



Organization of African Academic Doctors (OAAD)

Writing Critical Analytical Review Paper: the Nuts and the Bolts

By

EDMOND SANGANYADO



Writing a critical analytical review

THE NUTS AND BOLTS

EDMOND SANGANYADO

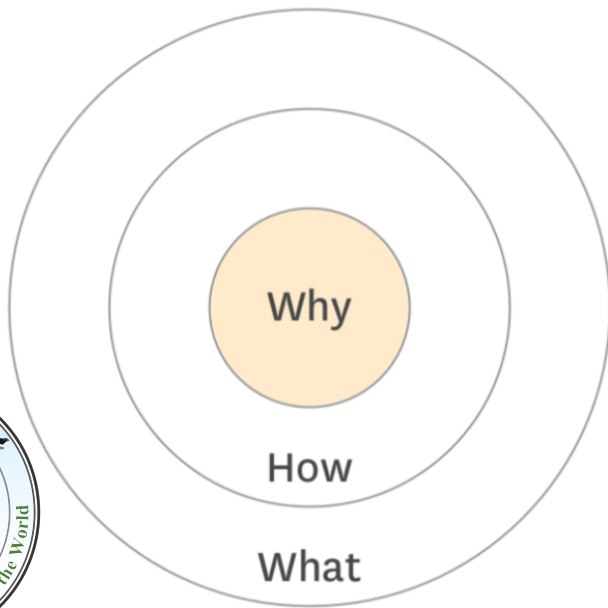


PREPARING TO WRITE

1. Start with why



The big question



Why - Your Purpose

What is your cause? What do you believe?

How - Your Process

Specific actions taken to realise your Why.

What - Your Process

What do you do? The result of Why. Proof.

The **big question** is an opportunity to drive research forward.

Types of review questions

Type	Formulation	Published examples
Descriptive research	What are the characteristics of X?	Characteristics, drivers and feedbacks of global greening Unique and common traits in mycorrhizal symbioses
Comparative research	What are the differences and similarities between X and Y?	Comparison of antibiotic-resistant bacteria and antibiotic resistance genes abundance in hospital and community wastewater: A systematic review The toxicology of gallium oxide in comparison with gallium arsenide and indium oxide
Correlational research	What is the relationship between variable X and variable Y?	Metal contamination and bioremediation of agricultural soils for food safety and sustainability



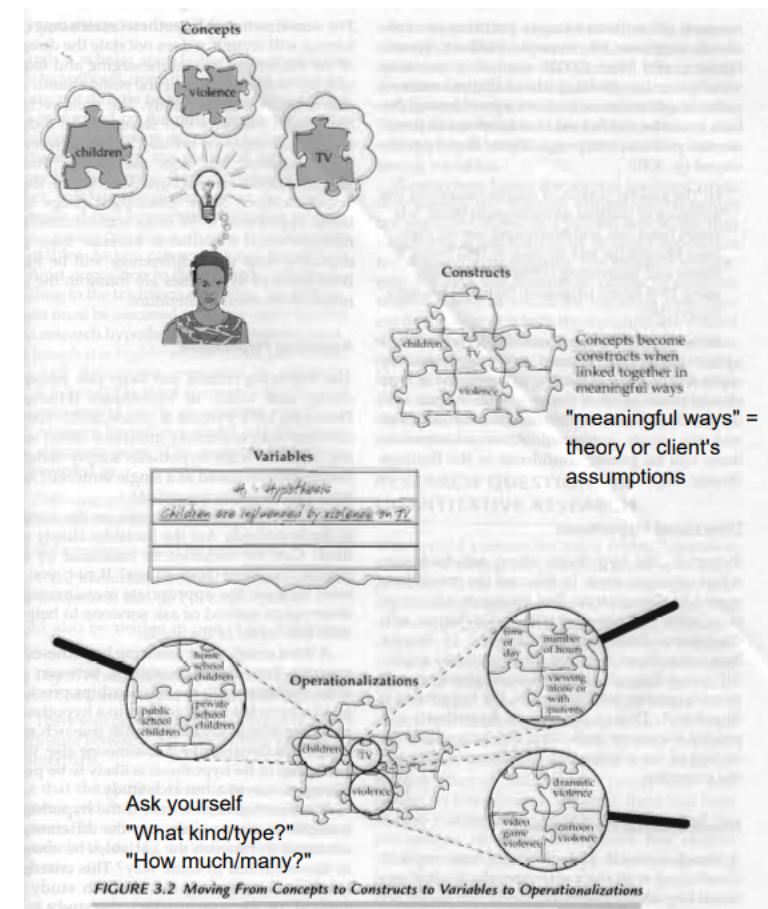
Types of review questions (cont'd)

Type	Formulation	Published examples
Exploratory research	What are the main factors in X? What is the role of Y in Z?	The role of cellular senescence in ageing and endocrine disease
Explanatory research	Does X have an effect on Y? What is the impact of Y on Z? What are the causes of X?	Metabolic and biogeochemical consequences of viral infection in aquatic ecosystems
Evaluation research	What are the advantages and disadvantages of X? How well does Y work? How effective or desirable is Z?	The benefits and challenges of using systematic reviews in international development research
Action research	How can X be achieved? What are the most effective strategies to improve Y?	Toward an integrated framework for assessing micropollutants in marine mammals: Challenges, progress, and opportunities



Framing the big question

- Choose a broad problem: Advances in *in situ* bioremediation of groundwater in developing nations: Challenges and opportunities.
- Identify the key concepts: define what you want to study as precisely as possible.
- Establish the constructs: concepts become constructs when linked together in meaningful ways.
- Operationalization: identify variables that correspond to the concepts (measurable or constant).



From concepts to variables

Example: What affects *in situ* bioremediation of micropollutants in groundwater?

- Physicochemical properties of the pollutant or groundwater; biological properties of the groundwater
- The **key concept** here is “*in situ* bioremediation.”
- Different **variables** to measure *in situ* bioremediation include:
 - Removal efficiency of micropollutants
 - The half-life of micropollutants in groundwater
 - The occurrence of micropollutants in groundwater.
- If we are to study variation in *in situ* bioremediation, we must identify variables that are **most pertinent** to our theoretical concerns.



Identify the research question type

- Identify the type of research question you want to explore, e.g.;
- **Descriptive research** – Critical parameters for effective *in situ* bioremediation of micropollutants in groundwater.
- **Correlational research** – Understanding the impact of environmental factors on *in situ* bioremediation micropollutants in groundwater.
- **Exploratory research** – The role of plant-microbiome interactions in *in situ* bioremediation of organic pollutants in groundwater.



Variables carry the direction of the review

Examples of research question framing

Exploratory research – The role of plant-microbiome interactions in *in situ* bioremediation of organic pollutants in groundwater.

Concepts

- Plant-microbiome interactions
- *In situ* bioremediation

Variables

- Microbial abundance and diversity
- Types of plant-microbiome systems
- Physicochemical properties (groundwater and micropollutants)
- Removal efficiency

Indicator

- What characteristics of plant-microbiome interactions influence *in situ* bioremediation of micropollutants in groundwater?
- What is the role of plant-microbiome interactions in *in situ* bioremediation of micropollutants in groundwater?



Example of a research frame

Problem	Question	Hypothesis	Objective
<ul style="list-style-type: none">Discuss the opportunities and challenges faced by developing countries in advancing in situ bioremediation of micropollutants in groundwater	<ul style="list-style-type: none">What is the role of plant-microbiome interactions in in situ bioremediation of micropollutants in groundwater?	<ul style="list-style-type: none">Since plant uptake and microbial transformation are critical in removal of micropollutants, advances in in situ bioremediation of groundwater in developing countries leverage plant-microbiome interactions. micropollutants in groundwater?	<ul style="list-style-type: none">Identify key characteristics of plant-microbiome interactions essential in in situ bioremediation.Compare and contrast in situ bioremediation techniques that utilize plant-microbiome interactions.Identify knowledge gaps and propose future studies

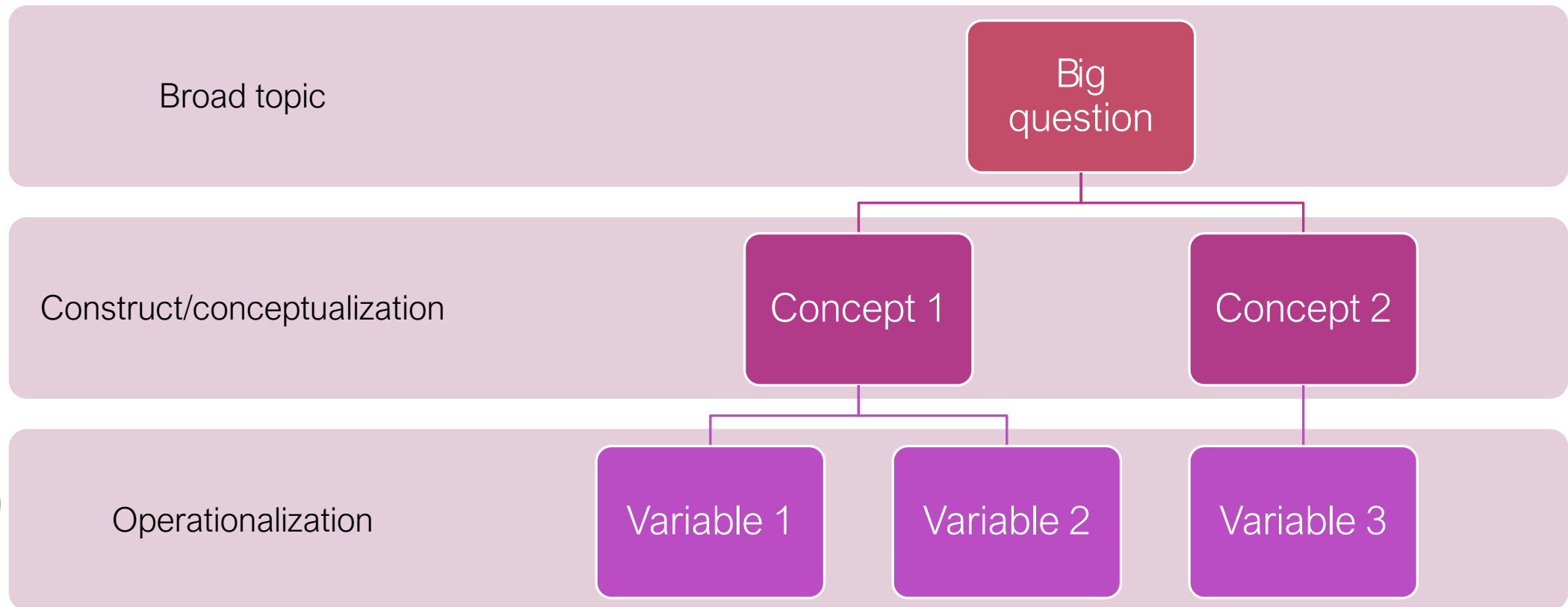


PLANNING TO WRITE

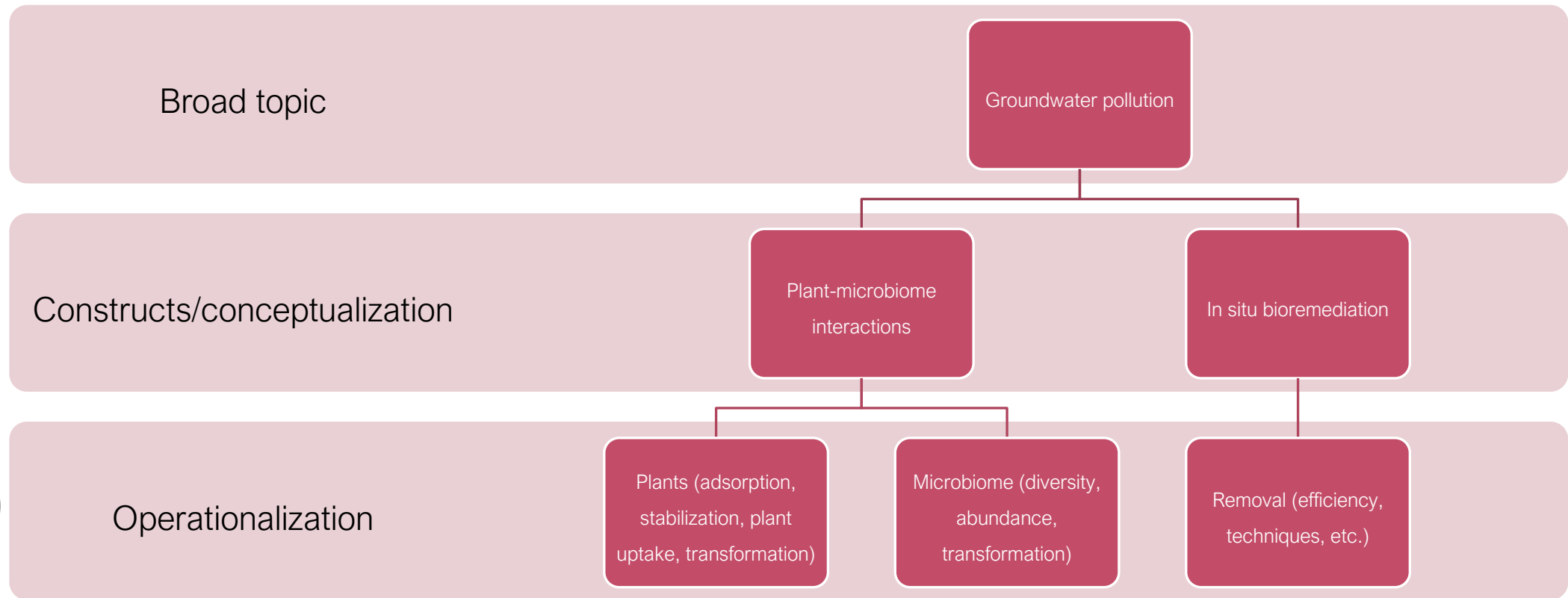
2. Then consider how



Concept-variable driven outline

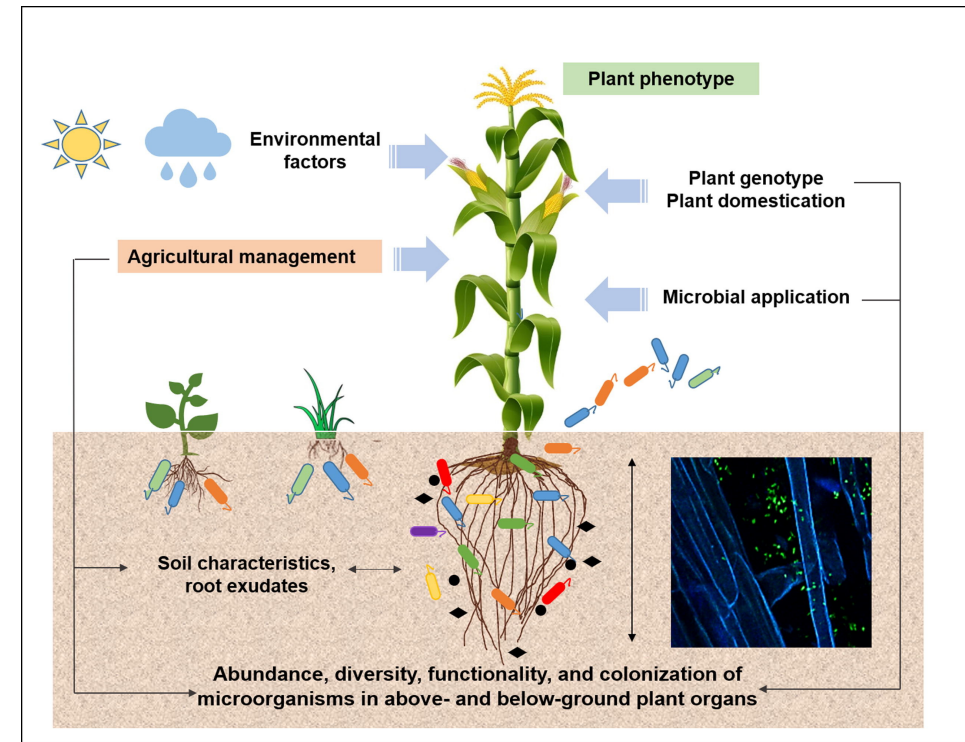


Examples of concept-driven outlines - 2



Design an anchor image

- An anchor image is a picture that captures the big question and corresponding concepts and variables that helps in orienting your writing.
- It is a **schematic overview** of the key concepts and how the key variables interact to form a meaningful construct.
- It is often used as the **graphical abstract**.



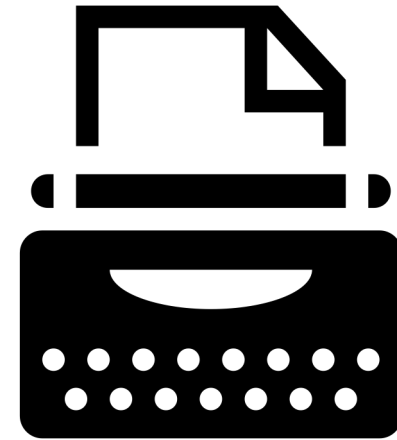
WRITE IN PLAIN ENGLISH

3. Clarity over obscurity



Why clarity matters

- Many manuscripts are desk-rejected because of poor English.
- Researchers often assume obscurity is a sign of expertise.
- Obscure writing ignores the needs of the reader.
- We write for the reader to understand.
- Poor scientific writing hinders the flow of ideas between disciplines



Sentence construction

- Subject and verb should be close.
- Use abstract nouns to cut clutter.
- Cluttered: The **behavioral manifestations** of stress responses **have been shown to** vary greatly between individuals in **rodents, pigs, birds, fish, and humans**.
- Uncluttered: Individual **rodents, pigs, birds, fish, and humans** **behave** very differently in response to stress.



Avoid big words

- Use strong verbs: replace be and have, e.g.;
- Cluttered: Understanding seasonal habitat ranges and their distribution is critical for Greater Prairie Chicken conservation and management.
- Uncluttered: Before we can conserve and manage Greater Prairie Chickens, we must understand their seasonal habitats.
- Use short words instead of long words, e.g.;



Long word	Implement	Develop	Terminate	Alteration	Subsequent	Endeavor	Facilitate	Utilize
Short	Put	make	End	Change	Next	Try	Help	Use

Additional principles of writing

- Keep terms the same: Avoid using synonyms in a single sentence or paragraph.
 - e.g., do not use grazers and herbivores in the same sentence or contaminants and pollutants.
- Break up noun strings: Avoid cluttering three or more nouns together,
 - e.g., This is a cluttered sentence structure write-up.
- Remove unnecessary words
 - Repetitions
 - Excess details
 - Phrases that can be replaced by a single word
 - Meta-discourse (I believe, to summarize, I will be talking about – avoid self-talk)
 - Affirmatives and not negatives (replace 'did not accept' with 'rejected', 'does not have' with 'lacks', etc.)



Paragraph structure

- Start a paragraph with a topic sentence.
- A good topic sentence is linking to your key concepts or variables.
- Paragraphs should be organized around one central character, idea, concept, or variable.
- Make these central themes the subject of your sentences.
- E.g., if your paragraph is about chemical polarity in groundwater treatment, then make polarity and the words related to polarity the subject of your sentences in the paragraph.

Chemical polarity plays an important role in the plant uptake of micropollutants. Neutral micropollutants are readily taken up by plants compared to ionized micropollutants. Chemical polarity is often influenced by the functional groups present on the micropollutant. Ionizable micropollutants normally have hydroxyl, sulfate, and ammonium groups in their structure.

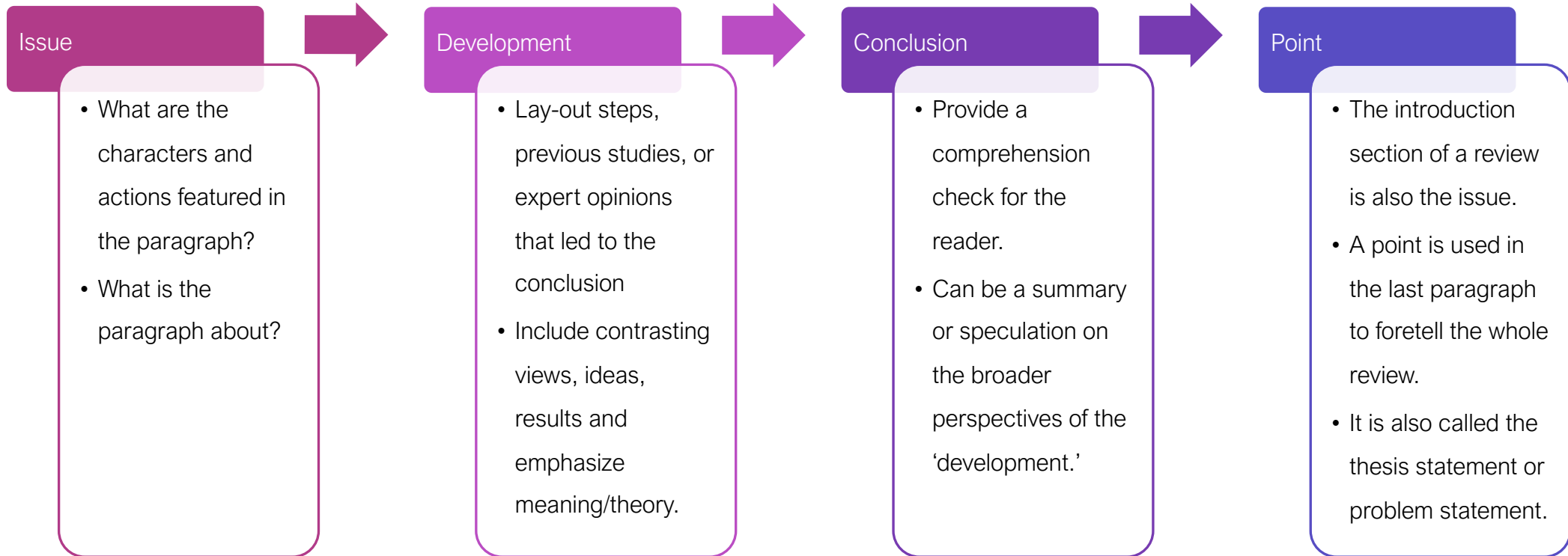


Paragraph structure (cont'd)

- Paragraphs have parts – an issue, a development, a conclusion and a point.
- Readers expect to find each of the four parts in the paragraph.
- Readers use these parts to help them recognize new ideas.
- If any part is missing, incomplete, or misplaced, readers become disoriented.
- A good paragraph is less than 200 words.



Design your paragraphs



Designing your sections

- Good writers arrange their paragraphs in **predictable patterns**.
- Such arrangements help readers move easily through the review while grasping the key points.
- Examples of patterns used when organizing paragraphs include:
 - **Chronological order** – works when describing a process.
 - **General to specific** – a logical way to present an unfamiliar topic is to start with general to specific.
 - Least important to most important
 - Problem to solution
 - **Compare and contrast** – one paragraph for attributes of one idea and another paragraph for the other idea



VISUALIZING YOUR REVIEW

4. Better figures and tables



Why visualization is important

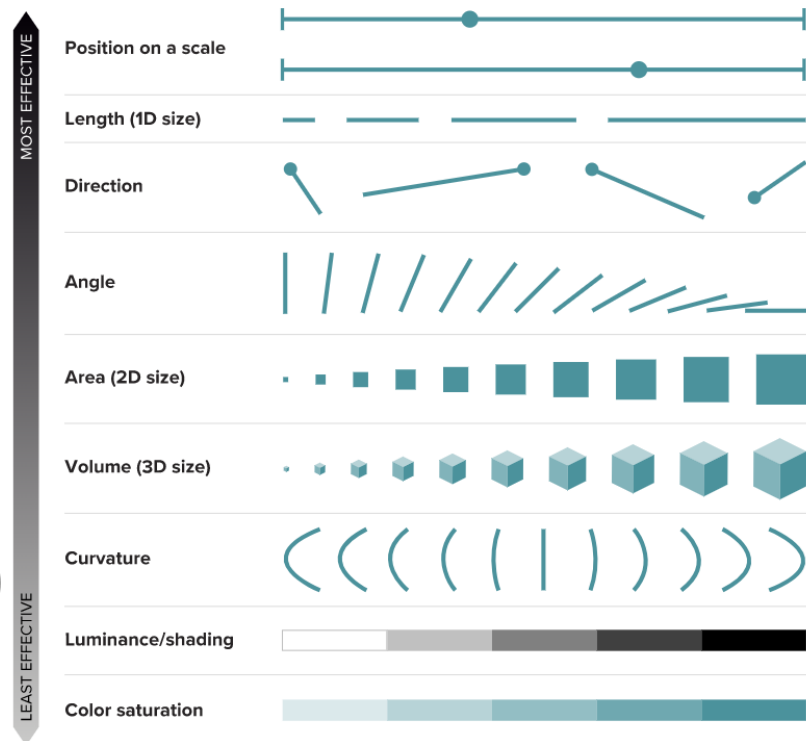
- Images are effective for all kinds of storytelling, especially when the story is complicated, as it so often is with science.
- Scientific visuals can be essential for **analyzing data**, communicating experimental **results**, and even for making **surprising discoveries**.
- Visualizations can reveal patterns, trends and connections in data that are difficult or impossible to find any other way.
- **Improving scientific visualization will require** better understanding of the strengths, weaknesses and biases of how the **human brain perceives the world**.



Selecting a better graph

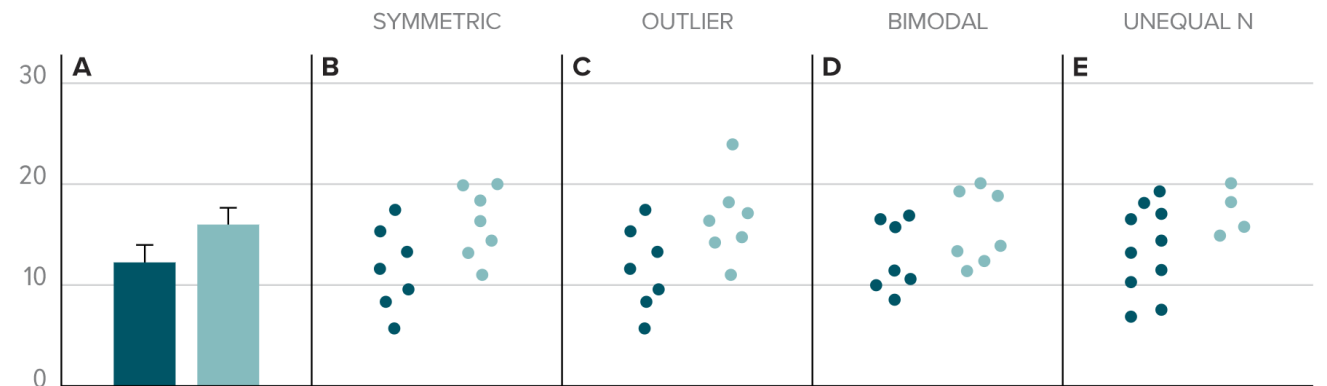
Ranking of visual elements

Studies have identified the easiest ways for people to understand differences in quantitative data, on a scale from most effective to least.



Hidden in the bars

Data revealed in scatterplots may be masked within a bar chart.



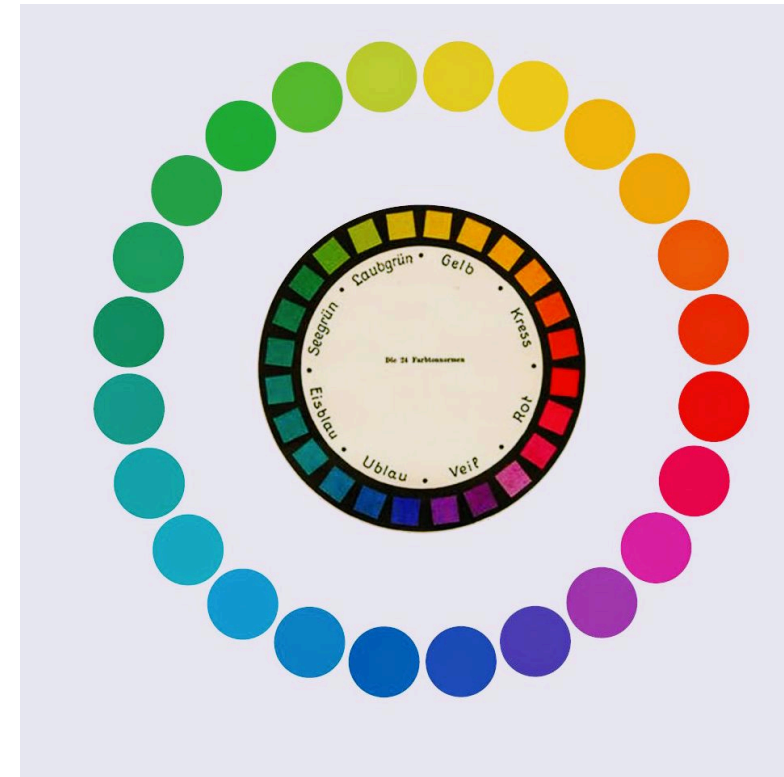
SOURCE: T.L. WEISSGERBER ET AL / PLOS BIOLOGY 2015

5W INFOGRAPHIC / KNOWABLE



Choose your colors with care

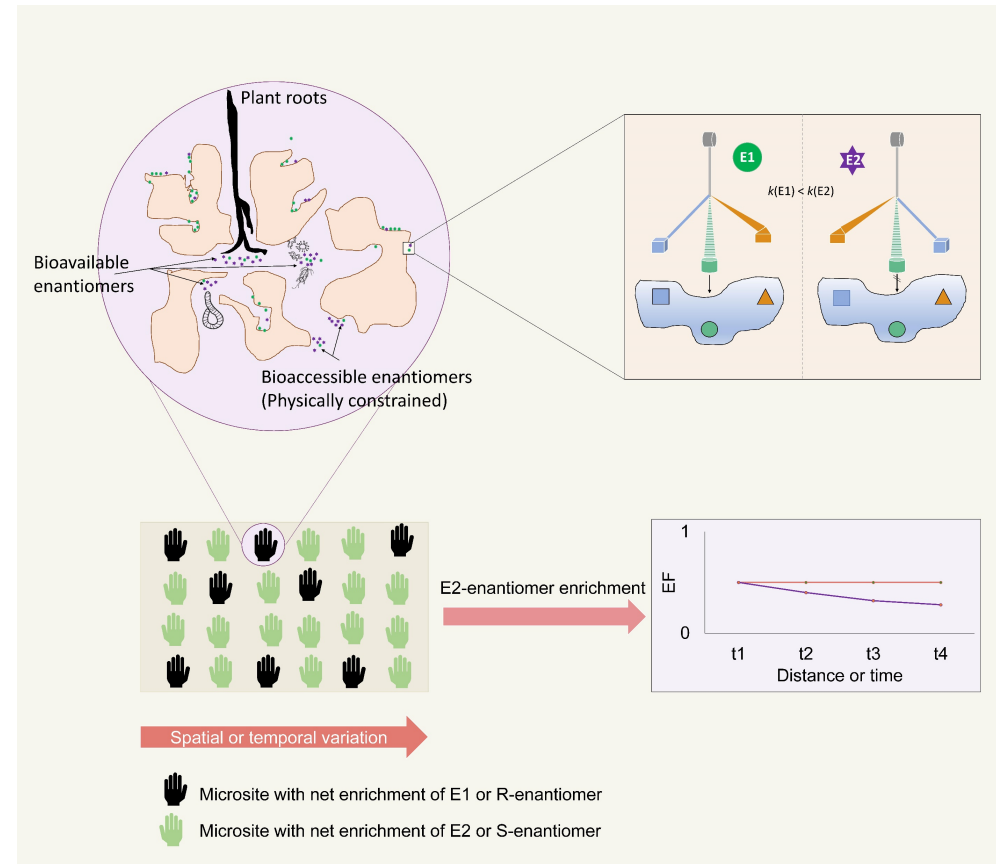
- Use rainbow color schemes with caution or avoid them if possible!
- The rainbow is perceived unevenly by the human brain.
- People see color in terms of hue (such as red or blue), saturation (intensity of the color), and lightness (how much white or black is mixed in).



How to create a better figure

My figure design toolbox:

- PowerPoint – save image as PDF at high resolution.
- PDF Editor – Foxit Phantom; convert to TIFF, PNG, or JPEG; 300 dpi
- Photoshop – Convert PDF to image; 300 dpi
- Pixabay.com – collect vector images free
- The Noun Project – premium stock for vectors
- Color hue (images from nature.com)



Additional resources

1. Anne E. Greene. (2013) Writing Science in Plain English, Chicago: University of Chicago Press
2. Gopen, G., Swan, J. (2018) [The science of scientific writing](#), Scientific American
3. Mason, B. (2019) [Why scientists need to be better at data visualization](#), The Knowable Magazine
4. Turbek, S.P et al. (2016), [Scientific Writing Made Easy: A Step-by-Step Guide to Undergraduate Writing in the Biological Sciences](#). Bull Ecol Soc Am, 97: 417-426.



Question and Answers
