia usually occur at scientific meetings and occasionally also among graduate students and postdocs at research institutions (e.g., end-of-quarter rotation talks, senior student symposia). Someone who isn't presenting serves as a moderator of the proceedings and introduces the speakers.

Length: Usually 10–20 minutes (including 3–5 minutes for questions).

Stated goal: To share your recent work about a specific topic with colleagues.

Unstated goal: To firmly place yourself and your work within the context of a specific scientific field. A symposium is likely to include other scientists within the field and attract an interested audience, and your participation demonstrates that you are a key player within the discipline.

Considerations: Because there are other presentations besides yours, the moderator will strictly enforce time limits. Therefore, you should ensure your talk is meticulously prepared to fit within the time allotted. You don't have time to figure out how you want to explain your experiments and results on the spot—deliberately plan your explanations ahead of time to ensure that you succinctly describe information in the best way possible. Audience members typically don't ask questions until the end of your talk, so you should be able to develop a talk of a specific length.

Unlike a seminar talk, you might only have time to talk about a single scientific goal or narrow set of experiments. For example, during a seminar presentation you might present three specific aims that all address the same topic; during a symposium, you might only have time to talk about a single aim. It is usually best to talk about a single topic in detail rather than try to cram too many topics into a short talk without adequate time to discuss ideas in detail.

Because symposia are usually framed around a specific topic, carefully consider your likely audience and the background material they are already likely to know. If the other presenters and audience members are already familiar with the fundamental concepts and seminal papers in your field, you can omit basic information that the audience already knows and focus your precious delivery time on your work.

The Data Blitz

What it is: A special, informal symposium at some scientific meetings and institutional retreats in which each speaker is allowed an extremely short amount of time and only one slide to describe their research. Data blitzes usually coincide with poster sessions and allow each speaker to publicly describe the work contained in his or her poster.

Length: Usually one slide in 1 minute.

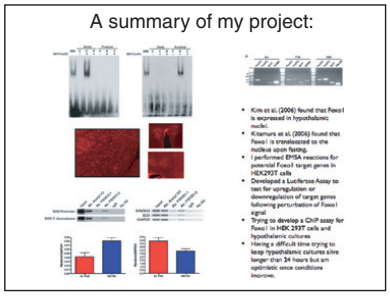
Stated goal: To present your entire research project in a minute or less.

Unstated goal: To be memorable so that you can have more meaningful interactions with other scientists at a later time.

Considerations: Just forget about the stated goal of a data blitz to present all of your work in a minute. If you do what everyone else does and cram too much information into a single minute, your talk will be forgotten almost immediately.

Instead, simplify your slide and delivery to include only what you want your audience to remember: your name, a one-sentence description of your research, a one-sentence description of why your project is exciting, and the location of your poster.

Before



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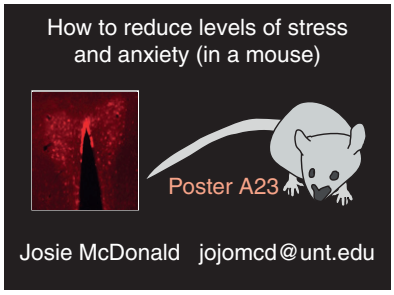

Data blitzes are meant to be fun; however, most speakers interpret fun as talking too fast or presenting too much data. Instead, try to be memorable so that more audience members want to talk with you after the data blitz is over.

The Course Lecture

What it is: A didactic presentation for an undergraduate- or graduate-level course.

Length: Usually 60–120 minutes.

Stated goal: To educate students about a topic that is new or unfamiliar to them.

Unstated goal: To communicate information in a way that students find exciting and memorable.

Considerations: Many scientists focus their lectures exclusively on details they expect their students to remember for upcoming exams and assignments. However, months and years after the course is over, students will forget almost all of these facts. Therefore, the best lectures also communicate a clear rationale of why the subject matter is exciting and focus on one or two big ideas that students will remember for months or years to come. When you think back to your own college science courses, you probably have forgotten most of the details but remember major concepts, demonstrations, or interesting examples about various topics. Try to deliberately incorporate a "take-home" message into every lecture to highlight one concept for your students to remember after the course is over.

Don't feel like you need to only use slides in a class lecture. Sometimes a slide presentation isn't the best way to convey information, and a whiteboard or demonstration is optimal. Not only is it okay to go back and forth between slides and other teaching strategies, it is also beneficial to student attention. By teaching in different ways, you also reinforce concepts and cater to different learning styles.

Whether fair or not, modern students expect you to post your slides online for future reference. Distributing your slides can pose a problem because, as discussed in previous chapters, you shouldn't necessarily place all of the information you present on your slides. The solution is not to deliberately overwhelm your slides with information just because you want to provide your students with a study tool. Instead, inform your students ahead of time that your slides are not necessarily intended to be study notes. Also consider providing students with a supplementary handout that contains a complete list of the information you expect them to know.

The Lab Meeting Presentation

What it is: An opportunity to present work in progress to your labmates.

Length: Varies depending on the lab culture: some lab meetings are strictly limited to 1 hour, while others can routinely last 2–3 hours.

Stated goal: To share your recent experiments and results with your labmates in a way that solicits advice and feedback.

Unstated goal: To cement your reputation among your labmates as a careful, detail-oriented scientist who enjoys working as part of a team.

Considerations: Don't assume that because lab meetings are routine and relatively informal it is acceptable to deliver a low-quality presentation. Because your labmates give up their time to attend your talk, any lack of effort on your part is disrespectful.

Also don't assume that your labmates are completely familiar with your presentation topic or will automatically remember what you presented during your previous meetings. Always start your presentation with a clear description of your scientific question or goal.

Lab members don't like it when they feel you are trying to use your lab meeting to teach them a concept. A didactic presentation to your peers can come across as condescending. Lab members also don't like it when they feel you are avoiding talking about your progress since your last presentation. Ideally, a typical lab meeting will start by reminding your audience about your topic and what you presented previously, then describing all of the progress (positive or negative) since your last meeting, as well as what you plan to do before your next meeting.

Lab members like to feel useful. Explain your work in a way that invites feedback and discussion. Try not to act defensively in response to suggestions or criticisms of your work. If you are receptive to the ideas of your colleagues, you will not only improve your own science but also communicate to your labmates that you respect their opinions and enjoy being part of a team.

The Journal Club

What it is: An opportunity to present a recent paper (or two or three related papers) to your lab or other colleagues at your institution.

Length: 30–60 minutes.

Stated goal: To critically examine a recent paper for the purpose of informing others about recent findings or an interesting, novel approach. A related goal is to discuss how the findings or methods used in the paper could directly influence your work or the work of your colleagues.

Unstated goal: To showcase a research topic or method that you are particularly interested in.

Considerations: Don't choose a paper that you don't like or aren't enthusiastic about. The best journal club presentations inspire others to do good science, and enhance ways of thinking about a scientific problem.

If the title of your paper contains jargon or esoteric phrases, consider beginning your talk by rewriting the title of the paper in words that your audience can easily understand. For example, in your title slide, write the title of the paper, but then start your talk by providing a quick translation (if necessary).

To ensure that your audience understands the context of the paper, it may be a good idea to highlight a few key papers that precede the current study. Although your journal club will be focused on the paper(s) you choose, it is always okay to mention others if it helps convey the background and context.

Don't feel you need to obediently follow the structure of the paper you choose. Although you should highlight the paper's rationale, scientific question, and major results, it is up to *you* to choose what you want to present. Due to time constraints, you may choose only to talk about the most relevant figures and, if you have good reason, you can present these figures in any order you choose.

At the end of the talk, discuss the relative strengths and weaknesses of the paper. Questions you might address: Do the results of the experiments justify the title? How does this paper contribute to our understanding of a field of science? Are any crucial experiments missing? What are the likely future directions?

Summary: Don’ts and Dos

Don’t underestimate the importance of a seminar presentation.
Do realize that any seminars will help to establish your reputation in the field, and require many hours of consideration and preparation.

Don’t try to cram too much information into a symposium talk.
Do meticulously design and rehearse your symposium talk to deliberately fit into the short amount of time you are allotted for your presentation.

Don’t try to talk about an entire project during a data blitz, even if other people tell you this is the goal.
Do deliberately design a data-blitz slide to attract further attention to you and your poster.

Don’t design a class lecture that only presents facts and concepts to memorize.
Do deliberately highlight at least one take-home message or memorable concept that students will remember long after the class is over.

Don’t assume that because lab meetings are routine and informal they don’t need to be professional.
Do respect your colleagues’ time and deliver a good lab meeting presentation that invites feedback and discussion.

Don’t choose a journal club paper that nobody will care about.
Do present an inspiring paper capable of sparking discussion about how the findings or methodology can be applied to your work or the work of your peers.

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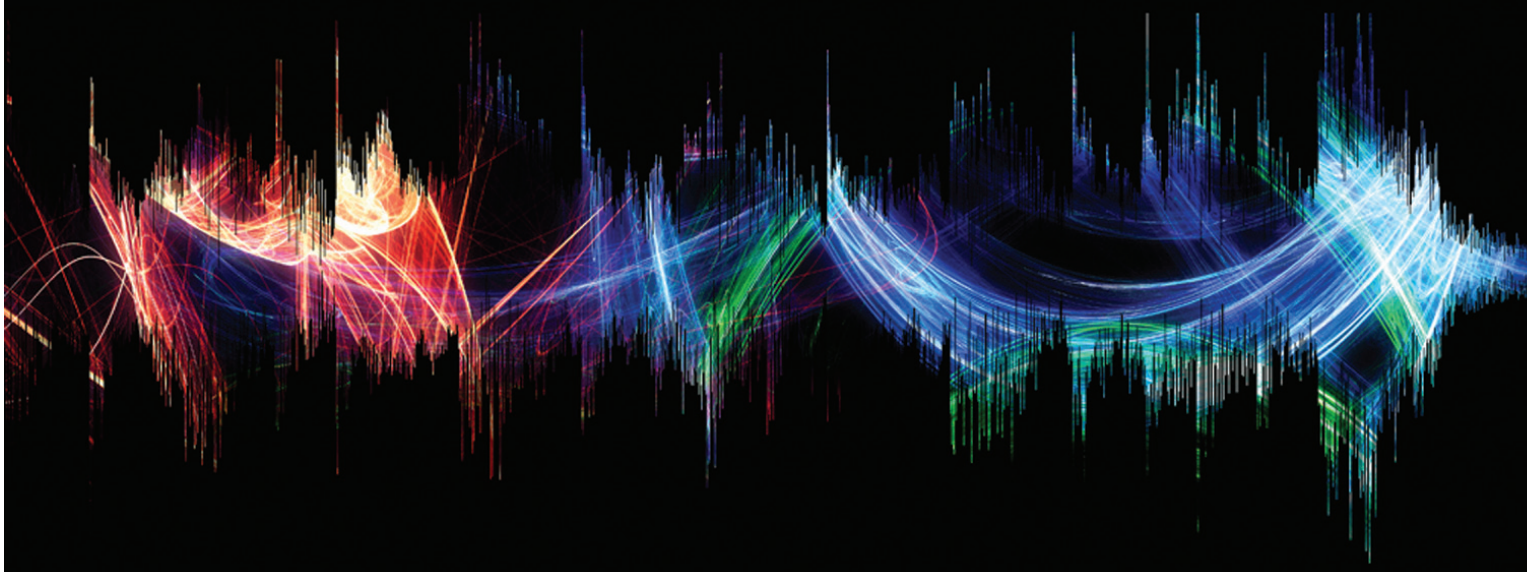
Presenting Without Slides

As scientists, we are so used to presenting with slides that we don't even notice how protected they can make us feel. When we find ourselves in situations in which we cannot use slides, we can feel naked—as if some safeguard is missing and our ideas and information are overexposed. Indeed, without a screen to look at, the audience will spend most of its time fully engaged in watching *you*. But isn't this a good thing? Don't we want to communicate information without adding anything to distract the audience? Presenting without slides might make us feel more exposed, but can also increase the intimacy of the relationship we have with our audiences. With careful and deliberate preparation, you can use your lack of slides to your advantage and better convey information and communicate your scientific story.



Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00023-4

You Never Needed Slides in the First Place

It is easy to forget that scientists have only used slides as visual aids for the previous 30–40 years, and digitally for just the past 10–20 years. And yet science has, in one form or another, been successfully presented to audiences for thousands of years. Not only did some of history's great scientific presenters (Richard Feynman, Rita Levi-Montalcini, Carl Sagan) not use slides; many exceptional contemporary presenters also use few or no slides (for example, check out online presentations by Richard Dawkins, Malcolm Gladwell, Steven Pinker, and Jill Bolte Taylor, among many others.) John F. Kennedy did not use slides to inspire America to go to the moon when America was losing the space race in the 1960s, and Ronald Reagan did not use slides to convince the nation that human space exploration was still necessary after the *Challenger* disaster in the 1980s.

The key to gaining confidence about presenting without slides is to realize that you don't *need* slides to communicate science and that you can give an exceptional talk without them.

In fact, the success of a presentation with slides has little to do with the slides themselves. (In Chapter 3, Twenty-One Characteristics Shared by Exceptional Presenters, all but two or three characteristics make no mention of using visual aids, and the ones that do only apply if you *choose* to use them). Successful presentations are more about how you design the structure of a talk, thinking about your audience and conveying the clearest message possible.

Of course, there *is* something missing from a slide-less presentation, and that is a set of figures that communicate the results of experiments. Data are best communicated visually, which is why we prefer to present figures in papers, slides, and posters in the first place. Without slides, it is more difficult to communicate complex scientific results or compare the quantitative relationships between two or more variables. However, there are methods to overcome a lack of prepared visual aids. By knowing your data as well as you should, you can develop strategies to communicate results, such as drawing a figure from scratch on a whiteboard or using your hands to draw a virtual graph in space.

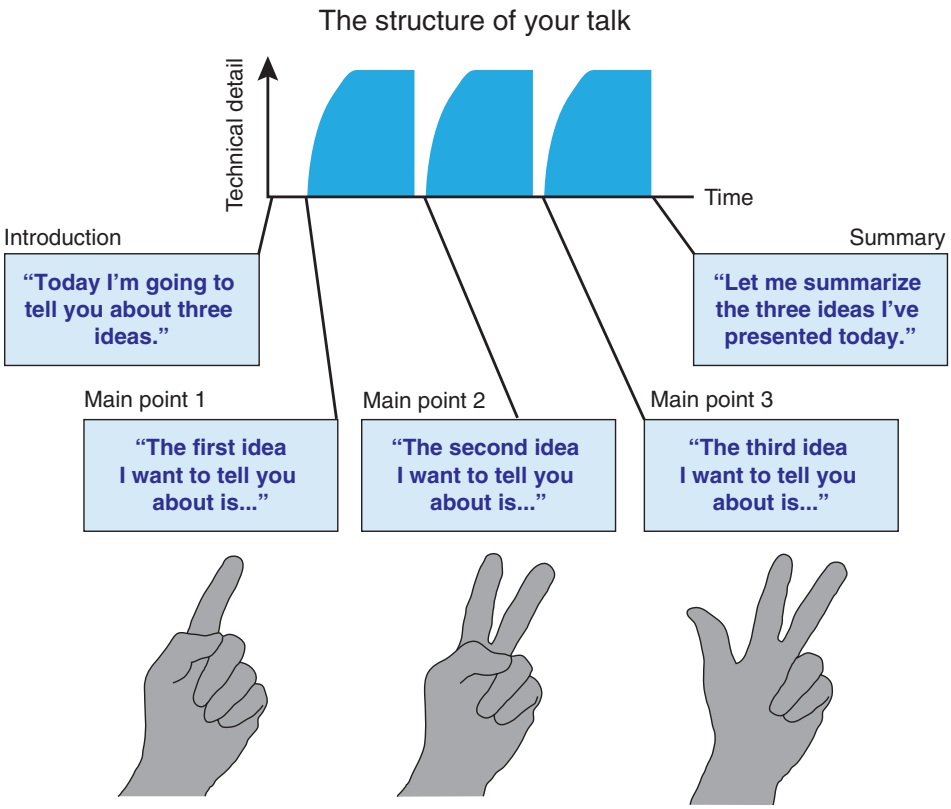
The first time you present without slides, you might feel like Dumbo the elephant when he had to fly without his magic feather; he eventually learned that the feather wasn't magic at all and he could fly by himself all along. Likewise, your slides are not magic, and if you feel good about your past presentations, you should realize that your success was due to good organization and structure independent of your visual aids.

Communicating Structure without Slides

It is relatively easy for an audience to perceive the structure of a slide presentation: your slides visually communicate the beginning, middle, and end of your story, and if you use a home slide (described in Chapter 16), your audience has a visual roadmap of your entire presentation.

In a presentation without slides, one of the best ways to help your audience is by conveying the structure of your presentation using clear, oral statements.

Be very deliberate about communicating the outline of your talk—if you only memorize and rehearse one aspect of your talk, it should be the presentation of your structure. Also be deliberate about including clear hand gestures that reinforce the structure you convey with your words.

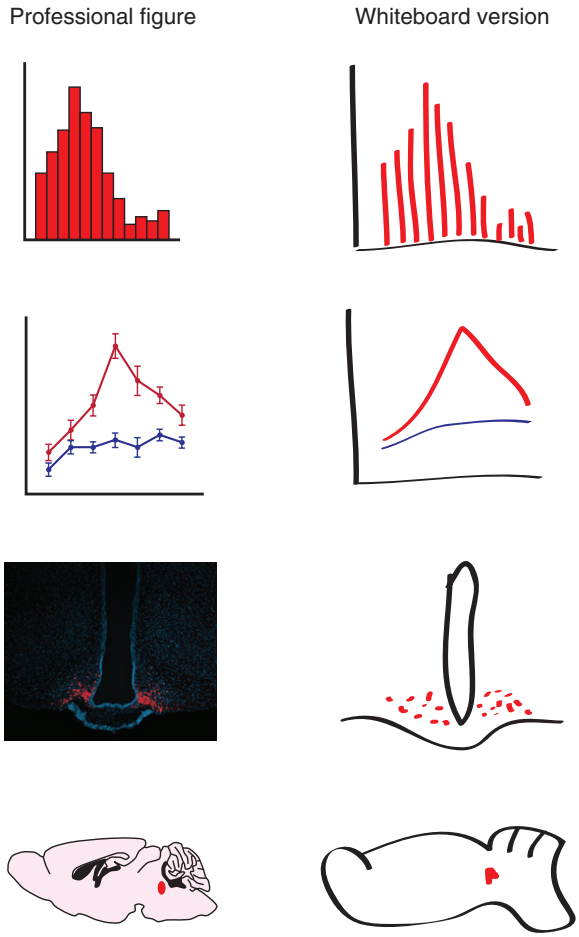


By clearly conveying structure to your audience, you also help yourself remember your scientific story and reduce the risk of off-topic rambling.

Plan Figures Ahead of Time

For a slide-less presentation, just because you don't present a set of prepared visual aids to your audience doesn't mean that you shouldn't design figures ahead of time.

Designing figures for a slide-less oral presentation involves choosing the most important results that you want to communicate, crafting simple figures that are easy to recreate on the spot, and practicing drawing your figures a few times to ensure you can quickly illustrate them for your audience. Don't forget to practice—you don't want the first time you try drawing a figure to be in front of your audience.



Remember that just because you recreate figures using chalk or whiteboard pens, you don't have to give up principles of design! For example, you can continue to use warm colors in the foreground and cool colors in the background.

Maintaining an Audience's Attention

Every time you advance to a new slide when giving a slide presentation, your audience members receive a new visual stimulus that can potentially refocus their attention. In a presentation without slides, your audience members only have *you* to look at, and therefore they can become more easily distracted. Although the following strategies for maintaining an audience's attention are useful for any category of live science presentation, they are especially important for a slide-less oral delivery in which you don't have visual aids to increase focus on your scientific story.

- **Maintain eye contact.** If you look your audience in the eyes and keep consistent eye contact throughout the duration of your presentation, your audience will feel more like they are having a direct conversation with you and less like they are passive observers.
- **Smile.** Audiences are more likely to watch friendly, smiling presenters than speakers who seem unhappy to be talking in front of others or dispassionate about their topics.
- **Gesticulate.** Instead of keeping your arms at your sides or behind your back, use gestures as much as possible to reinforce what you say verbally and also to be more animated.
- **Ask your audience questions.** Deliberately plan two or three moments throughout your talk in which you ask your audience an interesting question:

  "Does anyone know which planet or moon NASA sent a probe to most recently?"

  "What are some of the most endangered species on earth?"

  "What are some of the genes necessary for proper neural development?"

  Regardless of whether or not you actually decide to solicit answers, asking the question causes your audience members to think about your topic, resulting in a sustained moment of focused attention.
- **Walk around.** Moving objects attract attention more than stationary objects, and in a slide-less presentation the only moving object you can present is *you*. Walking about your presentation space also makes you seem more relaxed and conversational, and gives the impression of an intimate conversation rather than a formal delivery.
- **Sit informally.** When appropriate, find moments during your presentation when you can sit informally in front of your audience. Usually, remaining stationary will increase the likelihood that your audience will lose attention; however, if you sit informally on a desk, off the edge of a stage, or backwards in a chair, your audience members will see that you are relaxed and totally invested in your conversation with them.

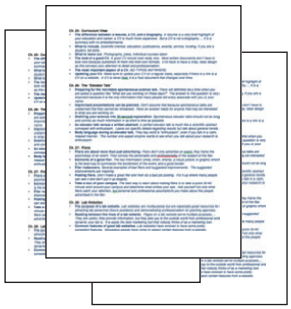
About Presentation Notes

As for any presentation, you should rehearse an oral talk without slides before your delivery to ensure that you know your material so well that you don't need presentation notes. However, the increased anxiety that might come with an oral presentation can have a powerful effect on your ability to remember all of your main talking points. One of the advantages of using slides in presentations is that if you forget what you planned on talking about next, you can always advance to the next slide to find out. In a presentation without slides you don't have this insurance, and it can be nice to bring notes to help you if you find yourself at a loss for words.

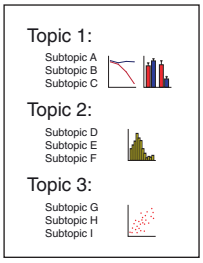
Try to resist the urge to use highly detailed presentation notes during your delivery. The problem with referring to a detailed outline of your talk is that each time you look at your notes, you break eye contact and, potentially, your emotional connection with your audience. Even if you don't plan on consulting your notes and only want to bring them in case you get stuck, the simple act of bringing them with you might cause you to refer to them more than you planned.

Instead of bringing highly detailed notes, bring a simple outline that is easy to read with a single glance.

Write only a general outline of your talk with two or three main topics and a few "can't forget" talking points for each. Using just a general outline will ensure that you present your most vital information without developing more of a relationship with your notes than you do with your audience.



Highly detailed presentation notes are difficult to refer to during a talk without risking breaking eye contact with your audience and breaking the flow of communication.



If you decide to bring notes, use a single page with large words in which you can remind yourself of the most important topics with a single glance.

Summary: Don’ts and Dos

Don’t think that you need presentation slides in order to deliver a dynamic, exceptional presentation.
Do realize that slides are one of a handful of tools you can use to deliver a presentation, and that many people deliver exceptional talks without them.

Don’t deliver a slide-less presentation without clearly conveying the structure of your talk to your audience.
Do use clear, discrete statements and non-verbal gestures to ensure your audience can clearly grasp the outline of your presentation.

Don’t draw figures for the first time during your actual delivery.
Do plan the figures you are most likely to draw on a chalkboard or whiteboard and practice drawing them until you can recreate them quickly.

Don’t deliver an oral presentation without using techniques to maintain an audience’s attention.
Do deliberately plan and employ strategies to increase the likelihood that your audience will watch and listen to you throughout the duration of your talk.

Don’t use highly detailed presentation notes during your talk.
Do rehearse enough so that you don’t need notes or, at the very least, only bring a single page of notes on which it is easy to see information with a single glance.

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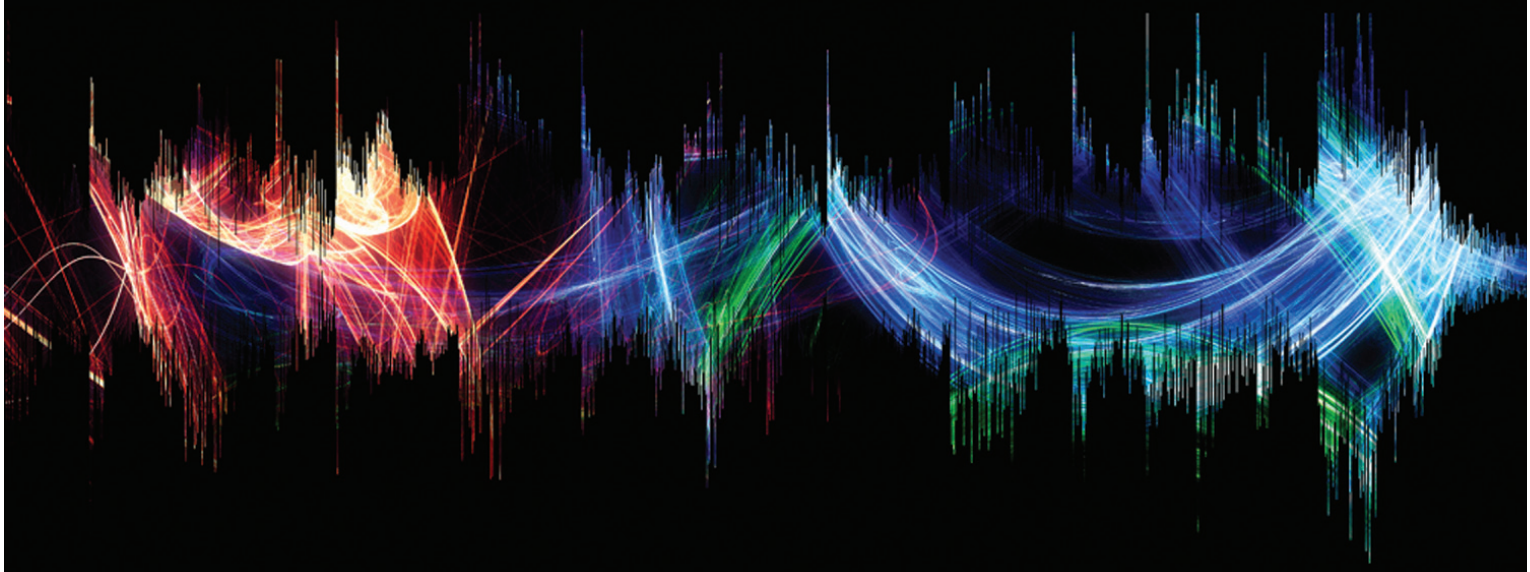
Considerations for Different Categories of Oral Presentations Without Slides

Oral presentations without slides are often less formal than presentations with slides; however, this informality does not imply that slide-less presentations are unimportant or require no forethought. In fact, oral presentations without slides often require more consideration than presentations with slides because you must achieve your goals without visual aids, using oral and nonverbal communication alone. Only by defining what impact you want to have on your audience and carefully considering the advantages and disadvantages of your specific category of oral presentation can you design a talk that perfectly communicates your ideas.



Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00024-6

The Chalk Talk

What it is: A presentation delivered in front of a chalkboard or whiteboard on which you can draw diagrams and charts in real-time in front of your audience, who will ask you questions throughout your talk. The advantage of a chalk talk over a slide presentation is that the audience can help direct the content of the talk in a way that would be impossible with pre-made, ordered slides, and you can adjust your flow as necessary. Chalk talks are usually included in job interviews for faculty positions.

Length: 45–60 minutes.

Stated goal: To present a scientific story or proposal for future experiments while answering a constant stream of questions from your audience.

Unstated goal: To demonstrate that you are exceptionally familiar with your scientific content and that you can think on your feet when questioned by other scientists. If your presentation is part of an interview for a faculty position, you will also be judged on your communication skills.

Considerations: Although the questions you receive from your audience will require you to be flexible about how you deliver your talk from beginning to end, always thoroughly prepare the structure of a chalk talk as you would for a slide presentation, with a clear beginning, middle, and end. You may have to modify your structure slightly during the actual presentation, but begin your talk with a clear plan in mind so that you deliver a focused and organized story.

Consider writing the major themes of your talk on the board, one at a time, during each segment of your presentation. For example, if you are presenting a proposal for future research and have three specific aims, write each aim on the board as you present it so that your audience will always have a visual reminder of your big picture. Writing these statements is the closest you can come to mimicking slide titles.

Don't face the chalkboard or whiteboard during your talk. When you need to draw something on the board, try to align your body at a 90° angle to both your audience and the board so that you can easily look back and forth between the two while you draw.

The Round Table Presentation

What it is: A format in which a small group of 5–10 people sit around a conference table and each person takes a turn showing the progress and results of his or her research. This style of oral presentation usually occurs for lab meetings or at annual meetings for awardees of specific grants or fellowships. Sometimes you are asked to bring a brief handout with figures, or you can even bring a laptop or lab notebook with primary results.

Length: 10–15 minutes per speaker; perhaps 1–2 hours for the entire session.

Stated goal: To share, concisely, the results of your most recent research.

Unstated goal: To show that you are making progress on a research project, even if the progress is not in the form of positive results.

Considerations: Although a round table presentation is shorter and more informal than many other categories of talks, make sure that you still prepare and rehearse a presentation with a clear beginning, middle, and end. If you don't have a clear idea of what you are going to say and how you are going to say it, you risk rambling with no coherent message and coming across as not knowing your own science very well.

Just like for any presentation, always state the rationale of individual experiments before you show data. If you bring a handout, wait to pass it out until you clearly explain the purpose and goal of your research. Likewise, don't show data from your laptop or lab notebook until you introduce its meaning and purpose.

Because the energy and attention span of the participants tends to wane over time, usually the people who present first in a round table session speak for longer than those who present at the end. Therefore, if there is no set speaking order, volunteer to present first if you expect to have a lot to say or if you want a lot of attention and feedback from your audience.

The Elevator Speech

What it is: An impromptu talk in which you give a short synopsis of your research to a scientist or group of scientists whom you have just met, typically in response to the question, "So what do you work on?" The name comes from a hypothetical scenario in which you meet another scientist in an elevator and have only the length of the ride to present your scientific story. Of course, such a talk doesn't often actually occur in an elevator but simply denotes any spontaneous explanation of your research. This category of talk is quite common at scientific conferences during which you meet other scientists and only have a brief opportunity to share your work.

Length: 2–3 minutes.

Stated goal: To effectively and succinctly describe your scientific story and goals to someone unfamiliar with your work.

Unstated goal: To inspire interest and enthusiasm in you and your work and create a memorable impression.

Considerations: Just because an elevator speech is spontaneous doesn't mean that it should be unplanned. If you are about to enter a setting in which you will meet other scientists (like a scientific meeting), realize that you will likely be asked to give an elevator speech. Mentally rehearse a short synopsis of your scientific story ahead of time so you are sure to make a great first impression.

A good elevator speech has a similar structure to a good scientific abstract:

- One or two sentences about your overall scientific topic
- One or two sentences about your specific scientific topic
- A single sentence that declares your specific scientific question
- One or two sentences about the methods you use to answer your question
- One or two sentences about what you have achieved so far
- One or two sentences about what you are planning to do in the future

Obviously, you should adjust the content of your research summary depending on the background of the person with whom you are speaking. An expert in the field needs less of an introduction than a scientist from a completely different subfield.

In addition to communicating your scientific content, you need to communicate enthusiasm for your work. The more enthusiastic you are, the more memorable you and the content are likely to be.

The Speaker Introduction

What it is: A short introduction for a speaker before he or she delivers a longer (usually 30- to 60-minute) presentation.

Length: 1–3 minutes (in general, the more formal the occasion, the longer the introduction).

Stated goal: To provide a brief biography of the speaker for the audience.

Unstated goal: To elevate the speaker's reputation with the audience by highlighting his or her credibility regarding a presentation topic and establishing why the topic is important and interesting.

Considerations: Most scientists consider a speaker introduction as an afterthought, something that can be hastily put together moments before the start of the talk. This lack of preparedness is disrespectful to the speaker, and often leads to rambling, omission of vital information, and a weak opening to a speaking event. If you are introducing someone who is already well known, you may not feel that the speaker *needs* a thorough introduction; however, he or she certainly *deserves* one.

Establish the speaker's credibility by highlighting key biographical details and achievements such as past research accomplishments, awards, and positions held. Don't mention facts that audiences aren't likely to care about (such as the dates of attendance at universities, or cities where the speaker has lived). In contrast, audiences like to hear specific details about a speaker's accomplishments. For example, you might mention a particularly outstanding research accomplishment and how it led to seminal advances in a field.

Something that most scientists fail to do when introducing a speaker is simultaneously to introduce the speaker's topic. Provide the audience with a strong motivation for listening to the talk and ensure that they understand why the topic is relevant and interesting. The audience will take cues from your introduction, so make sure to convey your own enthusiasm and passion—if you seem disinterested, your audience may become disinterested before the speaker even begins.

Finally, make sure that you get your facts right. Your own credibility and the impact of your introduction are weakened if you mispronounce a key scientific word (especially the speaker's name!) or misunderstand the research accomplishments of the speaker.

Summary: Don’ts and Dos

Don’t assume that presentations without slides don’t require preparation or consideration.
Do consider the needs of any category of slide-less presentation and deliberately play to the strengths of each format to have a maximal impact on your audience.

Don’t show data during a round table presentation before clearly introducing your rationale and goal.
Do give a round table presentation just as you would any other presentation format: by stating your rationale, goal, results, interpretations, and conclusions.

Don’t assume that just because elevator speeches are spontaneous you shouldn’t prepare for them.
Do mentally plan and rehearse a brief summary of your work before you enter situations in which you are likely to meet new scientists.

Don’t hastily prepare a speaker introduction at the last minute.
Do prepare a well-written introduction that enhances the credibility of the speaker and increases the audience’s motivation for listening to the presentation.

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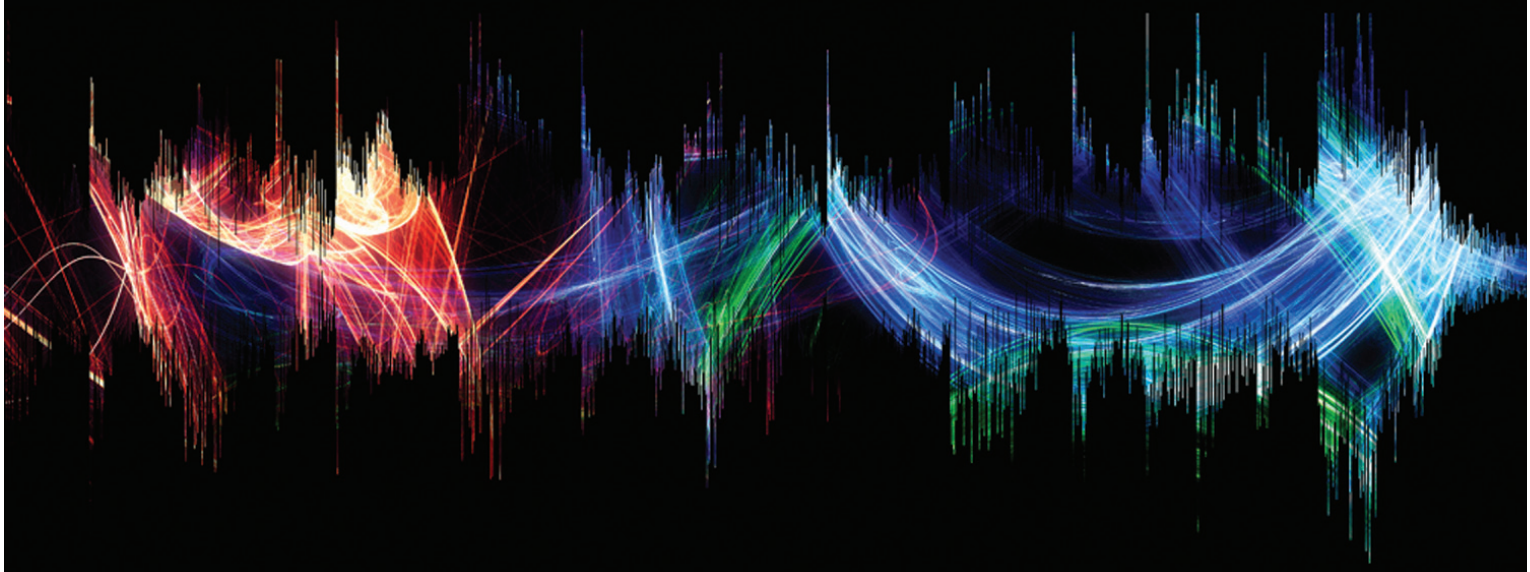
The Structure of a Scientific Poster

Once a minor aspect of a handful of scientific meetings, poster presentations are now the most common way that graduate students and postdocs share their research with scientists from outside their own institutions. In many cases, scientists below the faculty level must commit to designing and delivering a poster to be allowed to attend a scientific meeting. When scientists think about designing a poster, they usually focus on the visual layout and aesthetics. However, just as important is the structure of a poster: the scientific story you present and the accessibility of your information.



Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00025-8

The Purpose of Poster Presentations

The purpose of a scientific poster is to visually present a summary of your research that complements your interactions with other scientists during a poster session. Like slides in a slide presentation, a poster is a visual aid that supports your oral communication of information.

Although a good poster should be intelligible on its own, the primary purpose of presenting a poster is to complement yourself as you network with other scientists.

Poster sessions are a highly efficient way for scientists to interact and communicate information. In a large meeting, hundreds or even thousands of posters might be presented at once, and attendees can easily find the presentations that interest them the most. During a relatively brief 5- to 10-minute delivery, a scientist can discuss his or her research with others, receive feedback, and exchange contact information, then meet and interact with a whole new group of visitors.

The Paradoxes of a Scientific Poster

Sometimes the goals of a scientific poster seem to conflict with each other. For example, your poster should be able to stand alone so that you don't need to be present in order for the reader to fully understand the background, question, methods, results, and conclusions. However, when you *are* present (which will hopefully be the entire duration of the poster session), your poster should serve as a backdrop to your oral presentation, and your visitors should focus on what you say rather than focusing on the poster text.

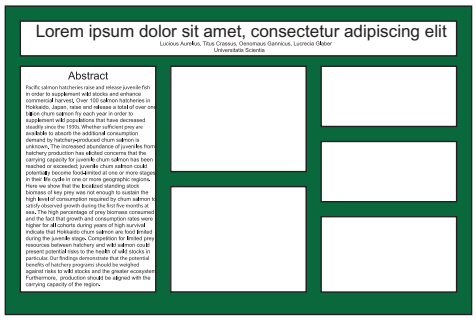
There is another paradox. On the one hand, you want your poster to be as detailed and complete as possible so that your audience fully understands your research. On the other hand, you want your poster to be clear, concise, and accessible. Therefore, you must squeeze a lot of information into a small space in a way that doesn't appear cluttered or wordy.

Designing a scientific poster is therefore a bit of a balancing act. Your challenge is to present as much information as possible in as few words as possible using a visual aid designed to complement you, yet that can be understood without your presence.

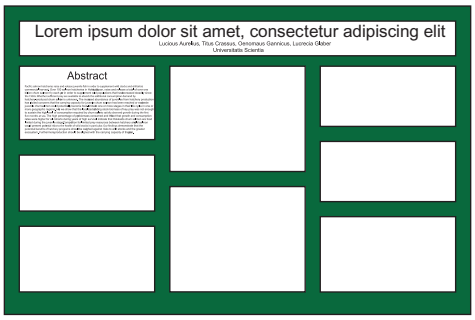
The First Step: Writing an Abstract

The very first step in the process of presenting a poster is usually writing an abstract (some meetings will call this a "summary"), which you submit to a conference organizing committee months before the actual meeting so that your poster presentation can be approved and assigned a presentation time/date. Once approved, the meeting organizers will publish your abstract in an official program so that attendees can find the posters they would like to visit. Write the abstract for a poster as you would for a research article (see Chapter 12, p. 165).

Never place your abstract on the poster itself. Unlike a research article, your abstract is not part of the actual presentation—it is for the conference program only.



If you rewrite your abstract on your poster using an optimal font size, it could take up a full third of your available space. This abstract is the same as the example from Chapter 12.



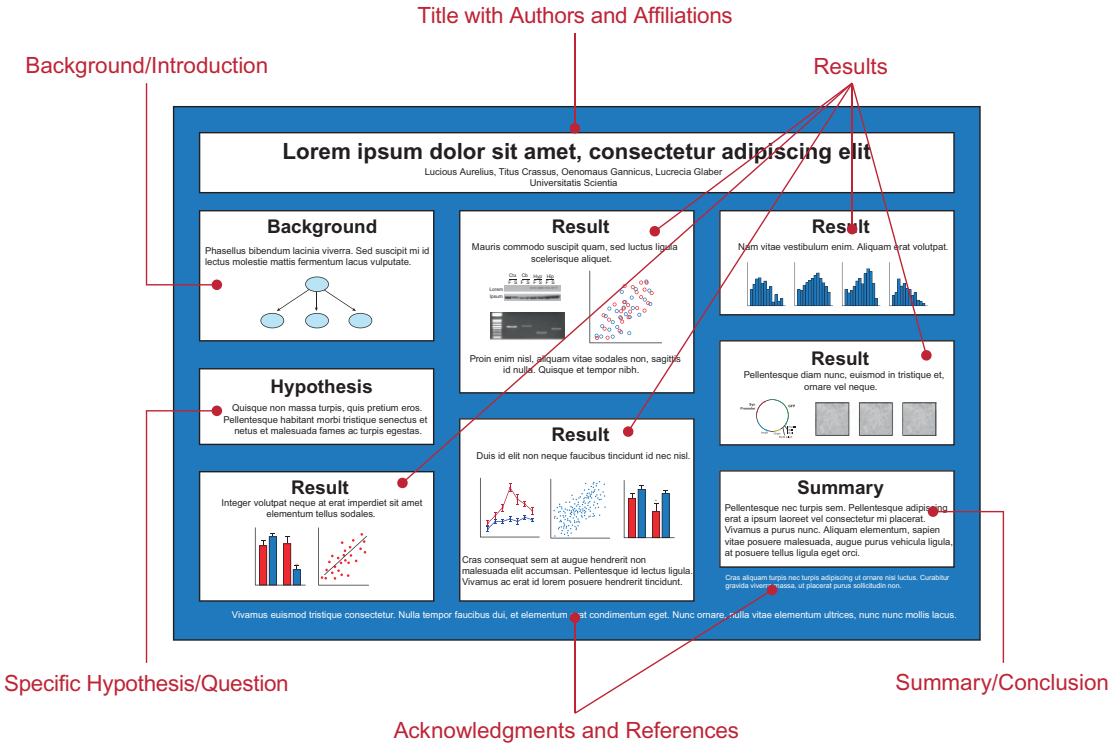
It is possible to use a smaller font size for your abstract, but nobody will want to read it. And if nobody reads it, why place it on your poster?

A poster is essentially already a summary of your research, and if you include an abstract on your poster itself you will waste 20–30% of your precious space in summarizing a summary. Some meeting organizers will tell you to rewrite your abstract on the poster; however, state governments currently lack adequate funding and, at the time of this book's printing, there are no known poster police that will arrive to take you to jail for not placing an abstract on your poster.

Many scientific meetings publish an online, searchable program of abstracts in addition to a hard copy version. To increase the likelihood that your poster will be found by interested attendees, deliberately include keywords in your abstract that someone might enter into a search field. Think of the top 5–10 words that you would want associated with your poster, and make sure those words appear somewhere in your abstract.

The Sections of a Poster

The sections of a scientific poster are similar to the main sections of a research article, except that ideally they will only contain a handful of sentences of text.



Title. Your title is incredibly important because, during the poster session, it will serve as the main attraction for potential visitors. People passing by will scan titles to see which posters they would like to see in further detail. Therefore, make your title not only informative but also easy to read. If your title seems wordy and full of jargon, you will likely turn away potential visitors.

Background/Introduction. Your background should provide just enough information for another scientist to be able to understand your poster. In a research article, the introduction might be composed of three to five paragraphs. In a poster, try to limit yourself to four to eight sentences. Use figures instead of words to communicate ideas whenever possible.

Hypothesis/Question/Purpose/Goal. To highlight your scientific goal, place the question or purpose that drives your science in its own section and not just at the end of your introduction. Ideally, this section will be composed of a single sentence, perhaps accompanied by a diagram.

Methods (optional). A methods section is crucial for a scientific paper, but not necessary for a scientific poster unless you used a single, unique method throughout your entire study (for example, you used a specific type of telescope to collect all of your astronomical data). Sometimes a statement on methods can be written immediately following your hypothesis/question (e.g., "To address this question, we…"). If you used several common methods throughout your study, simply refer to each method in the results (e.g., "To determine result X, we used method Y").

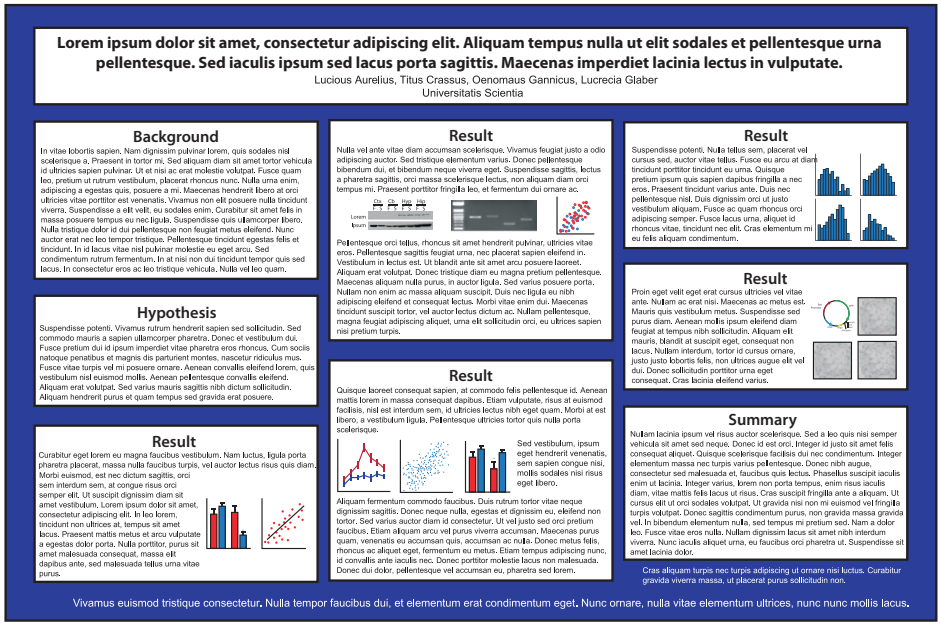
Results. Your poster will probably contain four to eight individual results sections. Write a specific, informative title for each section, as opposed to "Result 1," "Result 2," etc. Each section may contain several figures that each lead to the same conclusion. To reduce text, write only one or two sentences that state the results of your figures, and let the figures themselves be the most prominent aspect of each results section.

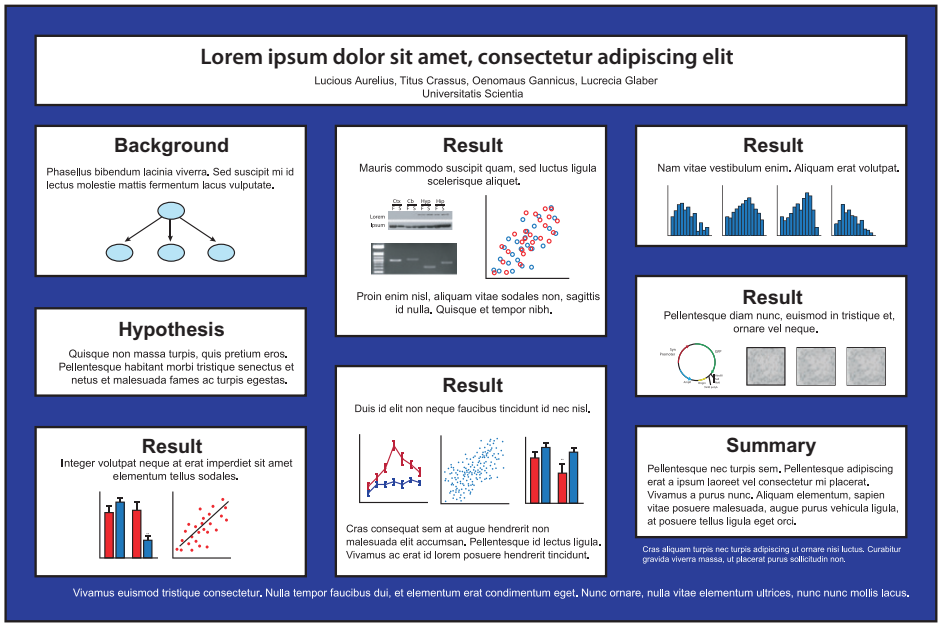
Summary/Conclusion. Briefly re-state the major results of your experiments. This section can sometimes seem redundant, especially if you did a good job crafting the results panels that show your data; however, many visitors will appreciate seeing all of your major results summarized together. At the end of your summary, you might include one or two sentences about whether your hypothesis was supported or disproved, or whether you sufficiently answered your research question.

References and Acknowledgments. References, acknowledgments, and other supplementary details are okay to include, but are no doubt the most boring aspects of a poster. Try to limit yourself to only three to five key references that are absolutely crucial to the background of your study and/or that visitors might like to consult for further information. Acknowledgments should mention specific contributions to the poster, including funding sources, shared reagents, and insightful advice.
To de-emphasize the references and acknowledgments and save room on your poster for more important items, shrink the font size of these sections compared to the font of the other sections and place them at the very bottom of your poster without any bounding boxes (see Chapter 26 for more information about layout).

The Importance of Reducing Text

Take a look at the two posters below and ask yourself two questions: (1) If you were attending a poster session, which poster would you rather visit? (2) If you were presenting at a poster session, which poster would you rather present to a visitor?





The poster on top will repel potential visitors because it looks like a chore to read.

There is an inverse correlation between the amount of text on your poster and the probability that someone will actually read it.

The poster on the bottom is more pleasurable to read, more visually appealing, and easier to present to a passerby. More importantly, the poster is easier to understand, and communicates your research much more clearly and effectively.

Posters are more like slides than they are like written manuscripts. The goal is to communicate information *visually* with figures and images, not to write a long document that a visitor reads like a paper. The purpose of text is to reinforce your oral delivery and provide your audience with key details and information that the figures cannot convey alone. The total word count for your poster should be no more than 600–800 words. Note that this is 10–20% of the word count of a typical research paper.

Advice on Composing the Content of a Poster

When most scientists begin designing a poster, they start by focusing on the visual design and layout of information. A better way to begin the poster design process is to focus on the structure of your poster, deciding what you want to communicate and the best order of information. Below is a good, universal set of steps for composing the content of a poster:

1. **Write your hypothesis/question first.** Starting with the overall question that drives your research will help you focus on your poster's message and exclude any content that doesn't matter.
2. **Design all of your tables, charts, and photographs.** Spend a good amount of time creating the figures for your poster. Your figures are the most important part of your poster because they are what you will refer to during your delivery, and they are what your audience members rely on to comprehend your work. Designing quality figures is discussed in Chapters 7–10.
3. **Group your figures into logical categories.** Each of these categories will form the basis of a single "results" section on your poster. When you group information together, eliminate any figures that don't add meaning or that don't address your specific question/goal.
4. **Write one or two sentences to describe each of your major results.** This text will become the text of each of your results sections.
5. **Arrange your results sections into a logical order.**
6. **Write a summary of all of your results and your overall conclusions.**
7. **Write your background/introduction.** By writing your introduction last, you help ensure that everything you write is relevant to the information you present in your results.
8. **Consider designing a diagram to replace or complement the text in your introduction and summary.** Diagrams (discussed in Chapter 9) are win–win presentation tools: they reduce the amount of text and they add a visual component that quickly communicates information to an audience.
9. **Write a title that succinctly describes all of your content.** If you discover that the title you submitted with your abstract is not the ideal title for your poster, it is usually okay to make a slight alteration. As long as you display your poster at the correct time and location, interested visitors will find it.
10. **Design the layout of your poster.** See Chapter 26. During the layout process, you may need to edit some of your sections slightly so they fit together nicely on the poster. However, writing them before you consider layout issues will greatly help you structure your scientific story and convey it to your audience.

Summary: Don’ts and Dos

Don’t think of a scientific poster as a text-based document that reads like a large version of a research article.
Do think of a scientific poster as a visually rich presentation medium designed to complement what you say during an oral delivery.

Don’t place your abstract on your poster itself.
Do write your abstract for the organizing committee and official meeting program, but avoid rewriting it on the poster so that you don’t take up valuable space.

Don’t overwhelm your poster with text.
Do use tables, charts, diagrams, and photographs whenever possible to enrich the visual impact of your poster.

Don’t begin designing a poster by focusing on layout.
Do begin designing a poster by making your figures and writing the text for the individual sections.

Don’t include information on a poster that doesn’t address your poster’s central concept or goal.
Do compose your hypothesis/question section first and always keep it in mind when composing the figures and text for your poster.

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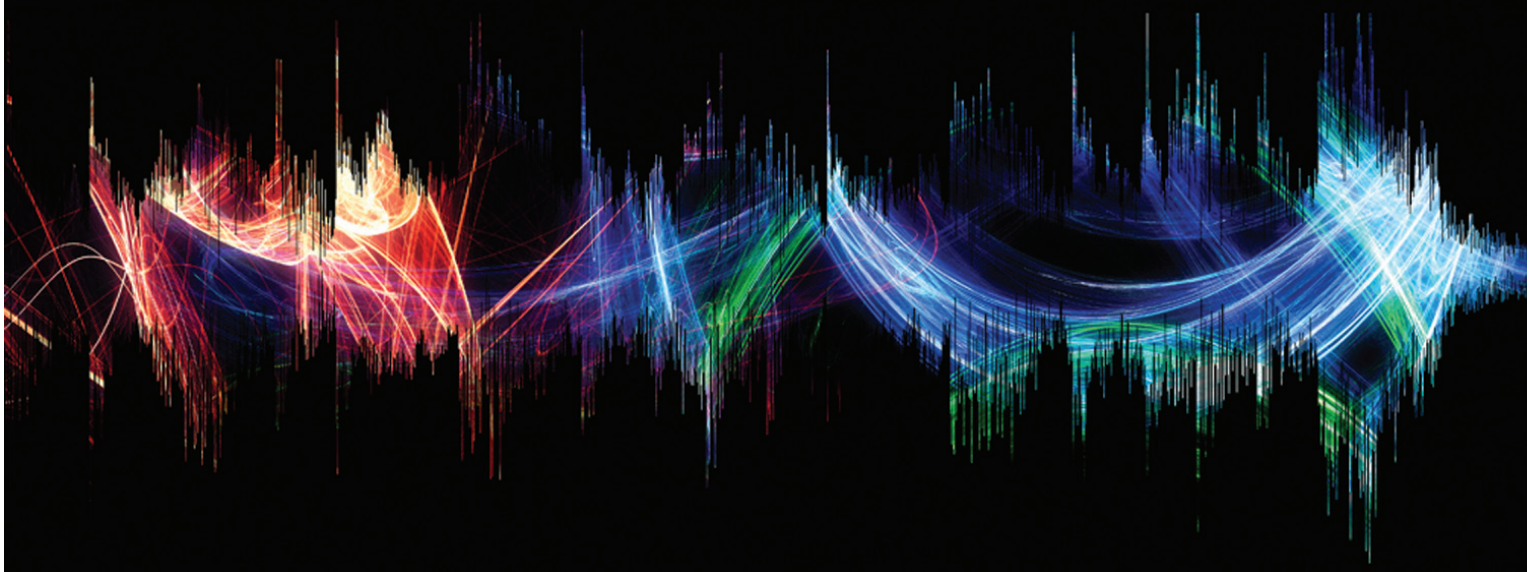
The Design and Layout of a Poster

The quality of a scientific poster is inextricably linked with its visual design and layout. Posters that contain poor font or color choices, meaningless visual distractions, and a lack of an obvious order of information are difficult to read and have less of an impact on audiences. In contrast, great posters present ideas clearly and succinctly in an intuitive, logical way. Optimizing the visual design of your poster will increase the efficiency with which you communicate information and enhance the impact you have on your target audience.



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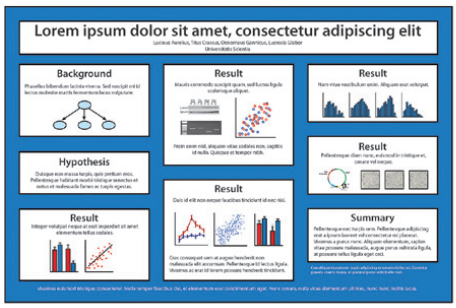
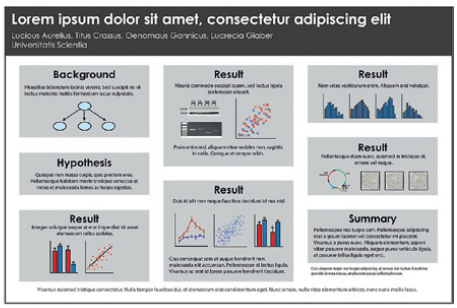
There is No Single Way to Design a Poster

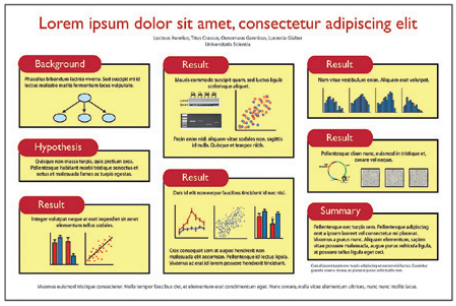
One of the most enjoyable aspects of creating a poster presentation is choosing your visual design and layout. What begins as a blank canvas becomes a beautiful visual scene that highlights your scientific story.

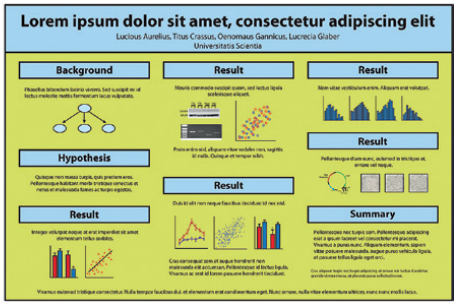
As you design your own poster, always remember that your scientific content should be the main attraction. Although you want your poster to be beautiful, your main goal is to clearly and succinctly communicate a scientific story.

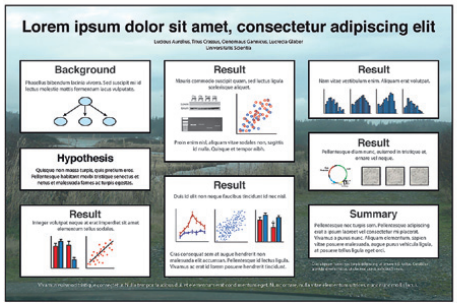
If you want inspiration for the design of your poster, look online. Just type "scientific poster" (or a related term) into a search engine and you'll find thousands of results. One good example is the Faculty of 1000 website (http://f1000.com/posters), which publishes scientific posters that were previously presented at conferences. Other sites provide dozens of downloadable templates that you can fill with your own content.

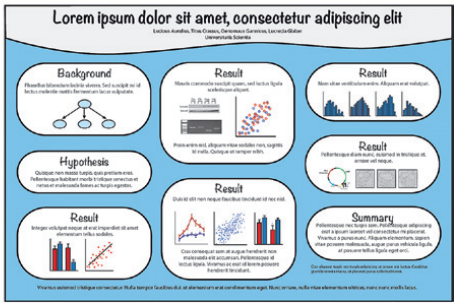






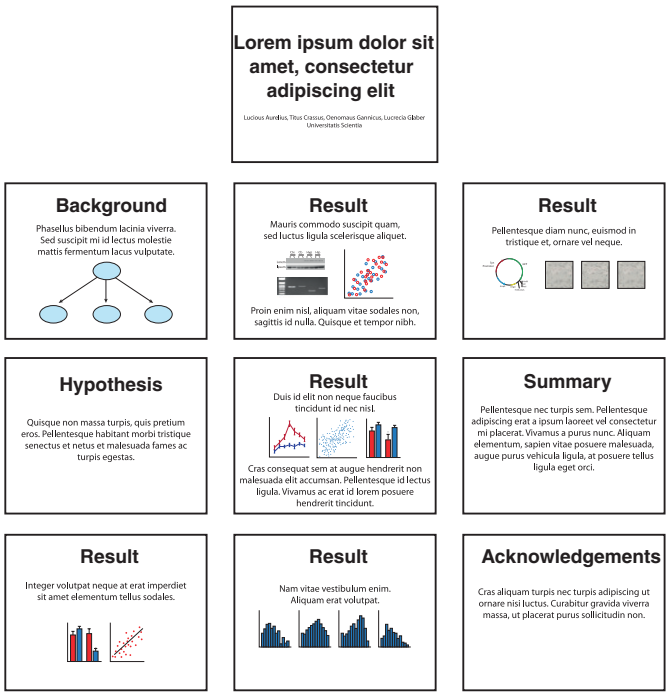






An Initial Consideration: The "Old-School" Poster

Before the ubiquity of easy-to-use software and printing services that provided everyone with the ability to create a poster on a single, large sheet of paper, posters were composed of separate sections printed on individual 8½"×11" sheets of paper and mounted together on posterboard.



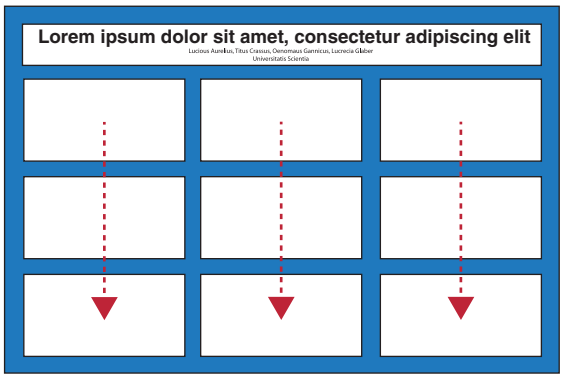
Nowadays, these "old-school" posters look old-fashioned. However, there are still some advantages to designing and printing your poster this way that you might consider:

- If you need to travel on an airplane, a poster divided into separate panels is easier to transport than a poster in a large poster tube that will either need to be checked in or counted as your carry-on item.
- If you present a poster at your own institution for an informal event, it is easier and less expensive to quickly print a poster in sections rather than order a print of a larger poster.
- The old-school format is great to use for printing rough drafts of posters that will eventually be printed on a single sheet so you can receive feedback from your lab colleagues or test how your figures will look when printed.

However, there are also disadvantages—principally that full, single-sheet posters definitely look much better and more professional to most scientists. Also, mounting many single sheets of paper onto a posterboard requires a surprising amount of time and skill to ensure that all sections are aligned and symmetrical.

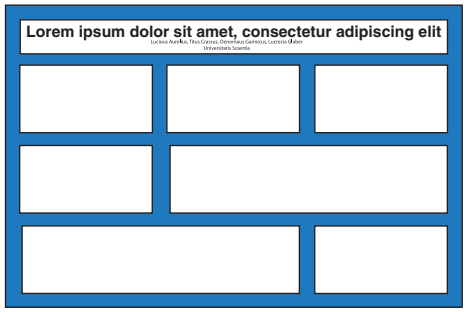
Design an Intuitive Order of Information

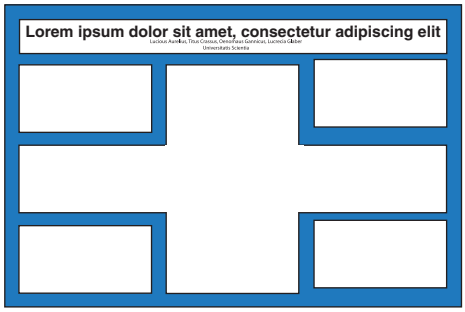
Your audience should instantly be able to determine which section of your poster to read first, as well as the correct order of the sections that follow. Unless you have good reason not to, it is usually best to arrange the sections of your poster into columns.



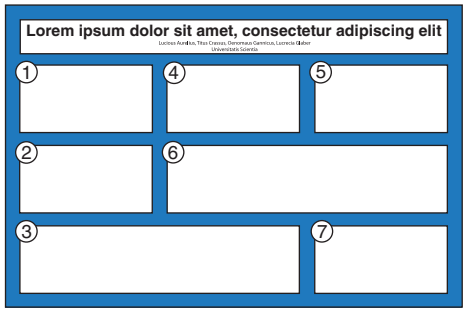
Audiences intuitively read the sections of a poster in columns (top to bottom) instead of rows (left to right).

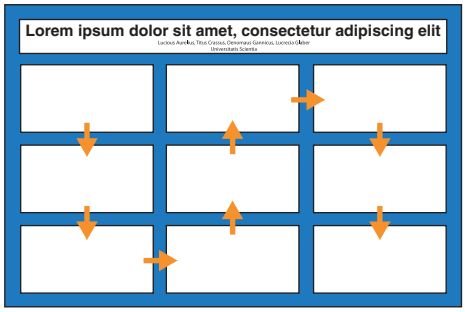
When the natural inclination to read poster sections as columns is disrupted, audiences can become confused about the order of information.





It is possible to inform your audience about the order of sections with numbers or arrows, however, you don't want to make your audience expend mental effort or feel like they have to search for which section comes next. Audiences shouldn't have to do any work to understand your layout.





Use Borders to Segregate Sections

To help your audience focus on one section at a time, place each section within its own border. Borders help your audience distinguish between discrete sections of a poster and reinforce the divisions between different categories of information.

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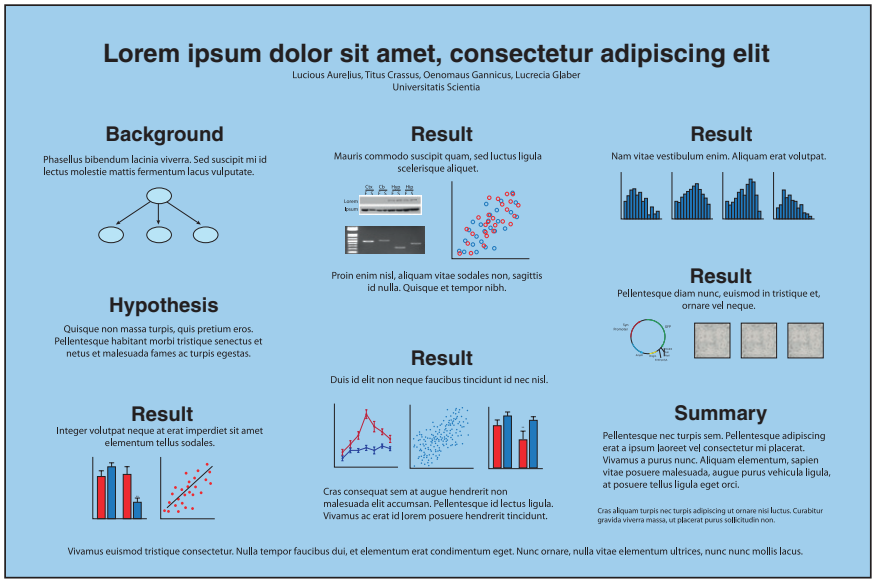

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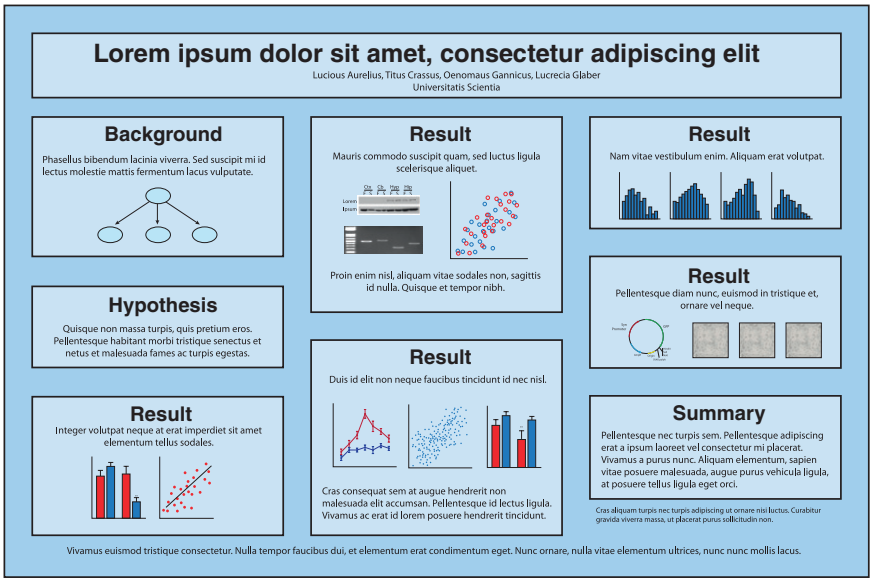


Make Your Words Easy to Read

The principal issue to consider when choosing a poster font is legibility. Choose fonts that are easy to read and large enough to be seen at a distance.

Use a sans serif font such as

Calibri
Century Gothic
Helvetica
Myriad Pro
Tahoma
Verdana

because these fonts are easier to read from a distance than serif fonts.

When you want to highlight a word, use **bold** or *italics* rather than underlining or writing in ALL CAPS. The latter options tend to make words more difficult to read and can distract from the rest of the text.

256
144
96
64
48
36
24

When you decide which font you want to use for your poster, print out a document like this one that shows you how the font will appear at different sizes. Your poster title should be 144–256 pts, depending on how well you can see these numbers from across the room. Don't use a font size that you can't easily see from 2 feet away.

TITLES ARE DIFFICULT TO READ IN ALL UPPERCASE

Lucious Aurelius, Titus Crassus, Oenomaus Gannicus, Lucrecia Glaber
Universitatis Scientia

Titles are Easier to Read in Title Case

Lucious Aurelius, Titus Crassus, Oenomaus Gannicus, Lucrecia Glaber
Universitatis Scientia

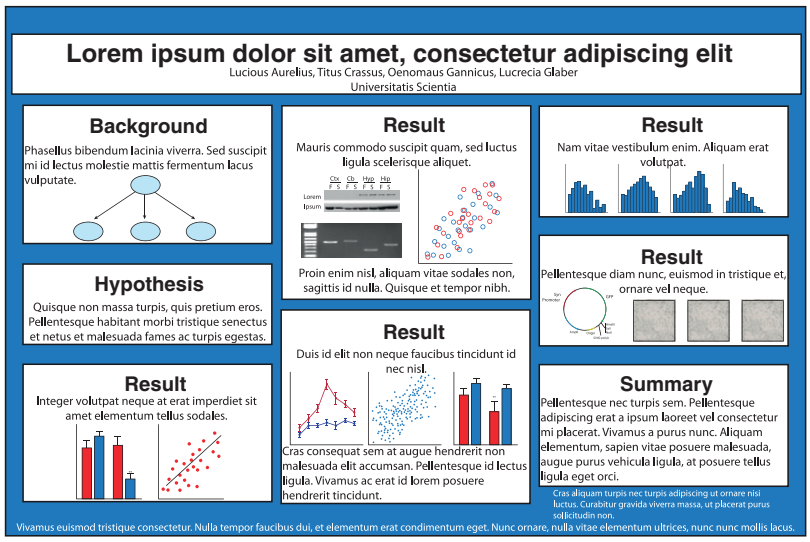
Titles are easiest of all to read in sentence case

Lucious Aurelius, Titus Crassus, Oenomaus Gannicus, Lucrecia Glaber
Universitatis Scientia

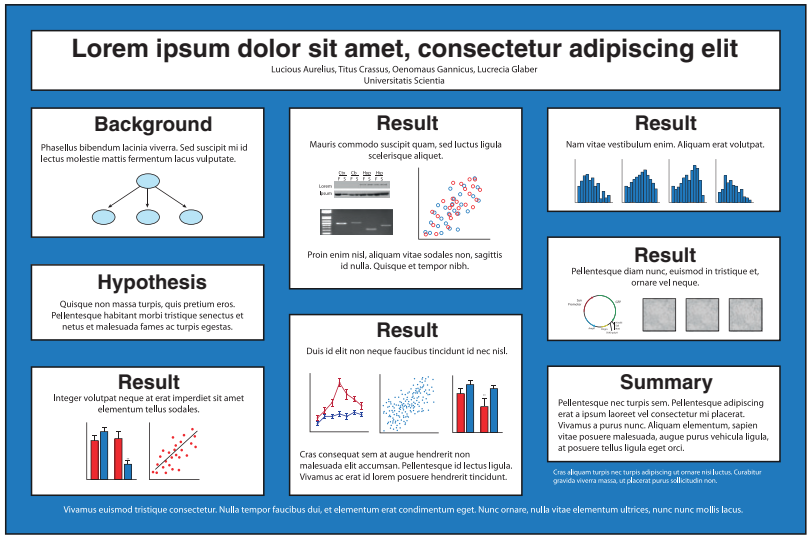
Let Your Text and Figures Breathe

Don't be so zealous about increasing your font and figure sizes that you make your poster too crowded. Surround your text, figures, and even individual poster sections with plenty of space so that your audience has an easier time focusing on one element at a time. In general, the surface area of a poster should be composed of 20–30% empty space.

Rather than making your poster look desolate, empty space adds clarity to a poster and amplifies your visual messages.



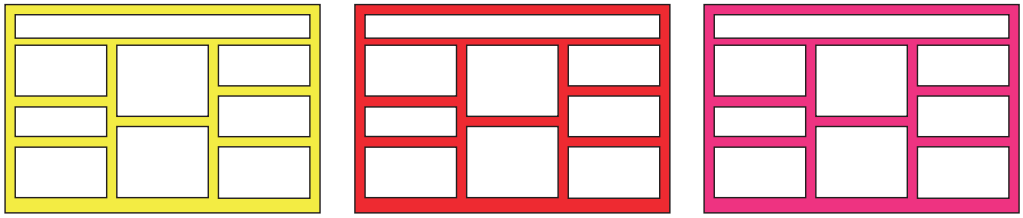
This poster seems visually overwhelming because it is too crowded. There are no margins and it is hard for the audience to focus on one section at a time.



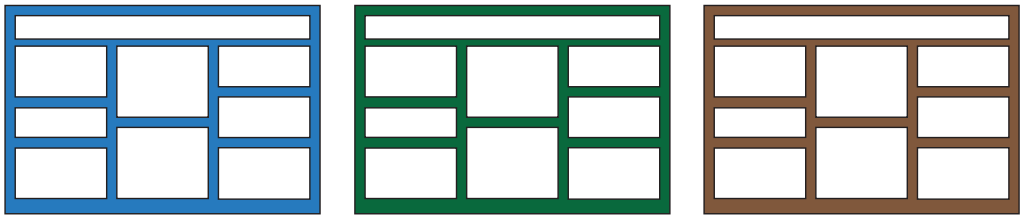
Although the font and figure sizes on this poster are smaller, they are still perfectly legible and the poster does not seem congested with information. It is easy for the audience to focus on a single section without being distracted by the others.

Background Colors

The choices you make about your background colors are important because poor choices can distract from your scientific content. In general, it is usually best to avoid warm colors (yellow, red, pink, orange, etc.) in favor of cool colors (blue, green, brown, etc.).



Warm colors aren't good choices for backgrounds because they are bright, overpowering, and can distract from your scientific content.



Cool colors naturally fade into the background so that your text and figures are the main attraction.

Also be cognizant about how your text and figures will appear on the background you choose for your text boxes. If you designed your charts or tables with a white background, it may be easiest to place them on a white surface; otherwise, you may inadvertently create white boxes that can break the unity of the visual scene and introduce an unnecessary visual element. If you want to place your figures on a colored poster background, remove any white backgrounds from the figures so that they fully blend into the background without distracting white boxes.

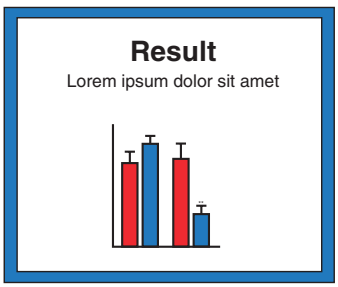


Chart with white background placed on a white background.

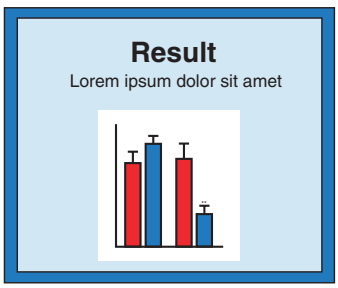
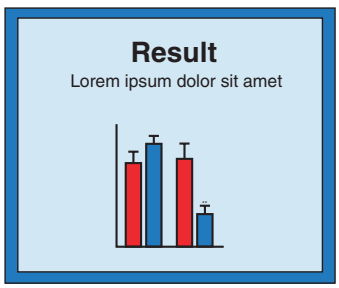


Chart with white background placed on a blue background. This pairing causes the appearance of a white square, an unnecessary visual element.

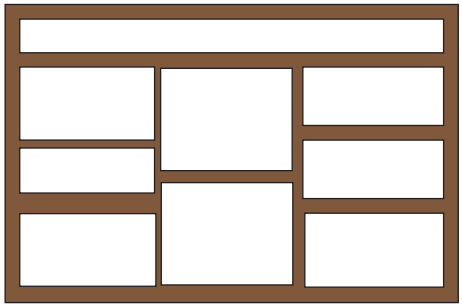


If the white background from the chart is removed, the white square is also removed and the visual scene achieves a greater sense of unity.

Align Elements for Harmony

The human eye is very good at detecting misalignment and asymmetry, which can create a sense of disharmony and distract from the content of your poster. Be deliberate about aligning the bounding boxes of your various sections and creating equal space between the sections of your poster.

Before



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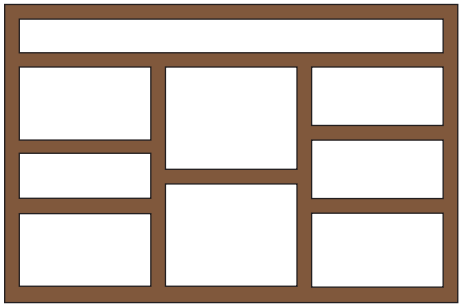
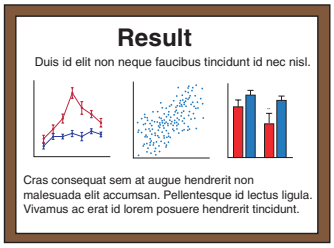


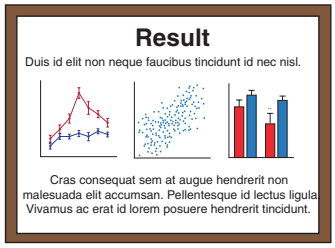
Also be deliberate about how you align text within each box. If you center the title of a section, make sure it is actually in the center. The main text within each box should be aligned center or aligned to the left. Text that is only one or two lines long usually is easiest to read when center-justified; text that runs three or more lines is usually easiest to read when aligned on the left.

Before



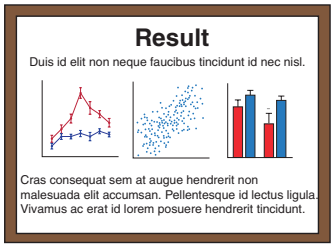
The title is slightly off center and the figures are not evenly spaced.

Before



The top line of text is not centered above the figures. The bottom line of text is center-justified and misaligned to the right.

After



All visual elements are ideally aligned, creating a sense of harmony and avoiding potential distractions.

Eliminate Extraneous Elements

When designing a poster you don't have much room to place important information, so it is crucial to ensure that the information you do include will be the main attraction. Don't include extraneous visual items that don't add meaning and can potentially distract your audience from your scientific content.

Items to eliminate:

- **Institutional logos.** Most scientists place these logos on the top of their posters next to their titles, but what purpose do they serve? The authors and affiliations are already located beneath the title. Institutional logos are usually made up of warm colors that can clash with your poster background color and distract from your content. Furthermore, usually scientists feel that if they put a logo on one side of a title that they should put something else on the other side of a title, so they add another meaningless element—the logo of a specific department, a picture of their research subject, etc. It's best to avoid adding logos altogether; doing so will allow you to make your poster title much bigger and potentially attract a larger audience. (By the way, if you ask most scientists why they add logos to their posters, they will tell you they only think to do it because everyone else does. That's not a very good reason.)
- **Poster numbers.** Once an organizing committee approves your poster, it usually assigns you an official poster number so your presentation can be indexed in a conference program and cited in future publications. Don't feel you have to add this number to your actual poster. It does not aid anyone's ability to find your poster, and a number like "AC-0033" doesn't communicate any useful information to your audience.
- **Decorative graphics.** Cute clip-art graphics or photos placed around your poster sections are distracting at best and annoying at worst. Only include visual elements that add meaning and communicate a message. Design rather than decorate.

Choosing Glossy versus Matte Prints

When it is time to print your poster, you will often have a choice between printing on glossy or on matte paper. Most audiences think that glossy posters look more appealing and professional. Glossy paper enhances the color contrast on posters compared to matte paper, resulting in darker blacks, brighter whites, and more brilliant colors. If you have many photographs on your poster (especially fluorescent photographs), glossy paper is always the best choice. The disadvantage to glossy paper is that the gloss can cause glare; however, most poster sessions take place in locations without bright lighting, so glare is often not a problem. Glossy posters are also usually more expensive than matte posters. If cost is an important factor and you don't have any photographs on your poster, a matte finish may be the best choice.

Summary: Don’ts and Dos

Don’t overlook the potential inspiration you might gain from observing other scientific posters.
Do seek out great posters online or in the hallway at your own institution for ideas and examples.

Don’t force readers to spend effort figuring out the order of information in your poster.
Do design a natural, intuitive layout that leads readers from one section to another.

Don’t allow different subsections of your poster to blend together.
Do use borders to clearly segregate different sections and visually reinforce the divisions between different categories of information.

Don’t select fonts that are hard to read because they are too fancy or too small.
Do select easy-to-read sans serif fonts in a relatively large font size so your text can be read from across a room.

Don’t overcrowd your posters with text and figures.
Do surround your text and figures with empty space so audiences can focus on one visual element at a time.

Don’t choose warm background colors that can overpower your scientific content.
Do use cool background colors so that your content is the main attraction.

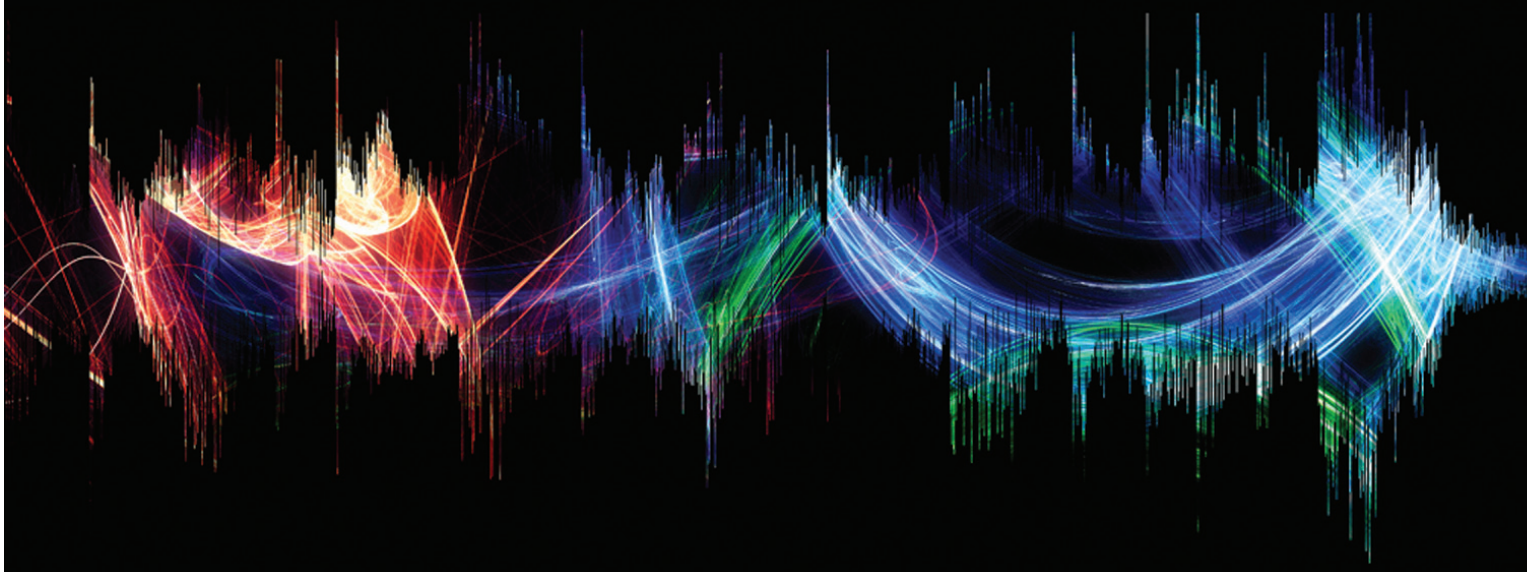
Don’t carelessly place visual elements on a poster.
Do deliberately align your visual elements to create a sense of harmony and symmetry.

Don’t include logos, poster numbers, or meaningless decorative elements on a poster.
Do eliminate any extraneous elements that don’t convey information to your audience.

27

Presenting at a Poster Session

Many scientists spend hours designing a beautiful poster only to hang it up at a poster session and then walk away. These scientists miss what presenting at a poster session is all about: interacting with other scientists to network and receive feedback on their work. Why spend time and money to design, print, and transport a poster if you don't plan on talking about it with anyone? With a minimal amount of effort, you can complement your beautiful poster with a beautiful delivery and form meaningful relationships with scientists across your field.



Designing Science Presentations. DOI: http://dx.doi.org/10.1016/B978-0-12-385969-3.00027-1

Posters are for Personal Interactions

Unlike written or oral presentations, poster presentations allow you to meet dozens of people in your field, gain insightful feedback on your research, and form potential collaborations with scientists outside of your lab or institution.

Consider that a fraction of your audience may be highly influential during the course of your career. Many graduate students meet their future postdoctoral advisors through poster presentations, and many postdocs meet members of faculty search committees. Scientists interested in your work may suggest ideas that lead to meaningful collaborations. Additionally, the scientists who visit your poster may serve as anonymous peer reviewers of your future manuscripts. Therefore, presenting a poster may have profound consequences for your future success, and you should take advantage of the opportunity to meet as many people as possible.

Maximize the time you spend with your poster audience. If your poster session coincides with a happy hour, skip the food and drinks so you can concentrate on your visitors. Even if you're only required to stand next to your poster for one-fourth or half the time of the poster session, try to be present the entire time. If there is another poster you really want to see that is at the same time as yours, try to view it at the very beginning of the poster session. (Most attendees don't start showing up until 15–30 minutes after the start of the session, so this gives you a small window to see some of the other posters.)

Preparing for the Presentation Venue

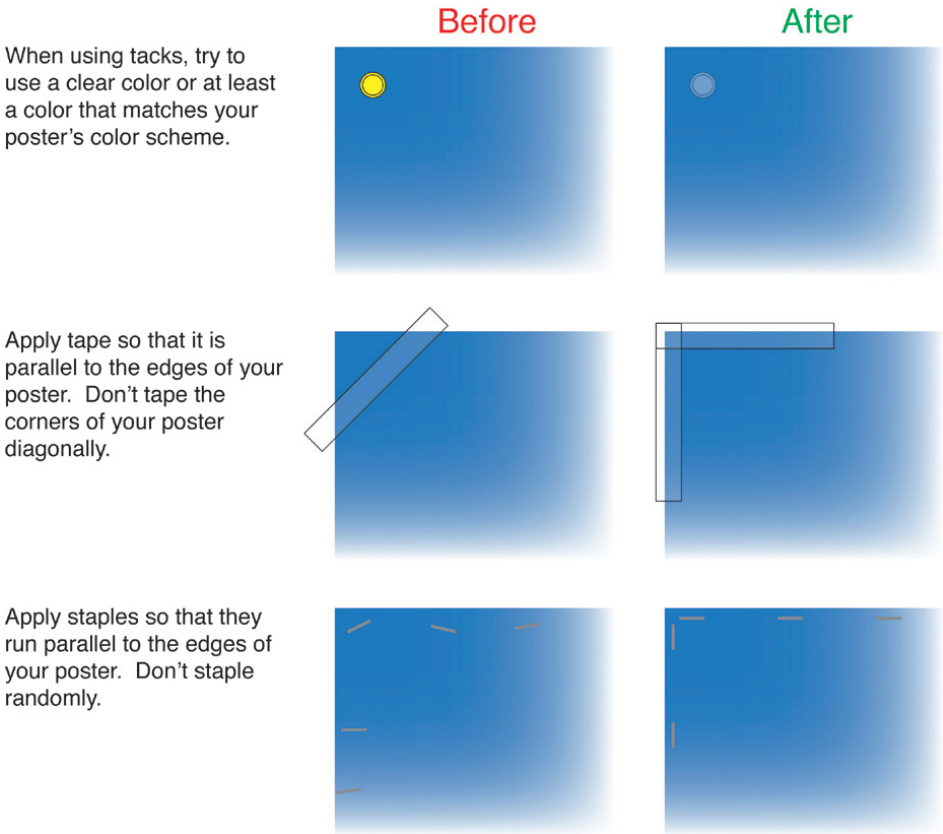
Poster presentation venues vary in size and atmosphere. Large conferences make use of poster halls the size of airport hangars, where conference attendees navigate through thousands of posters displayed at once. Smaller conferences and institutional retreats may exhibit only 10–20 posters at a time, usually during a happy hour with free food and drinks.

Poster sessions also vary by time of day: some start at 8:00 am, others start at the end of the evening before social activities.

One of the best ways to prepare for a poster session is to anticipate the likely atmosphere of the venue. Your poster content and design should remain the same from venue to venue, but you may need to adapt your delivery to match the mood of your audience.

Displaying Your Poster

The meeting organizers will provide you with some sort of flat surface and tacks, tape, or a stapler for hanging your poster. Make sure to hang your poster in a way that is aesthetically pleasing and doesn't distract from its content.



At larger meetings, your poster will almost certainly be assigned a specific location (so it is easy for interested visitors to find). At smaller meetings, posters may be displayed on a "first come, first served" basis, with presenters hanging their posters wherever they find space. If this is the case, try to display your poster near an area of higher traffic—such as an entrance/exit, a drinking fountain, etc. Try to avoid areas of low traffic and where the environment may repel visitors, such as near a noisy air vent.

Bring a Poster Repair Kit

Although you personally proofread the final version of your poster multiple times, there is nothing like displaying your full-size poster at the actual venue to make you realize an embarrassing error. For this reason, it's great to bring a small kit to quickly fix your mistake and any other disasters that may befall your poster. Items to bring include pens with the same color as the fonts you used, a small bottle of correction fluid or "white tape," a small cloth to wipe away fingerprints (especially for glossy prints), and clear tape to fix any rips or tears. If you have to use tape, be sure to tape the *reverse* side of the poster and not the side your audience will see.

The content of a modest poster repair kit.

Giving a "Walkthrough"

A walkthrough is a brief guided tour of your poster for interested visitors. It is essential that you keep your walkthrough succinct—5 minutes or less. Otherwise, you'll bore your audience and they will either start to walk away or politely stay and hate you. To ensure a short delivery, you should plan on what you are going to say and mentally rehearse before any visitors arrive.

The following is a good, generic walkthrough for most posters:

- Introduce yourself and your research interest: "My name is Matt and I'm interested in…"
- Provide a brief introduction (two or three sentences): "The physiological basis of xxx is unknown. Previous studies have demonstrated A, B, and C, but D is unknown. The goal of my research is to study D."
- If relevant, provide a brief explanation of the methods you used.
- Describe each result as its own mini-study, with a rationale, statement on methods, statement on results, and conclusion. "We first decided to examine… To investigate this we… We found that… This means that…"
- Summarize the two to four main conclusions of your study.
- Provide a brief statement about future directions.
- *Thank your visitors* for stopping by your poster. And be genuine—your visitors could have spent their 5 minutes doing something else.

If visitors arrive halfway into your walkthrough, make sure to finish your talk for your current audience first before starting again.

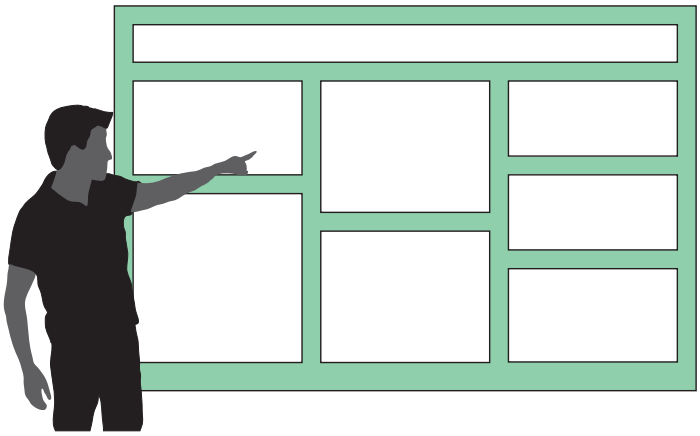
During your walkthrough, point to the various figures on your poster to show your data, but don't point to text. The information on your poster should be the same as the information that you say.

Also, let your narration lead you through your figures rather than letting your figures lead your narration. Discuss your concepts and point to figures for support, rather than point to figures and then explain the concepts behind them.

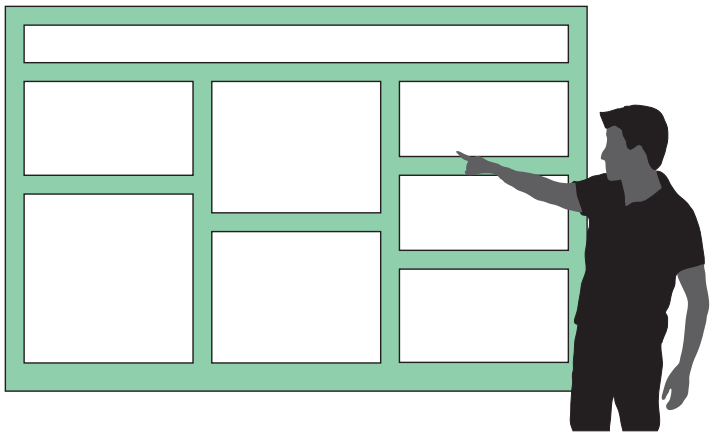
Knowing Where You Stand

Try not to block your poster by standing in front of it. When greeting new visitors, stand to the left of the poster. At some point, as you describe the various sections to your visitors, cross completely to the other side and remain there until you thank your visitors for stopping by. Finally, walk back to the left side of your poster again to start over with a fresh audience.

Always start a walkthrough by standing just to the left of your poster.

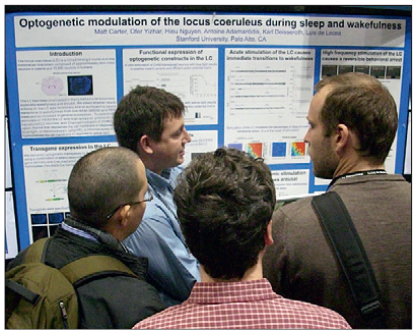


When you are about halfway through, completely cross to the other side.



Looking (and Smelling) Good

A poster presentation is probably the most intimate way to present science, as you stand one or two feet away from your audience, likely in a crowded meeting room. Therefore, personal hygiene is key. Bring breath mints, and make sure your breakfast or lunch isn't stuck in your teeth. Also make sure to wear deodorant but not ostentatious perfume or cologne.



Poster sessions can become very crowded and intimate. Make sure you have impeccable hygiene!

How professionally you should dress depends entirely on the presentation venue. A good rule of thumb is to dress slightly more nicely than your audience. If you are at a professional meeting, business casual is usually best. At an informal meeting (such as a university institutional retreat), you may not need to dress as professionally, but you should dress as you would if you knew your future boss might be stopping by.

When you stand next to your poster you immediately become part of your poster's "visual scene," so don't wear colors that contrast with your poster's color scheme. If possible, wear colors that match or complement your poster's background color.

Wear a visible nametag with your first and last name. Approaching visitors want to know who is talking, and especially if you are one of the authors listed on the poster. Visitors may also recognize your name if you recently published a paper of interest.

Finally, you will attract many more visitors if you make eye contact, smile, and appear happy to talk about your research. Speak to your audience as you walk through your poster instead of looking at notes, poster text, or your watch. Keep your hands out of your pockets, as this conveys a lack of enthusiasm. Never look at your smartphone.

Although communicating enthusiasm to your audience may seem obvious, even the perkiest of personalities can become despondent during periods of few or no visitors. If nobody stops by your poster, resist the temptation to walk away or check your email on your smartphone. Showing disinterest in your own poster will only cause you fewer visitors in the future. As hard as it may be, try to remain by your poster looking outward, friendly, and happy to talk with anyone passing by.

Supplementary Information

Consider bringing miniature versions of your poster that visitors can take as handouts. If you have prior publications that are relevant to your poster, you can also bring along reprints for anyone interested. Keep in mind that poster session attendees generally don't like being given items to carry around with them, so offer handouts only if someone seems genuinely interested.

Just as research papers can include supplementary movies and figures, you can provide supplementary materials for your poster, too. For example, if a short video will easily convey information to your visitors, bring a tablet computer or mobile phone to show your video to anyone who is interested.

Embrace the senses and think of ways to share relevant sounds, smells, textures, or tastes with visitors. For example, if you study bird song, offer to play a 5- to 10-second clip of song recordings to your visitors. If you study how mice respond to odors, bring examples of the odorants in small vials or bags. Audiences appreciate these kinds of "show and tell" moments, and you might attract a bigger crowd.

Summary: Don’ts and Dos

Don’t leave your poster during the poster session.
Do stay by your poster to meet and interact with as many scientists as possible.

Don’t display your poster in a way that isn’t aesthetically pleasing.
Do use clear-colored tacks, or align tape or staples so that they are parallel with the edges of your poster.

Don’t be caught off guard if you find a typo or rip on your poster during the poster session.
Do bring a simple poster repair kit to fix any mistakes or blemishes you find.

Don’t present a poster without rehearsing a short walkthrough.
Do determine a brief but informative way to present the information in your poster, and mentally rehearse before any visitors arrive.

Don’t ever stand in front of your poster.
Do stand to the left of your poster at the beginning of your walkthrough and to the right of your poster at the end.

Don’t present a poster with a clashing outfit or bad hygiene.
Do ensure you look and smell your best before the poster session begins.

Appendix B

Learning to Use Illustration and Presentation Software

Throughout this book, I recommend guidelines for creating figures and presentations while deliberately avoiding any descriptions about how to accomplish these tasks using modern illustration and presentation software. If this book were to provide step-by-step lists about how to use computer applications, it would be about five times as long. However, you may be wondering which applications I use and how I learned to use them.

Personally, I only use four applications to create all of my science presentations:

- Word (Microsoft)
- Keynote (Apple)
- Photoshop (Adobe)
- Illustrator (Adobe)

These are not necessarily recommendations, although I do enjoy using these programs.

If anything, I want to emphasize that I don't use very many applications and yet I feel confident in my ability to create any figure or presentation that I want. I never went to art school, and I don't have a graphic design certificate above my desk. I learned how to use these applications partially on my own, partially by skimming some guidebooks, and partially by looking for answers to my questions on the Internet. Additionally, throughout my career, the academic institutions I've worked at have all offered short workshops and courses on how to use these programs. There were many opportunities to learn, and I just had to be proactive about taking them.

If you feel deficient in using the software mentioned above (or other applications of your choice), realize that these are tools you can learn on your own in a short amount of time. There are many wonderful step-by-step guidebooks that describe how to use all of these programs. Many of these books are written in a "lesson in a day" format, so that you can teach yourself a useful function in just 30–60 minutes a day. I taught myself how to use all of the programs above as a graduate student (usually while waiting for gels to run or DNA to

fully flow through purification columns). Also, the mighty Internet has never failed to answer any of my specific questions when typed into a Google search field (e.g., "How do I extract an image in Adobe Photoshop CS5?").

In short, don't be intimidated by presentation technology. The software engineers really have done a remarkable job making these applications fun and simple to use. A good guidebook or workshop and effort are all you need.

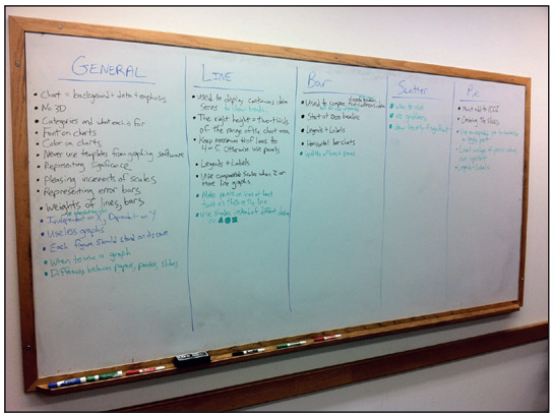
Appendix C

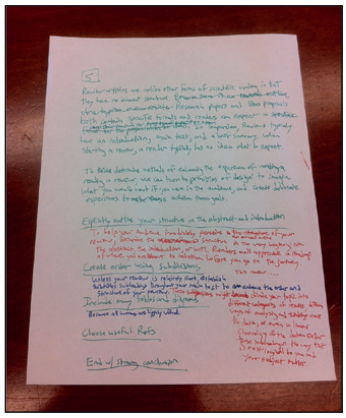
Thoughts on How to Design a Presentation from Scratch

Many people find that the hardest part of designing a science presentation is starting. True, when you begin working on a written, slide, or poster presentation, there isn't anything quite as intimidating as a blank screen. For many years, I forced myself to stare at these blank screens until I was finally able to type something, but this was a miserable process and I never enjoyed forcing myself to fill up empty white space. Only recently have I figured out a more efficient process that makes the design and creation process more fun and efficient. While these methods might work better for some than others, I offer three pieces of advice for designing presentations from scratch:

1. **Start by turning off your computer.**
   Adding information to a page or slide before figuring out what you want to say is like getting into a car before you know where you want to go. If you are not clear about what you want to write on a page or display on a slide, turn off your computer and brainstorm.

2. **Find your most effective method of brainstorming.**
   Brainstorming a science presentation means identifying all of the content you want to communicate, determining the best method of communicating that content to your audience, and structuring your content into a logical flow of information. There is no way you can keep track of all of this information in your head, so you will need a method of physically visualizing your ideas. I like to write all of my ideas out on a whiteboard or scratch paper. Other people like to use sticky notes or index cards. It doesn't matter what you use as long as you can see all of your ideas in front of you. After writing everything out, I start to group similar content and get rid of information that doesn't seem to relate to anything else.





I used the whiteboard on the left to brainstorm the content for Ch. 8: Charts. At right are some initial ideas I wrote on scratch paper for a page from Ch. 13: Review Articles.

Only by brainstorming in this way do I make sense of my ideas and how they relate to each other. What begins as a bedlam of information develops into whole paragraphs, sets of slides, or regions of a poster.

3. **Stand up.**
   For whatever reason, most people think better when they are standing or walking than when they are sitting. I don't know a good reason why this should be true, but for me it is a fact of life. My best ideas, scientific and otherwise, come to me while standing in line for coffee, walking to work, or mowing the lawn. For many years now I've applied this self-realization to designing science presentations. When I need to come up with a new section of a paper, slide show, or poster, I always go for a quick walk. Usually I take a clipboard with me so I can write down good ideas along the way. (Here's a little secret I'll share with you at the end of this book: most of the first draft of this book was written while walking.)

Only after I've brainstormed ideas and gone for a quick walk do I return to my desk and turn on my computer. The screen may be blank, but I fill it with content within minutes.

Appendix D

Thoughts on Using Design Principles to Market Yourself

This book has argued for using principles of design to enhance how you present your scientific content. Likewise, it is also possible to use these same principles to enhance how you present *yourself* on paper and online. Just as you shouldn't present science without thinking about the way you want to impact your audience, you also shouldn't write a CV, make a flyer, or design a website without thinking about how you want to come across to others.

When designing a CV, think of what information you want to emphasize.

Before

Education

2000–2004 Bachelor of Arts (B.A.), Biology
Whitman College, Walla Walla, WA

2004–2010 Doctor of Philosophy (Ph.D.), Neuroscience
Stanford University, Stanford CA

After

Education

Doctor of Philosophy (Ph.D.), Neuroscience
Stanford University, Stanford, CA 2004–2010

Bachelor of Arts (B.A.), Major: Biology
Whitman College, Walla Walla, WA 2000–2004

Provide a clear sense of structure for your audience by writing major headings in bold and a larger font size. Make sure to arrange information in the order that is most important: for example, list your most recent education first, and emphasize schools and degrees over dates of attendance.

When designing a flyer for an upcoming event, think of how to attract attention so that your flyer will be noticed.

Before

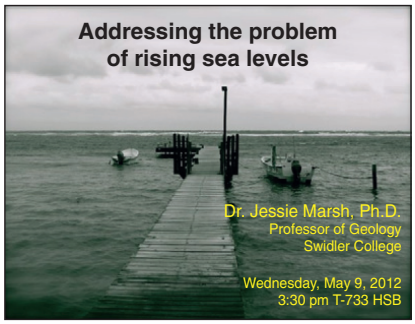
Department of Biology Presents:

"Addressing the problem of rising sea levels"

Dr. Jessie Marsh, Ph.D.
Professor of Geology
Swidler College

Wednesday, May 9, 2012
3:30 pm T-733 HSB

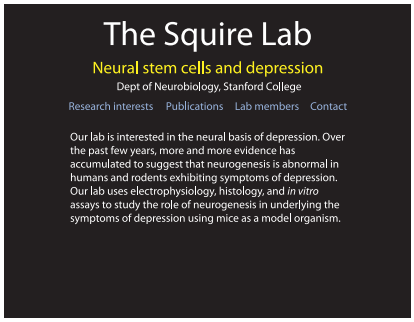
After



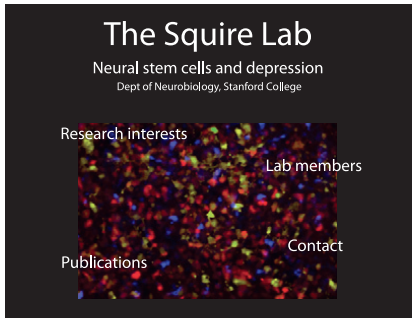
In a flyer, make sure to include all of the necessary information (name, date, location, etc.), but also add an exciting visual element that will attract attention and make your flyer stand out.

When designing a lab website, think about what information you want to emphasize on your homepage. Do you want the first page your audience sees to be a paragraph of text, or an attractive picture that invites them to learn more?

Before



After



Design a website that is attractive and inviting to your visitors. Make your hyperlinks big and conspicuous so it is as easy as possible for a visitor to find information.

All of these topics could obviously be discussed in much greater detail, and there are other excellent resources written specifically about CVs, flyers, and websites. My main point in presenting this information here is that, as a scientist, anything you produce that is intended for other people should be *designed* for other people. Always think about the experience you want to provide your audience, and the way you want them to remember you.

Index

Note: Page numbers followed by "f" refer to figures respectively.

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