



Science Writing

(how to continually improve our writing productivity and clarity)

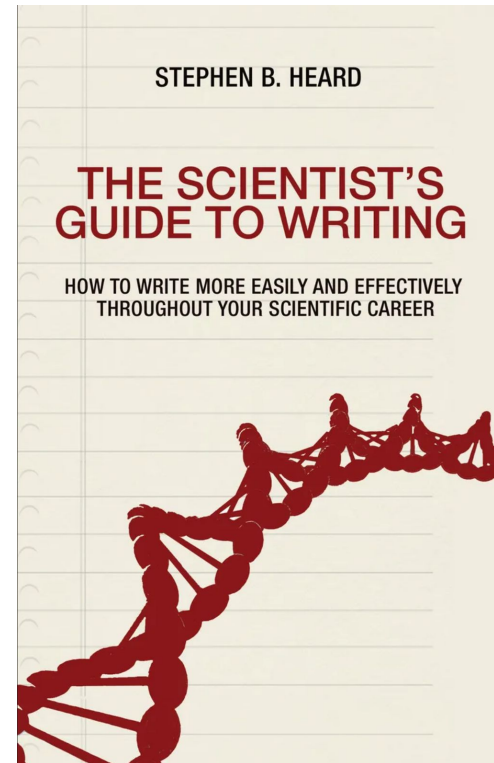
Shannon Danforth

September 2020

These aren't my ideas - I got them all from one book

- The Scientist's Guide to Writing by Stephen B. Heard
- Topics:
 - Writing behavior
 - Writing structure
 - Writing style
 - Revisions

I'll focus on these two



These aren't my ideas - I got them all from one book

- The Scientist's Guide to Writing by Stephen B. Heard
- Topics:
 - Writing behavior
 - Writing structure
 - Writing style
 - Revisions
- Note: there are LOTS of books about technical writing!

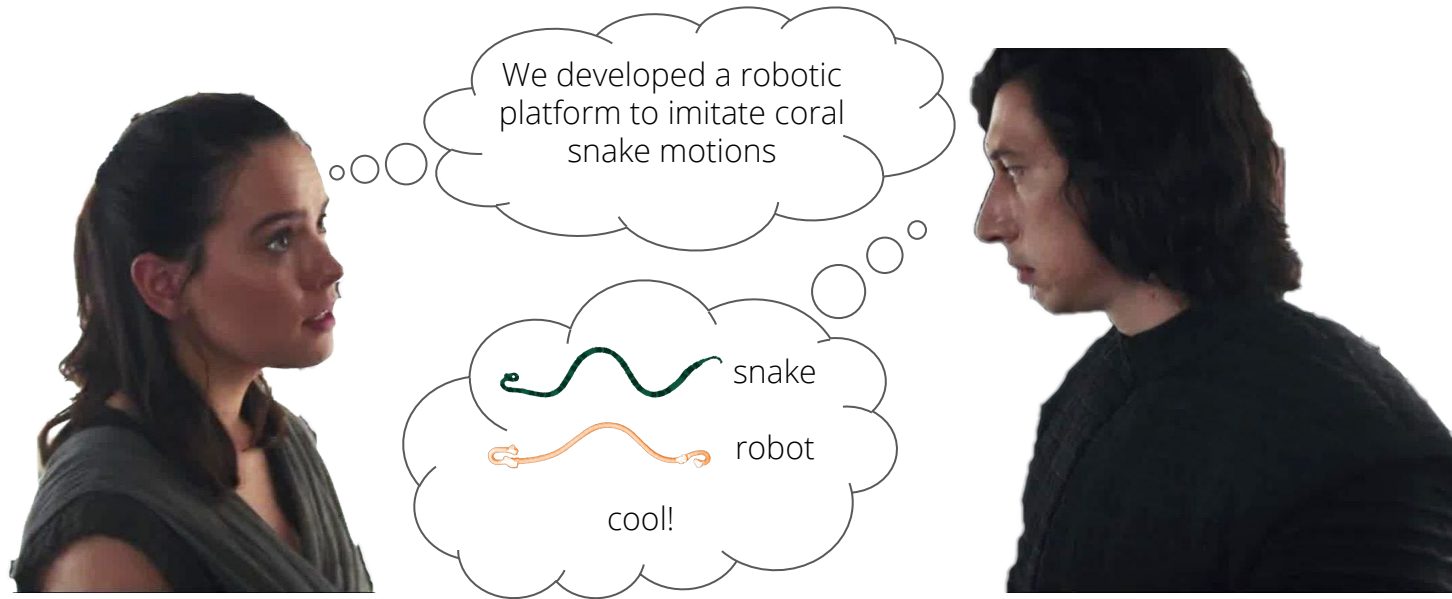


Why do we care about being good at science writing?

- Our goal is *telepathy*: “direct transmission to the reader’s brain from ours”

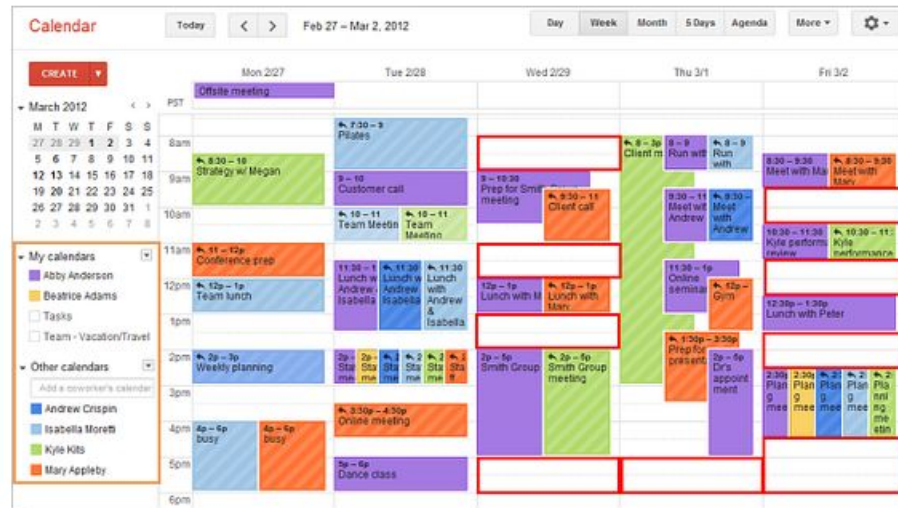
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Why do we care about being good at science writing?

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- Isn’t spending time on clear writing just a selfless waste of time?



Why do we care about being good at science writing?

- Our goal is *telepathy*: “direct transmission to the reader’s brain from ours”
- Isn’t spending time on clear writing just a selfless waste of time?
- In fact, taking the time to produce clear writing benefits *your career* as well!

Principal Investigator/Program Director, East, PhD, Institute, Wake, UNC

Specific Aims

Microscopy has emerged as one of the most powerful and informative ways to analyze cell-based high-throughput screens (HTS) samples in experiments designed to uncover novel drugs and drug targets. However, many diseases and biological pathways can be better studied in whole animals—particularly diseases that involve organ systems and multifactorial interactions, such as metabolism and infection. The worm *Caenorhabditis elegans* is a well-established and effective model organism that can be robotically prepared and imaged, but existing image analysis methods are insufficient for most assays.

We propose to develop algorithms for the analysis of high-throughput *C. elegans* images, validating them in three specific experiments to identify chemicals to cure human infections and genetic regulators of host response to pathogens and metabolism. Novel computational tools for automated image analysis of *C. elegans* assays will make whole animal screening possible for a variety of biological questions not approachable by cell-based assays. Building on our expertise in developing image processing and machine learning algorithms for high-throughput screening, and on our established collaborations with leaders in *C. elegans* research, we will:

Aim 1: Develop algorithms for *C. elegans* viability assays to identify modulators of pathogen infection.
Challenge: To identify individual worms in thousands of two-dimensional brightfield images of worm populations infected by *Mycobacterium*, and measure viability based on worm body shape (few worms are curly whereas dead worms are straight).

Approach: We will develop algorithms that use a probabilistic shape model of *C. elegans* learned from worm images.

grant proposals

papers

fellowship applications

cover letters

Aim 2: Develop algorithms for gene expression pattern assays to identify regulators of the response of the *C. elegans* host to *Staphylococcus aureus* infection.
Challenge: To map each worm to a reference and quantify changes in fluorescence localization patterns.

Approach: We will develop worm mapping algorithms and combine them with anatomical maps to extract atlas-based measurements of staining patterns and localization. We will then use machine learning to distinguish morphological phenotypes of interest based on the extracted features.

Impact: These algorithms will address addressing a variety of biological questions by measuring complex morphologies within individual worms.

In addition to discovering novel anti-infectives and genes involved in metabolism and pathogen resistance, this work will provide the *C. elegans* community with (a) a versatile, modular, open-source toolbox of algorithms readily usable by biologists to quantify a wide range of important high-throughput whole-organism assays, (b) a new framework for extracting morphological features from *C. elegans* populations for quantitative analysis of the organism, and (c) the capability to discover disease-related pathways, chemical probes, and drug targets in high-throughput screens relevant to a variety of diseases.

Estimating duration and curvature of corneal snake anti-predator thrashing behaviors using a soft-robotic platform

Shannon M. Darvish¹, Magan Kohler², David Brooker³,
 Aaron R. Davis Rubinsky¹, Sridhar Kana⁴, Ram Vasudevan¹, Talla Y. Moore¹



Abstract:—This paper presents a soft-robotic platform for capturing the individual behavior of non-biometric responses to stimuli under observation. Corneal snake systems (CSSLs) are soft robots that are used to study the behavior of non-biometric responses to stimuli under observation. The robot is made from thin layers of elastic material that allows it to make contact. In this work, soft robot equipped with differential elements (DDEs) are used to study the behavior of non-biometric responses to stimuli under observation. Curvature and duration of strokes are related to both the stroke and stroke, providing a quantitative assessment of the robot's ability to make stable poses. The curvature of the differential element, head, neck, and tail, and the stroke, will be used to study the behavior of non-biometric responses to stimuli under observation. The duration of strokes will be used to study the behavior of non-biometric responses to stimuli under observation. The curvature of the differential element, head, neck, and tail, and the stroke, will be used to study the behavior of non-biometric responses to stimuli under observation. The duration of strokes will be used to study the behavior of non-biometric responses to stimuli under observation.

Personalized Identification of Knee Injury Risk through Convex Optimization

Research Idea: The goal of the proposed research is to create and analyze dynamic models of human motion using non-invasive sensors that can automate the process of evaluating and correlating for biomechanical deficiencies in humans. By non-invasively and automatically assessing the risk of specific injuries, these quantitative tools will improve the accessibility of diagnostic tests.

Motivation and Background: Clinicians evaluate factors such as balance, strength, or endurance to identify biomechanical deficiencies in individuals, allowing for targeted performance enhancement and injury prevention training [1]. Although these functional movement screenings are effective in identifying injury risk, they rely on the trained eye of a clinician, making them time- and cost-intensive. With limited time to conduct functional screenings, clinicians must prioritize populations most at risk of injury, such as older adults and patients recovering from surgery.

My proposed research focuses on automating the identification of Anterior Cruciate Ligament (ACL) injury risk. An estimated 200,000 ACL tears occur in the United States each year, with over 100,000 people undergoing reconstruction surgery to regain the lateral stability necessary in sports as well as everyday tasks [2]. Currently, clinical methods of assessing ACL injury risk involve a lengthy screening with lateral and vertical jumping, agility tests, and balance tasks. The automated, non-invasive process described in my research will

fellowship applications



Fig. 1. The proposed research aims to develop dynamic models of human motion, identify parameters and control inputs given a 3D kinematic observation, and solve optimization problems to determine likelihood of injury risk.

Task 1 - Identifying Model Parameters and Control Input: Human movement can be modeled by hybrid dynamics, which exhibit continuous behavior described by differential

September 30, 2012

Mr. Steven South
 Flight and Ticket Recorder
 Pan American Airlines
 Miami International Airport
 Miami, Florida 33129

Dear Mr. South:

While reviewing an article in the Wall Street Journal recently, I learned that your company is planning to assume a portion of Bonifati Airlines' routes to South America. Many of your new customers will be the Hispanic populations of Miami, New York, Dallas and the South American countries you intend to serve. No doubt, you

cover letters

I look forward to your response. My involvement as the Vice President of the Latino Student Union has prepared me for recognizing the most appropriate methods in identifying problems and offering solutions, along with developing methods for troubleshooting areas of concern. These skills, along with my positive attitude and strong work ethic, will work to your advantage in meeting the needs of the new Hispanic population you will be serving.

I will be in Miami the week of October 14-17th, 2012, and would appreciate the opportunity to meet with someone within your office to discuss my qualifications for a full-time entry-level position within your organization. Within the next two weeks I will contact you to determine if it is possible to connect with someone during my visit to the Miami area. Thank you for your time and consideration of my qualifications.

Sincerely,

Mary Anne Swarez

Mary Anne Swarez
 1854 Circle Ave.
 Charlottesville, VA 22905

In return for my and an excellent cover letter.

If your paper isn't clear, the reader will turn to another

Say I want to learn how to analyze the Sit-To-Stand motion.

Which of the following two papers am I more likely to read (and cite)?

If your paper isn't clear, the reader will turn to another

Dynamics of the sit-to-stand movement

Abstract

The strategies of the sit-to-stand movement are investigated by describing the movement in terms of the topology of an associated phase diagram. Kinematic constraints are applied to describe movement sequences, thus reducing the dimension of the phase space. This dimensional reduction allows us to apply theorems of topological dynamics for two-dimensional systems to arrive at a classification of six possible movement strategies, distinguished by the topology of their corresponding phase portrait. Since movement is

If your paper isn't clear, the reader will turn to another

Event Standardization of Sit-to-Stand Movements

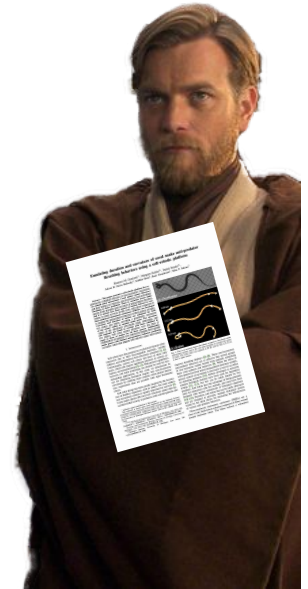
Background and Purpose

Unlike gait analysis, no commonly accepted method for studying sit-to-stand (STS) movements exists. Most previous studies describing STS events used various methods to identify movement events while restricting sitting positions and movements. The present study observed natural rising from a sitting position using a simple method for measuring this common task. The purposes of this study were to compare commonly performed STS movements and to propose a standard system for defining identifiable sequential events.

(I like this one better, so I'm going to read it and maybe cite it!)

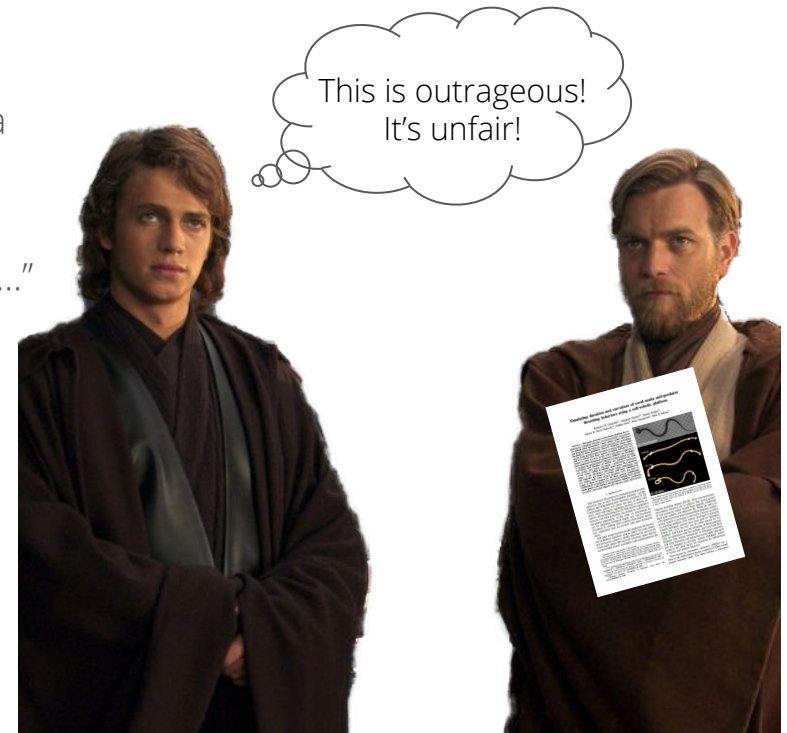
Few people are “geniuses” when it comes to science writing

- We may have a rare person in our lives who produces a near-perfect first draft in record time



Few people are “geniuses” when it comes to science writing

- We may have a rare person in our lives who produces a near-perfect first draft in record time
- The rest of us “write, delete, undelete, and delete again...”



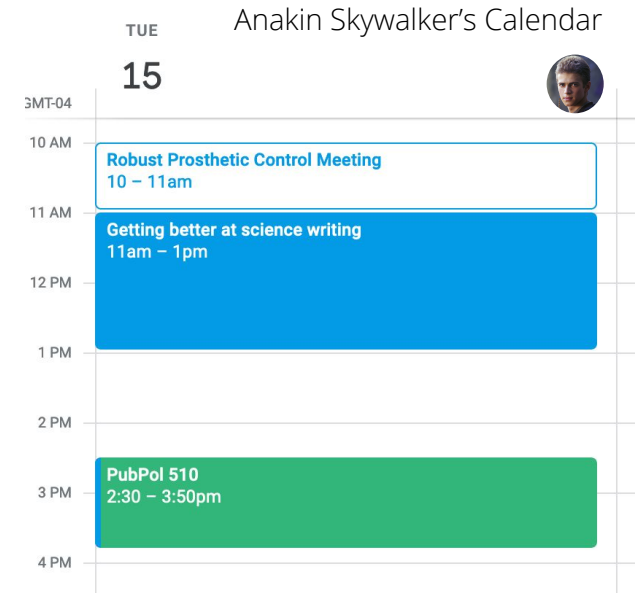
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- Product vs. process



Few people are “geniuses” when it comes to science writing

- We may have a rare person in our lives who produces a near-perfect first draft in record time
- The rest of us “write, delete, undelete, and delete again...”
- Product vs. process
- As engineers/scientists, we should consider working on the *craft* of writing as a normal part of our job



Today, I'll talk about a strategy for improving our writing:

1. Everything we write should satisfy our goal of crystal-clear communication



Sir, the possibility of successfully navigating an asteroid field is approximately 3,720 to 1.

Today, I'll talk about a strategy for improving our writing:

1. Everything we write should satisfy our goal of crystal-clear communication
2. Reflecting on and changing our writing behaviors to:
 - write more
 - write more easily
 - write better



Outline

1. Content and Structure
 - a. Defining your story
 - b. Tools for organizing your story
 - c. General structure of scientific paper
 - d. Individual sections
2. Behavior
 - a. Self-awareness
 - b. Getting started
 - c. Momentum

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Content and structure - it's for the reader

- Your paper needs to be easy for readers to absorb
- Your specific discipline also has standards and conventions that you should learn and respect
- Here, we'll talk about some general principles and tools that can help you make decisions

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Defining your story

mountains of data from multiple experiments, many different models, many ways of fitting the models, mock-ups, prototypes, several different analyses, follow-up procedures to answer lingering questions, lots of tests to check if a method works...



what should I write about?

Defining your story

mountains of data from multiple experiments, many different models, many ways of fitting the models, mock-ups, prototypes, several different analyses, follow-up procedures to answer lingering questions, lots of tests to check if a method works...

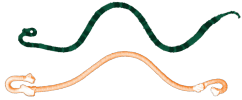


what does my reader need to hear about?

Your paper should raise and answer an interesting question

Construct a two-sentence mini-summary of your paper's central question and answer.

Your paper should raise and answer an interesting question



EMBiR Lab snake robot paper examples:

Bad:

We designed soft robots with strain-limiting fibers to imitate specific snake shapes. We explain how the robots were designed, and show some comparisons.

Better:

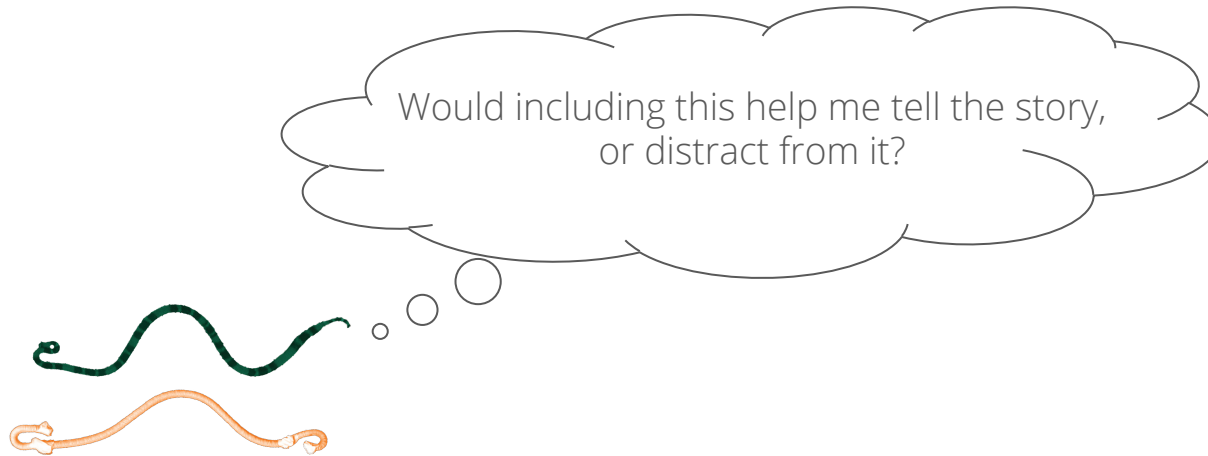
We present a soft-robotic platform that mimics coral snake thrashing behavior. We show that the robot has similar thrash durations and curvatures to wild-caught coral snakes.

Good:

It is unclear how the thrashing and bright color patterns of coral snakes interact to keep predators away, and robots can help investigate this question in a controlled manner. We present a soft-robotic platform to mimic the thrashing behavior, and show the close comparisons to three different snake genera.

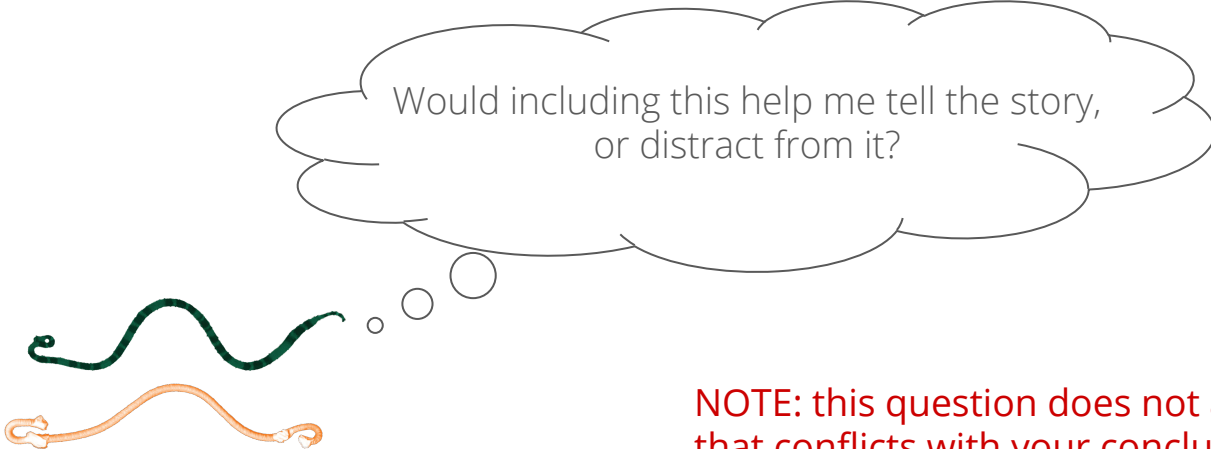
Use your summary to make decisions

(for every dataset, model, figure, table, piece of information...)



Use your summary to make decisions

(for every dataset, model, figure, table, piece of information...)



Would including this help me tell the story,
or distract from it?

NOTE: this question does not apply to omitting data that conflicts with your conclusion. That is unethical!!

Overall story-finding process

1. Develop your two-sentence summary (that may be a process in itself)
2. Determine which information, data, model, or analyses belong in your paper
3. Decide the order in which to present it

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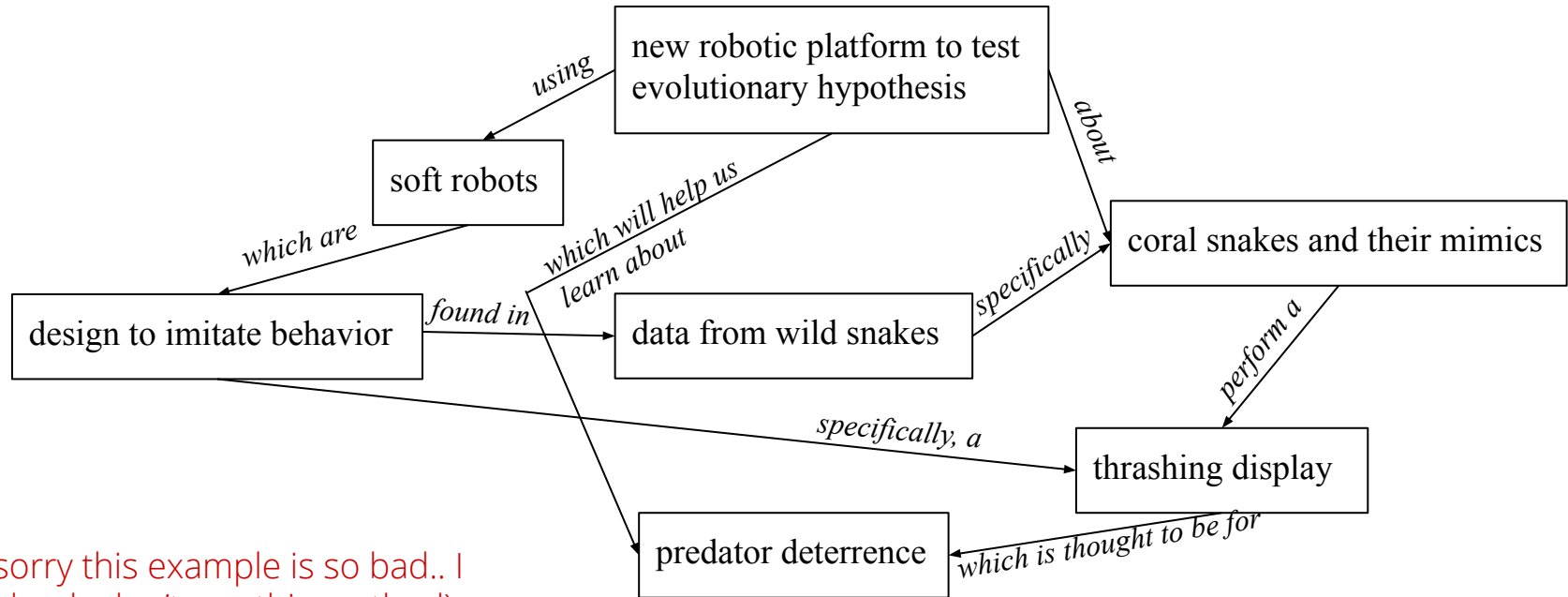
Story-finding tools: Wordstack

An unsorted list of points (words or phrases) that you think might be useful in your manuscript.

coral snakes
mimics
predator deterrence
color pattern, thrashing
how to measure interaction?
ethical, controlled experiments
robotic platform
data from wild-caught snakes
snake data collection
robot design and theory
robot experiment
comparisons
figures
color-coded: green for snake, orange for robot
modular design - easy for fieldwork
discussion of applications and future work

Story-finding tools: Concept Map

A tool for exploring relationships among concepts - a set of nodes connected by lines.



(sorry this example is so bad.. I clearly don't use this method)

Story-finding tools: Outlines

An ordered list of topics or points that summarizes the intended content of your manuscript.

1. The story summary. Answers to the following nine queries about your work and your story:

1. What is the central question?
2. Why is this question important?
3. What data are needed to answer this question?
4. What method are used to get those data?
5. What analysis might be applied for the data to answer the central question?
6. What data were obtained?
7. What were the results of the analyses?
8. How did the analyses answer the central question?
9. What does the answer tell us about the broader field?

Story-finding tools: Outlines

An ordered list of topics or points that summarizes the intended content of your manuscript.

2. The subhead outline. Made up of phrases of other entries intended for use as headings/subheads:

1. Introduction
2. Methods
 - a. Snake Data Collection
 - b. Robot Design
 - c. Robot Experiment
 - d. Thrash duration computation
 - e. Curvature computation
3. Results
 - a. Comparisons between snake genus
 - b. Comparisons between snake morphologies
4. Discussion

Story-finding tools: Outlines

An ordered list of topics or points that summarizes the intended content of your manuscript.

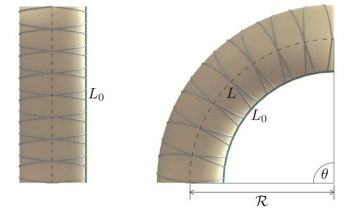
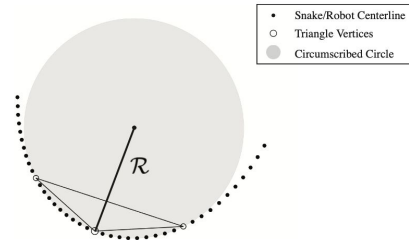
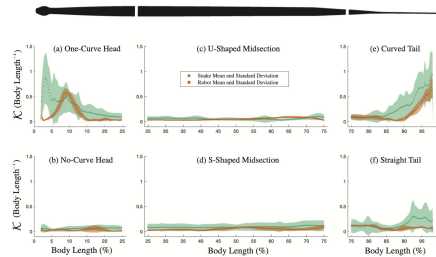
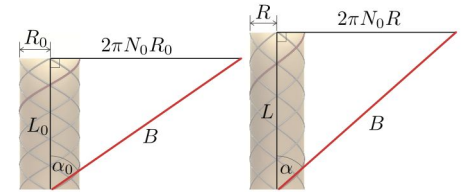
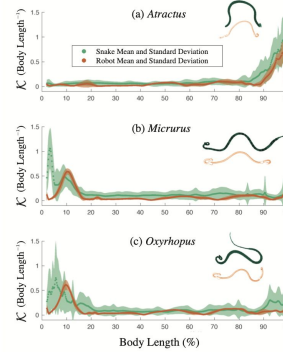
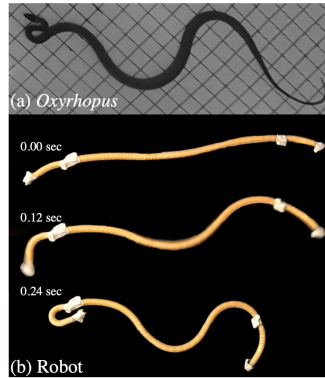
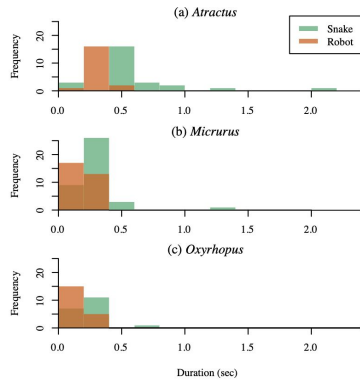
3. The topic-sentence outline. One entry for each intended paragraph of the completed manuscript.

1. Soft robots can be used to investigate biological hypotheses
2. Soft robots can be used to investigate coral snake anti-predator behavior
 - a. Color pattern and thrashing
 - b. Safely hunted by live predators
 - c. Non-locomotory movement
3. FREEs are a type of soft robot that can be designed to exhibit the thrashing behavior we want
 - a. Extension, torsion, bending, coiling
4. Summary of our contributions for this paper
 - a. Design and fabrication of the robots
 - b. First quantitative comparison between coral snakes and mimics
 - c. Comparison between snakes and robots
5. Overview of each section of the paper

Story-finding tools: Figure Shuffling

An alternative to outlining; focuses on data and analyses as the elements that define your story.

- Print out rough figures or tables on hand from preliminary analysis
- Pin to a wall or arrange on a table
- Shuffle and eliminate until it presents a story you want to tell



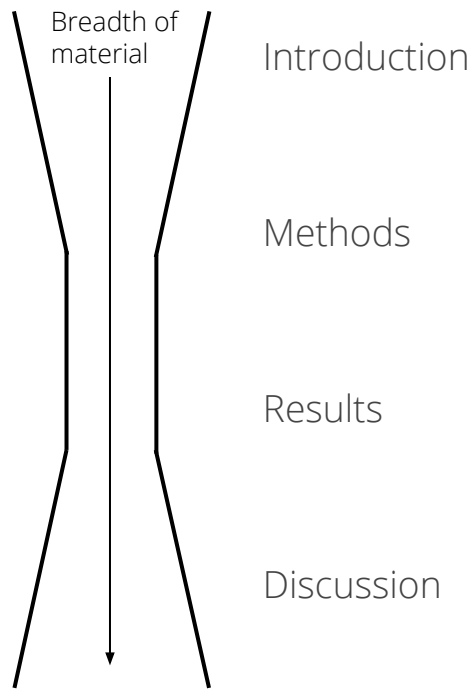
Revising your story

- The story-finding tools are helpful guides, but they don't have to be strict
- As you start writing, you may find that you want to change the story
- Go back to your outline/wordstack/figure shuffle/concept map and ask:
 - Does adding new material improve the story?
 - Does reordering or deleting a topic help you improve the story?

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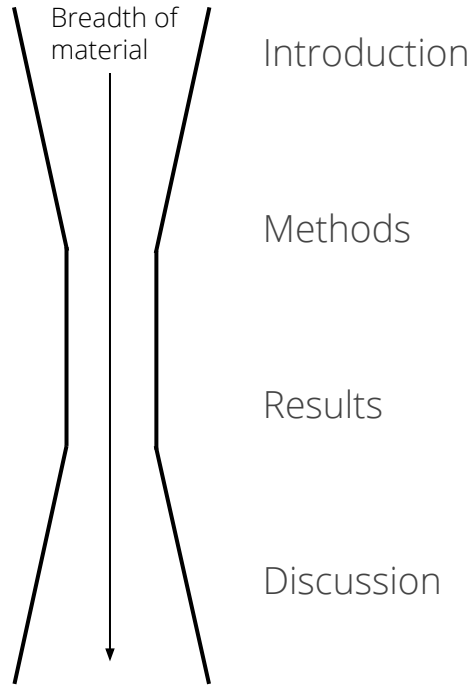
Getting to know the IMRaD format



I'M RAD FORMAT

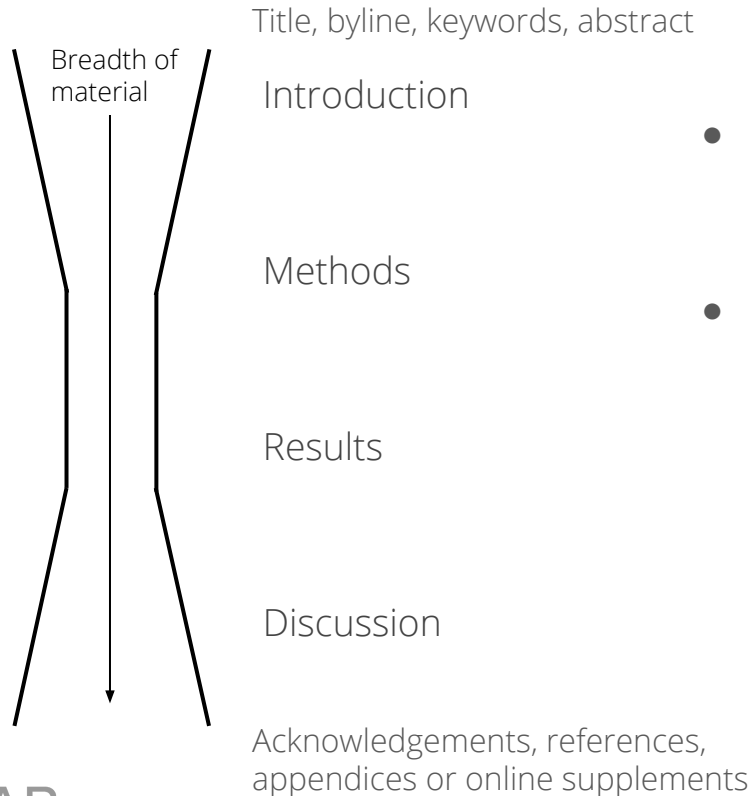


Getting to know the IMRaD format



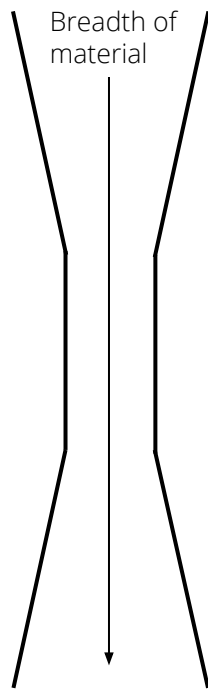
- A helpful structure for both reader and writer, and encouraged by many publishers (there are exceptions!)

Getting to know the IMRaD format



- A helpful structure for both reader and writer, and encouraged by many publishers (there are exceptions!)
- These main sections are preceded by front matter and followed by back matter

Getting to know the IMRaD format



Title, byline, keywords, abstract

Introduction

General context, identify gap, research question, summary of approach

- A helpful structure for both reader and writer, and encouraged by many publishers (there are exceptions!)

Methods

Materials, experiments, models, hardware design, data analyses, etc.

- These main sections are preceded by front matter and followed by back matter

Results

Results of experiments, observations, or modeling in tables, text, or figures

- And lots of standardized substructure in each section

Discussion

Interpretation of results, consideration of weaknesses, broader implications, future work

Acknowledgements, references, appendices or online supplements

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The introduction sets the context for the work

define a research territory

- The broadest possible context for your work
- Degree of breadth will depend on the target journal or conference
- Narrow a bit more to get closer to your research area using literature review

The introduction sets the context for the work

define a research territory

Soft robots have the potential to revolutionize human-robot interaction due to their biocompatible materials, variable stiffness, and independence from electronic actuation [Rus et al. 2015, Laschi et al. 2016]. Unfortunately, current soft robots fall short of these lofty goals, which still require significant advances in control, actuation, and manufacturing [Kim et al. 2013, Majidi et al. 2014]. With present capabilities, however, soft robot technology can already be used for less-demanding applications. In this work, we demonstrate its use for enhancing biological inquiry into non-locomotory movement by enabling more realistic robot-animal interaction experiments than are possible with rigid biomimetic robots.

The introduction sets the context for the work

define a research territory



establish a niche within
the research territory

- Discuss a concrete and narrow open problem within the research territory
- Examples: a research gap, apparent contradiction, or a published claim that is vulnerable
- State your central research question

The introduction sets the context for the work

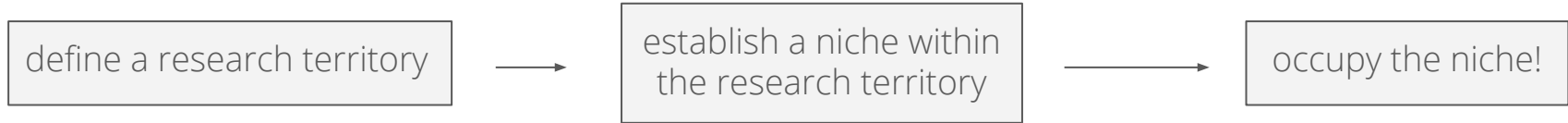
define a research territory



establish a niche within
the research territory

...While the effect of color pattern has been tested using painted stationary models, precise control of movement is necessary to test for an effect on deterring predation [Brodie et al. 1993]. Robots developed to precisely emulate biological motions have been used for hypothesis testing [Libby et al. 2012, Patricelli et al. 2009], but few can be safely hunted by live predators....Therefore, soft robots that can be safely destroyed and are designed to precisely emulate biological motion would be the ideal choice for measuring the effectiveness of various anti-predator behaviors.

The introduction sets the context for the work



- How does your work address the central question you just brought up?
- Indicate your basic approach, general form of your data/model/analysis
- How to end the introduction? Check what others do in your target journal/conference

The introduction sets the context for the work

define a research territory



establish a niche within
the research territory



occupy the niche!

In this work, we develop soft robots composed of fiber-reinforced elastomeric enclosures that can precisely mimic the thrashing vigor and curvature exhibited by multiple species of snake while safely interacting with live animal predators. Our contributions are as follows. First, a framework for the design and fabrication of such robots. Second, the first quantitative comparison of the anti-predatory thrashing behavior between *Micrurus* coral snakes and two of its mimics. Third, an approach for comparing non-locomotory behavior between bio-inspired robots and their biological templates.

The methods section establishes the credibility of your approach

- Establish your qualification as a researcher
- Establish the plausibility of your approach to the problem
- Establish your sequence of investigative steps, so there's a logical basis for the claims you make
- What about for repeatability? Use an online supplement or appendix for more detail

The methods section can be organized in many ways

Chronological order is not necessarily the most clear way to present the methods!

- **Common Option 1:** for “simpler” papers
 - Background, experiments or observations, analysis
- **Common Option 2:** for more complicated papers with a combination of theory and experiment
 - Work through each procedurally distinct component of the work separately
- Whatever you pick, signal it clearly with subheads

Beware of “self-plagiarism”

- Writing multiple papers that use the same methods or study system
- You may think they're your words to copy... but they're probably owned by a publisher
 - (note: it's fine to copy your own writing in grant proposals)
- Technique 1: Describe a bare-bones method in the second paper, and reference the first
- Technique 2: Get creative and rephrase the first paper :)

Results draw attention to data you will interpret in the discussion

- Remember the importance of finding and telling your story!
- The goal is a short and simple section where every word/graphic/table contributes to your story
- **Common Option 1:** for “simpler” papers
 - Place main result in first paragraph
 - Subsequent paragraphs can include data and analyses that support or complement
- **Common Option 2:** for complex arguments where analyses build on each other
 - Order from least to most important results
 - Signals like “finally,” “most important,” or “combining the results so far” help the reader
- **Common Option 3:** for complex arguments where analyses build on each other
 - Same as Option 2, but start the section with a brief overview of most important result

The discussion section turns data into knowledge

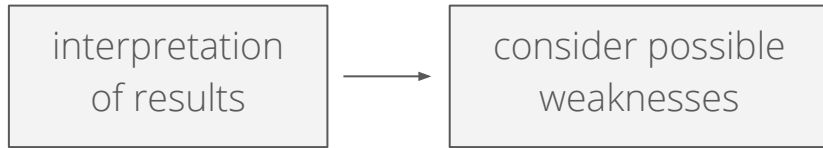
Every question raised in the introduction should be answered in the discussion, and every major issue treated in the discussion should be signaled in the introduction.

The discussion section turns data into knowledge

interpretation
of results

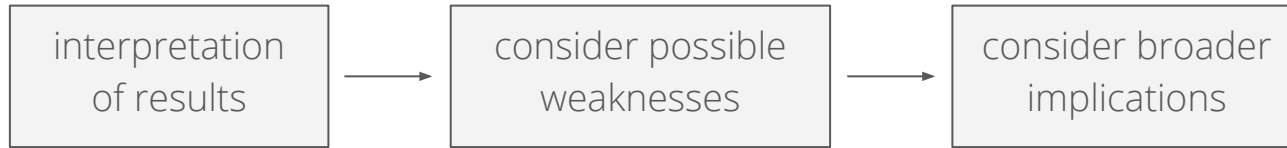
- First paragraph supplies a concise answer to your central research question
- Might re-state some results: consider what the patterns mean and how they apply to your question
- Could draw on comparisons with results from the literature
- Might comment on whether the results were expected or unexpected
 - If unexpected, provide a possible explanation!

The discussion section turns data into knowledge



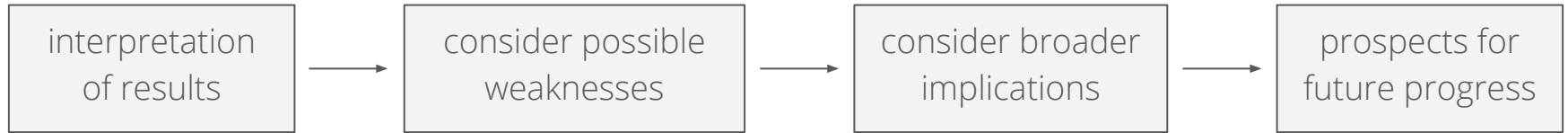
- Was there...
 - an absence of a looked-for pattern,
 - weaker steps in a chain of logic,
 - gaps in the data, or
 - alternatives to the preferred interpretation of results?
- Early-career writers: be careful of overstating your weaknesses!

The discussion section turns data into knowledge



- How do your results relate to other research questions, answered or unanswered, in your field?
 - Does it support or call into question current hypotheses?
 - Does it open up new questions?
 - Does it establish consensus, draw attention to conflict, or increase understanding?
- Relate your research question to the broadest possible set of readers

The discussion section turns data into knowledge



- DON'T: vaguely say “more research is necessary”
- DO: indicate specific directions such research should take
- Emphasize the importance of your work by showing that it leads to future research projects

Talia note: be careful of being too detailed with future work, so people don't steal your idea

Outline

1. Content and Structure
 - a. Defining your story
 - b. Tools for organizing your story
 - c. General structure of scientific paper
 - d. Individual sections
2. Behavior
 - a. Self-awareness
 - b. Getting started
 - c. Momentum

Writing is a *process*, and writing behavior is important



Writing is a *process*, and writing behavior is important



Outline

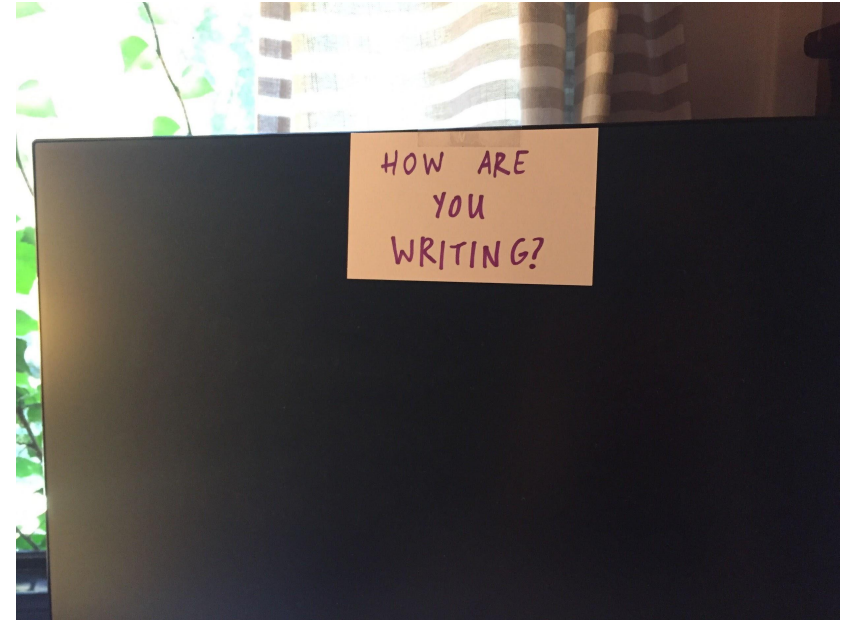
1. Content and Structure
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Switch focus from *what* you're writing to *how* you're writing



Behavioral self-awareness: set reminders

- Move it around from day to day
- Make a new one in a different color or font
- When you see it, ask yourself:
 - What am I doing right now?
 - Am I on-task or distracted?
 - Am I writing new words or revising old ones (and what was I supposed to be doing)?



Behavioral self-awareness: “writing conscience”

- Put a stuffed animal on your desk
- Every time you notice it, think about what it sees
- (is it judging you for being so distracted?)
- Creepy



Behavioral self-awareness: writing log

- Document a writing session
- Choose a writing session that is 2-3 hours long
- Set an alarm to go off every 6 minutes
- When it sounds, jot down what you were doing at that instant

At:	I was:
9:00	writing new text
9:06	writing new text
9:12	writing new text
9:18	checking email
9:24	fiddling with wording
9:30	reading baseball blog
9:36	writing new text
9:42	getting a snack
9:48	staring into space

Behavioral self-awareness: writing log

- Document a writing session
- Choose a writing session that is 2-3 hours long
- Set an alarm to go off every 6 minutes
- When it sounds, jot down what you were doing at that instant
- Daily writing log (just once at the end of each day) is more sustainable

Writing Log 08.19.20.

How much did you write? I wrote three paragraphs in methods section of paper

Did you write something of high quality? No.
Thoughts/topics are organized well, but not written well.
Will need revision

If you are satisfied with your writing today, what made that possible? Started early in the morning, made an outline, had big cup of coffee and snacks, put phone on other side of the room and silenced notifications

If you didn't accomplish much, what got in the way, and how could you avoid this problem tomorrow?

Behavioral self-awareness: cooperate with a friend

- Agree to (regularly) discuss writing behaviors with a friend or colleague
- Ex. 1: Send each other copies of what you wrote or revised each day, with commentary on what you actually did while writing
- Ex. 2: exchange and discuss daily writing logs
- A second person can notice behaviors you aren't aware of yourself



Common behavioral challenges you may learn about yourself

avoidance
distraction
feeling stuck
perfectionism
fear of criticism
reluctance to revise

Common behavioral challenges you may learn about yourself

avoidance	getting started
distraction	momentum
feeling stuck	momentum
perfectionism	momentum
fear of criticism	sharing drafts
reluctance to revise	tips for revision

stuff we'll talk about today

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There are two ways to “not get started” on writing...

1. Unintentional non-starting

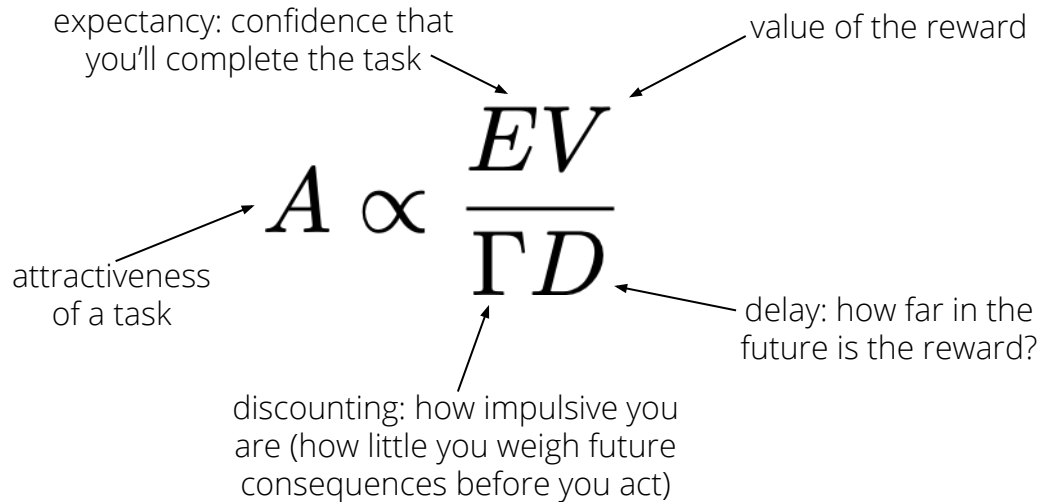
- A form of procrastination
- Make plans to write, reach the end of the day, and realize you haven't written anything

2. Intentional non-starting

- Are sure you will write better and faster if you wait for the right moment
- (nearly always wrong about this)

Unintentional non-starting: make writing seem more attractive

We *can* learn to reduce procrastination!



Expectancy E : confidence that you'll complete the task $A \propto \frac{EV}{\Gamma D}$



We can increase expectancy E by

$$A \propto \frac{EV}{\Gamma D}$$

- Making the task seem easier: reduce your goal!
 - Writing entire paper → producing a rough draft
 - Writing the introduction section → writing one paragraph
 - Writing one paragraph → writing the topic sentence
- Get better at writing ;)
 - The more often you write, the easier it will seem
- Think highly of yourself as a writer, even if it isn't true
 - Or, keep in mind that you're capable of success
 - High confidence leads to higher expectancy



Value V : expected value of the reward

$$A \propto \frac{EV}{\Gamma D}$$



We can increase value V by

$$A \propto \frac{EV}{\Gamma D}$$

- Bribing yourself
 - Complete a manuscript → take a day off
 - 1,000 words → get some ice cream
- Make writing seem like a better experience for you
 - Comfy chair
 - Scented candle
 - Favorite snacks on hand



Delay D : how far in the future is the reward?

$$A \propto \frac{EV}{\Gamma D}$$



We can decrease delay D by

$$A \propto \frac{EV}{\Gamma D}$$

- Offering yourself small rewards for incremental progress instead of one large reward at the end
- If you have a willing friend or colleague, send incremental progress for them to review



Discounting Γ : how often do you push writing aside?

$$A \propto \frac{EV}{\Gamma D}$$

*BUT MASTER YODA SAYS I SHOULD
BE MINDFUL OF THE FUTURE*



We can decrease discounting Γ by

$$A \propto \frac{EV}{\Gamma D}$$

- Encouraging awareness of the rewards to come
- Tape printed-out job offer in corner of computer screen
- Paste the title of your paper on the cover of the target journal/conference proceedings
- Keep a list of future projects, research directions, or collaborations that may result from publishing your paper

BUT MASTER YODA SAYS I SHOULD BE MINDFUL OF THE FUTURE



Intentional non-starting: welcome a dynamic approach to writing

You're never going to have a perfect first draft.

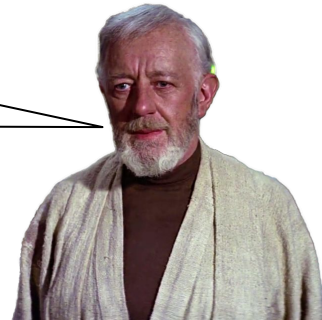
“I don’t have all the data/analyses yet”

- Certainly, you’ll need to wait on the results section--but you *can* start filling in the rest
- Begin writing as soon as you know the overall story you plan to tell
- Two-way road:
 - The science/engineering results suggest the story to tell
 - As you start telling the story, you’ll find more directions for the science/engineering to go
- As you go through the review process, others will suggest new data/analyses too
 - So “having all the data/analyses” is rarely achieved

“I don’t know what I’m going to write yet”

- (almost) Nobody can compose a full, perfect draft in their head and write it down in one shot
 - Our writing often twists and turns, needing multiple revisions
 - It’s not a waste of time to start writing, even if you will end up needing to revise
- Start by scribbling down incomplete outlines, any short thoughts
 - Utilize the tools for story-planning we discussed earlier
- Waiting for a mysterious process to provide inspiration is not a good strategy either

*IN MY EXPERIENCE, THERE'S
NO SUCH THING AS LUCK*



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Why is momentum important?

A career in science or engineering requires a substantial and sustained pace of writing.

Being disciplined will maintain your momentum

- Set a writing quota
 - Number of words: <https://750words.com/>
 - Number of hours
- Scheduling writing time into your day
- Timing: earlier in the day gives it priority
- Environment: remove unwanted distractions

How to manage interruptions and intermissions

- Resist the instinct to “finish that thought!”
- Instead, deliberately leave your work unfinished
 - Don't end with last sentence of a paragraph, end with the first sentence of the next one
 - Jot down an outline or notes for the next section, paragraph, or sentence

...With present capabilities, however, soft robot technology can already be used for less-demanding applications. In this work, we demonstrate its use for enhancing biological inquiry into non-locomotory movement by enabling more realistic robot-animal interaction experiments than are possible with rigid biomimetic robots.

Soft robot design has been greatly inspired by the locomotion of limbless organisms, such as snakes...

“Storming the beach”

- No need to get weighed down by making each sentence perfect, just get something on the page!
- Your first draft will not be seen by anyone
- Stuck on word choice? Need a citation?
 - Add in a symbol that’s easy to search (?? or !!) and move on

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This first sentence introduces Prof. Simon Kim and where he works, also brief description of what his work is like. This is a sentence introducing the concrete block project that he spoke about at the *Robotics Interfaces* talk, and what the goal of the project is. This sentence describes what experience the users had while interacting with the project and what their takeaway was.

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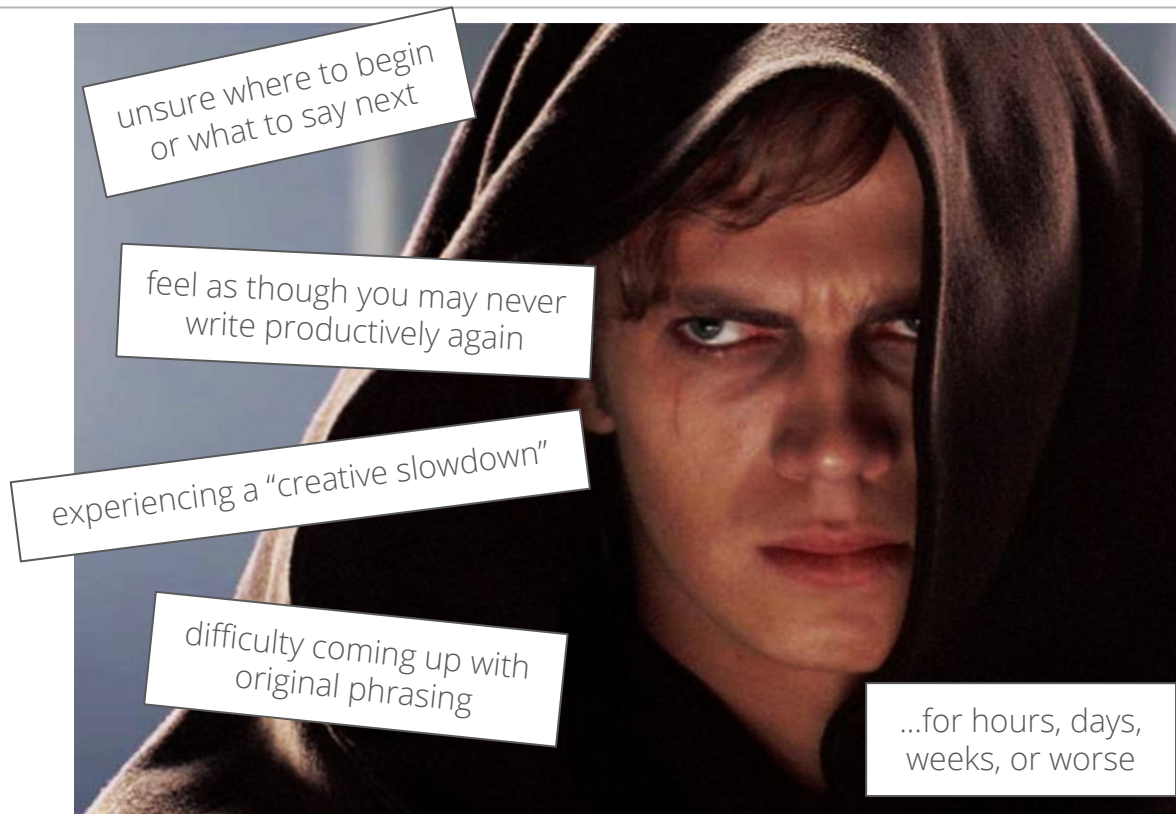
At the University of Pennsylvania’s School of Design, Professor [Simon Kim](#) [??does something that uses robots in architecture and design--figure out how to phrase it]. One of Kim’s [projects](#), [??describe the concrete block project with sensors], was designed to help humans empathize with inanimate objects. As humans interact with the concrete shapes, the sensor output is played over speakers, [??describe the outcome of this project].

“Storming the beach”

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At the University of Pennsylvania’s School of Design, Professor [Simon Kim](#) incorporates intelligent systems into buildings and cities and then explores their agency in those spaces. One of Kim’s [projects](#), a collection of concrete shapes embedded with sensors, was designed to help humans empathize with inanimate objects. As humans interact with the concrete shapes, the sensor output is played over speakers, providing insight into how various motions produce signals through the material.

“Writer’s block” (or your *perception* of an obstacle)



Thankfully, there are a lot of strategies for un-blocking

<p>Lower your standards</p> <p>Stop being blocked by your inner critic - the first draft is none of their business.</p> <p>For ten minutes, write something deliberately terrible, then move on.</p>	<p>Divide and conquer</p> <p>Instead of thinking about writing a whole section, think about writing one sentence.</p>	<p>There's more than one way</p> <p>Write two versions of the passage you're stuck on. Aim for 10 minutes each, then pick one to pursue after that.</p>	<p>Change your environment</p> <p>Go somewhere else, no more than 10 minutes away. Don't take your usual laptop with you, try just a pen and paper, or tablet. Immediately start writing something when you get there.</p>
<p>Talk it out</p> <p>Take 10 minutes to speak the passage you're working on. Record yourself, then play it back--and no matter how bad it is, stitch a sentence together and write it into the manuscript.</p>	<p>Freewrite</p> <p>Write about anything for 10 minutes. It doesn't have to be correct grammar or on-topic, just whatever comes to mind.</p>	<p>Skip ahead</p> <p>Find a part of the project that's easier: figure captions, keywords, or formatting references, and work on it for 10 minutes... then switch back to the writing.</p>	<p>Back up</p> <p>You may be uneasy about something you wrote previously. Is there a way to phrase it differently, to present your argument more clearly? Spend 10 minutes brainstorming.</p>

In conclusion, you are now unstoppable writers



content and structure for
crystal-clear communication

strategies for improving
writing behavior