Title: Visual Science Communication

Speakers: Henry Reich

Collection: Scicomm Collider

Date: April 13, 2023 - 4:30 PM

URL: https://pirsa.org/23040099

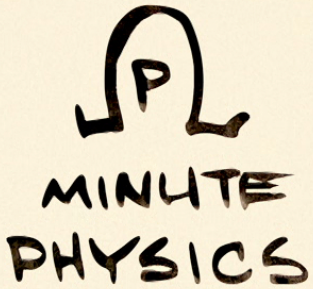
*How I think about*

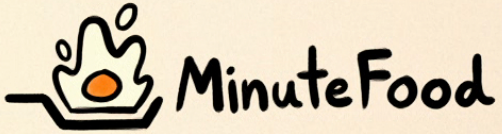
# Visual Communication

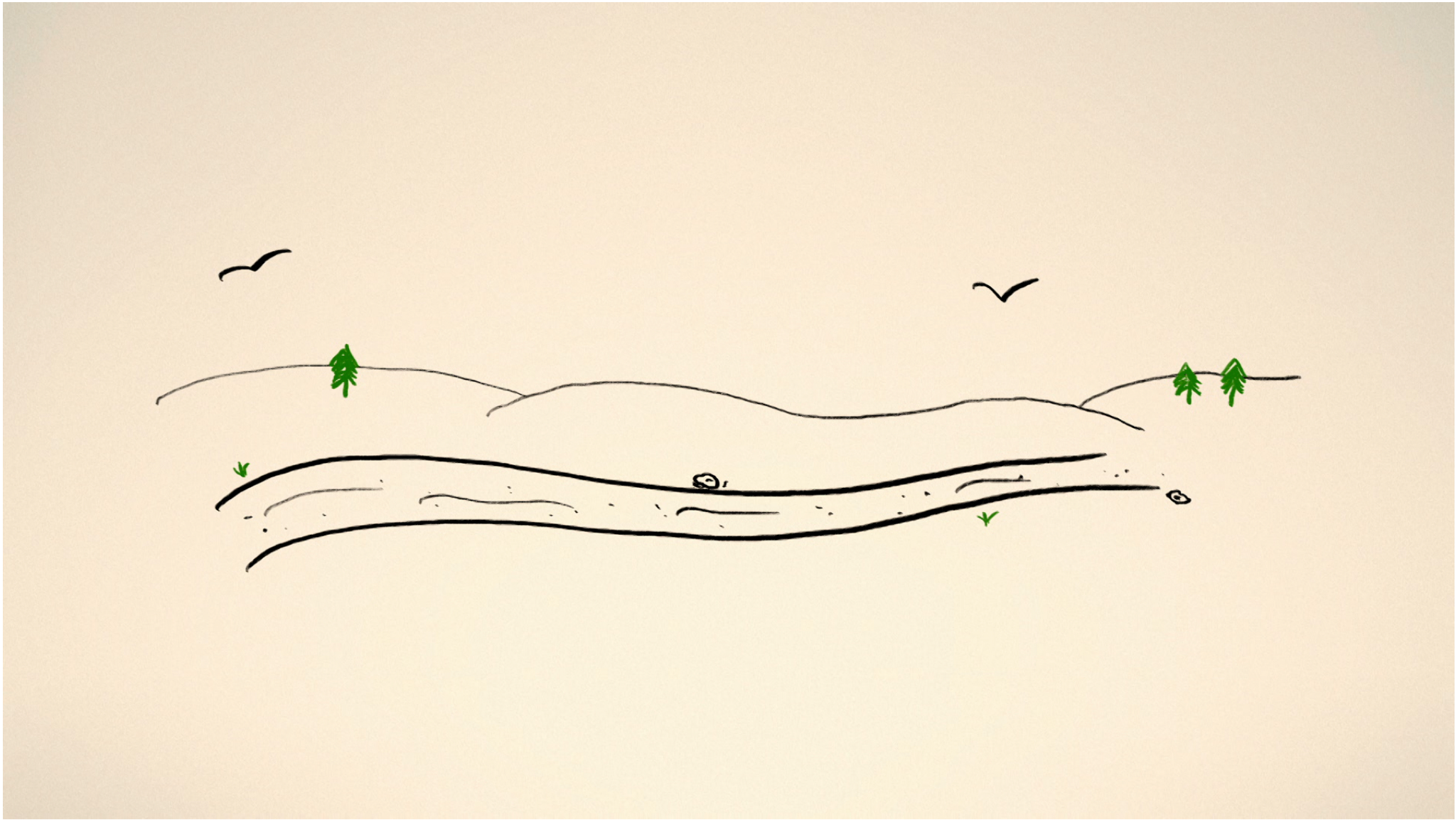
*of simple and complex ideas*

Henry Reich

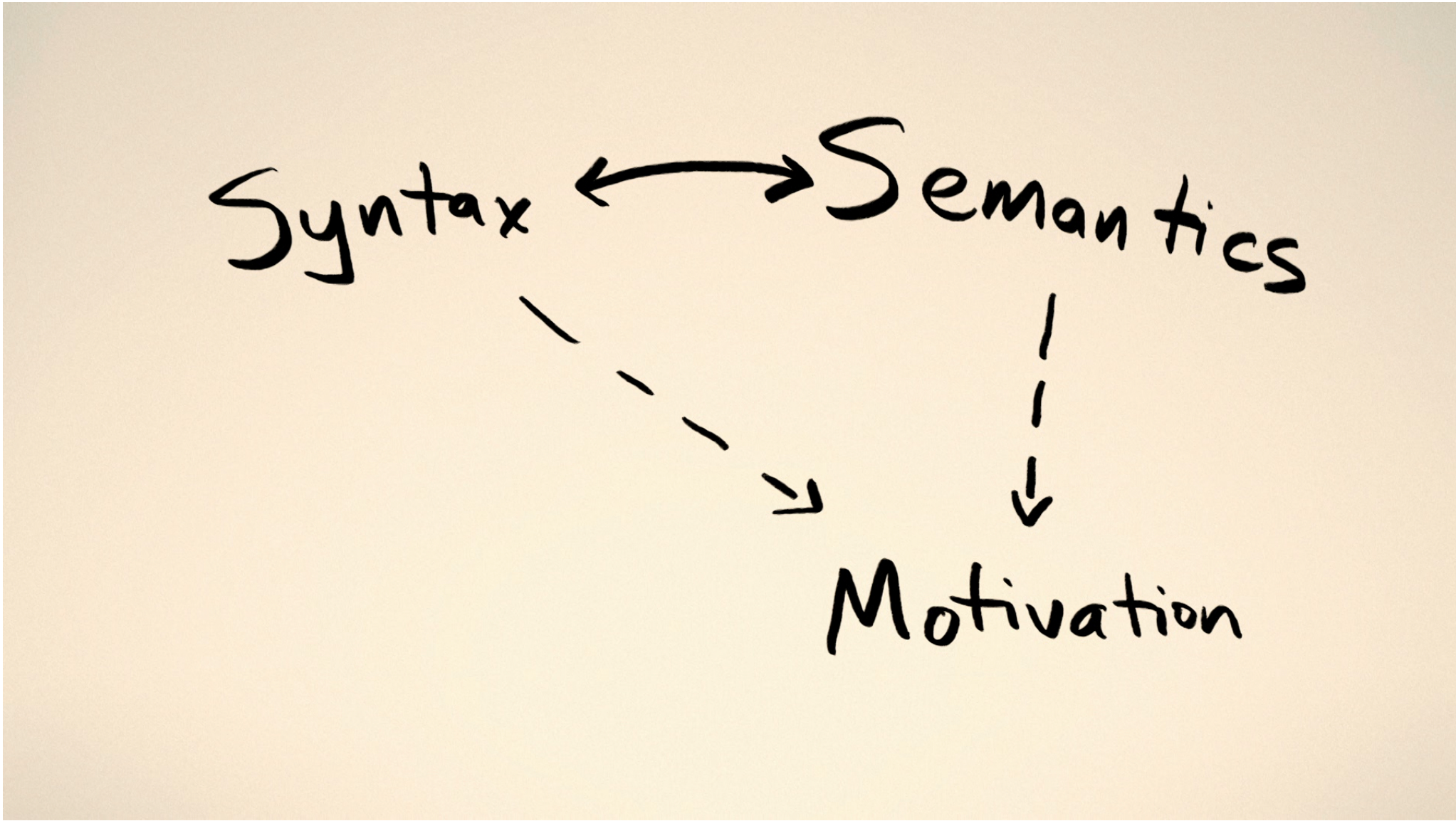
April, 2023

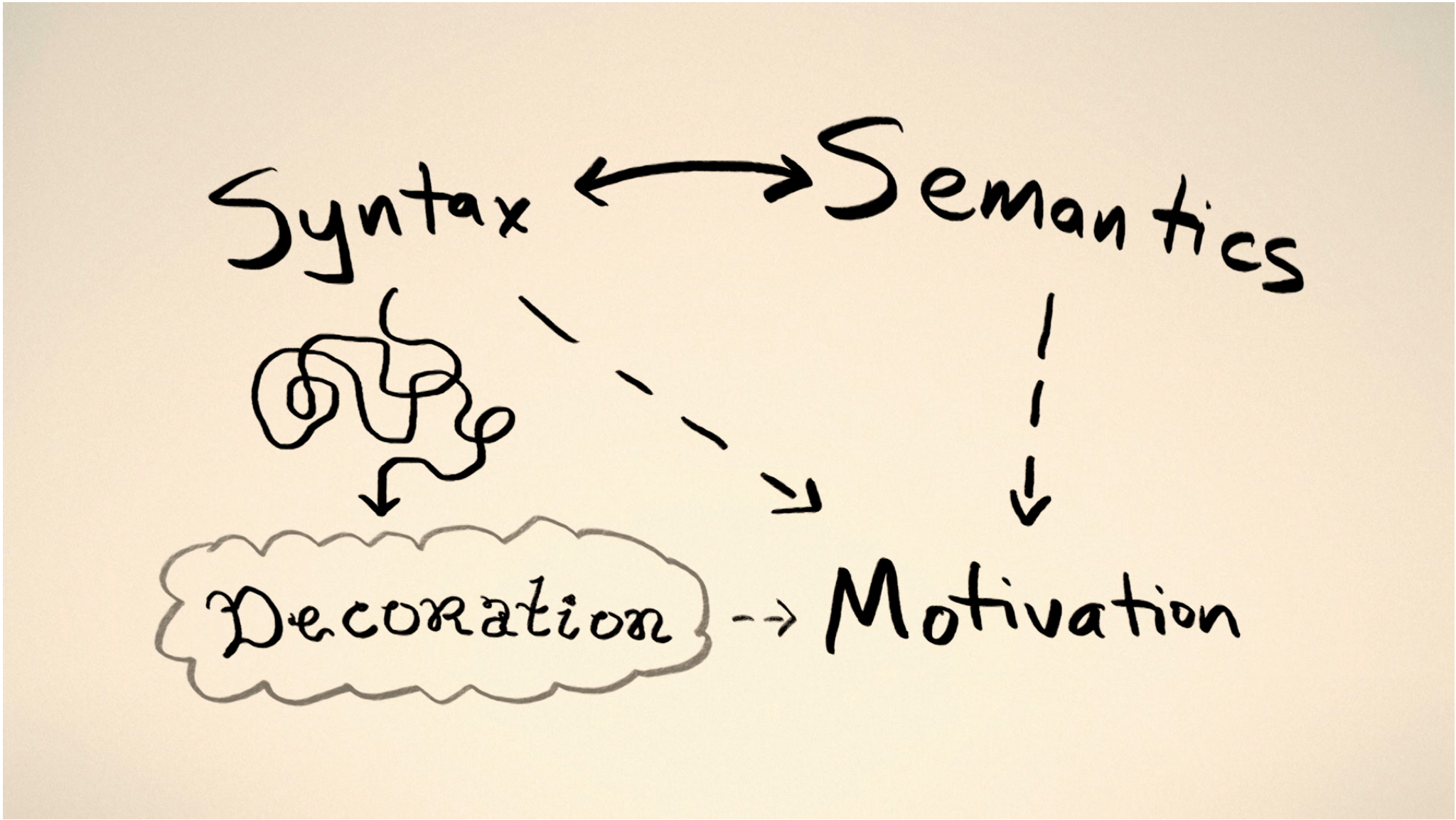




# Syntax


Syntax
Semantics
Motivation

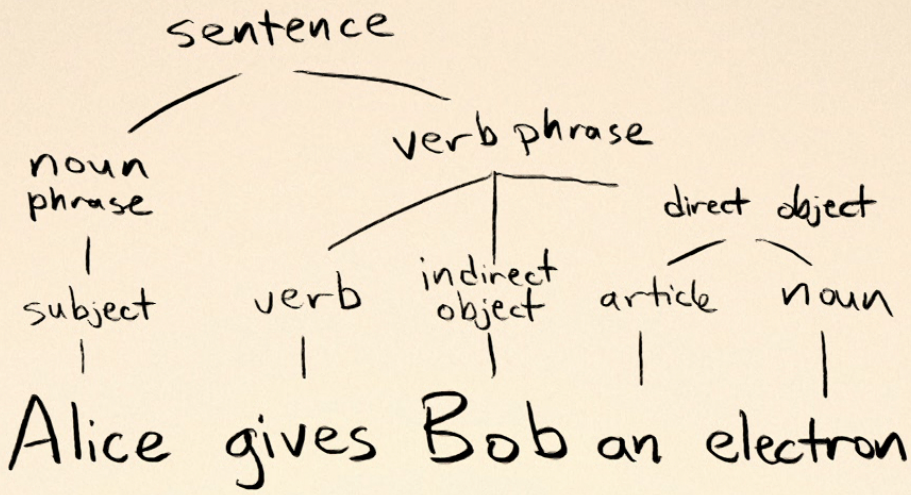

Syntax
Semantics
Decoration
Motivation

# What about Delight?

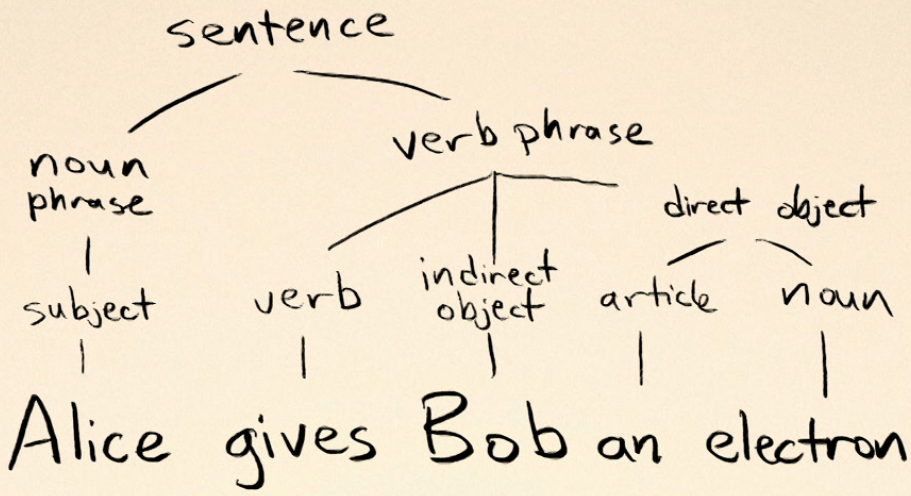
It can permeate everything!

It can come from understanding, from clarity, from motivation, from aesthetics, from decoration…

# What is Syntax?



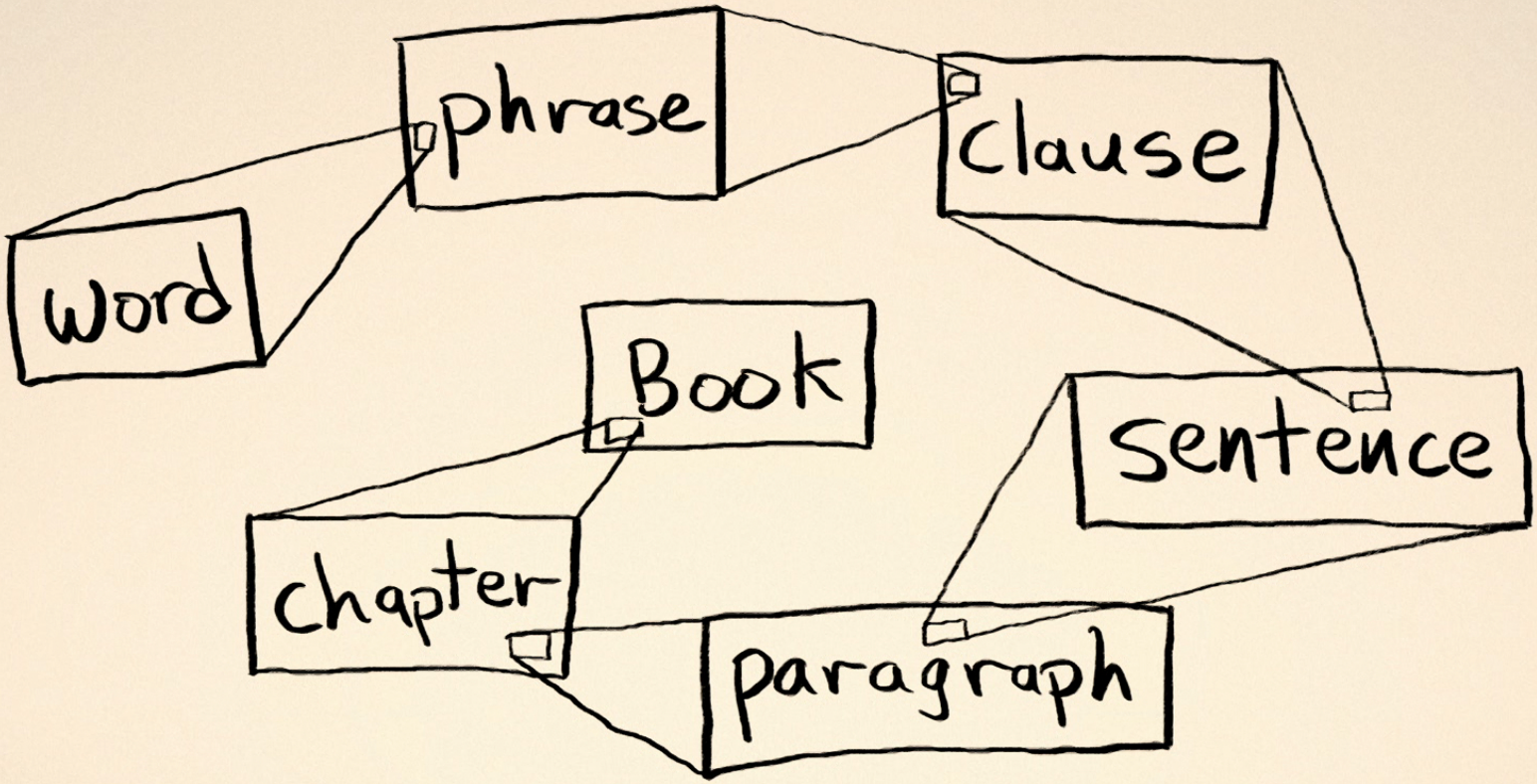
# What is Syntax?

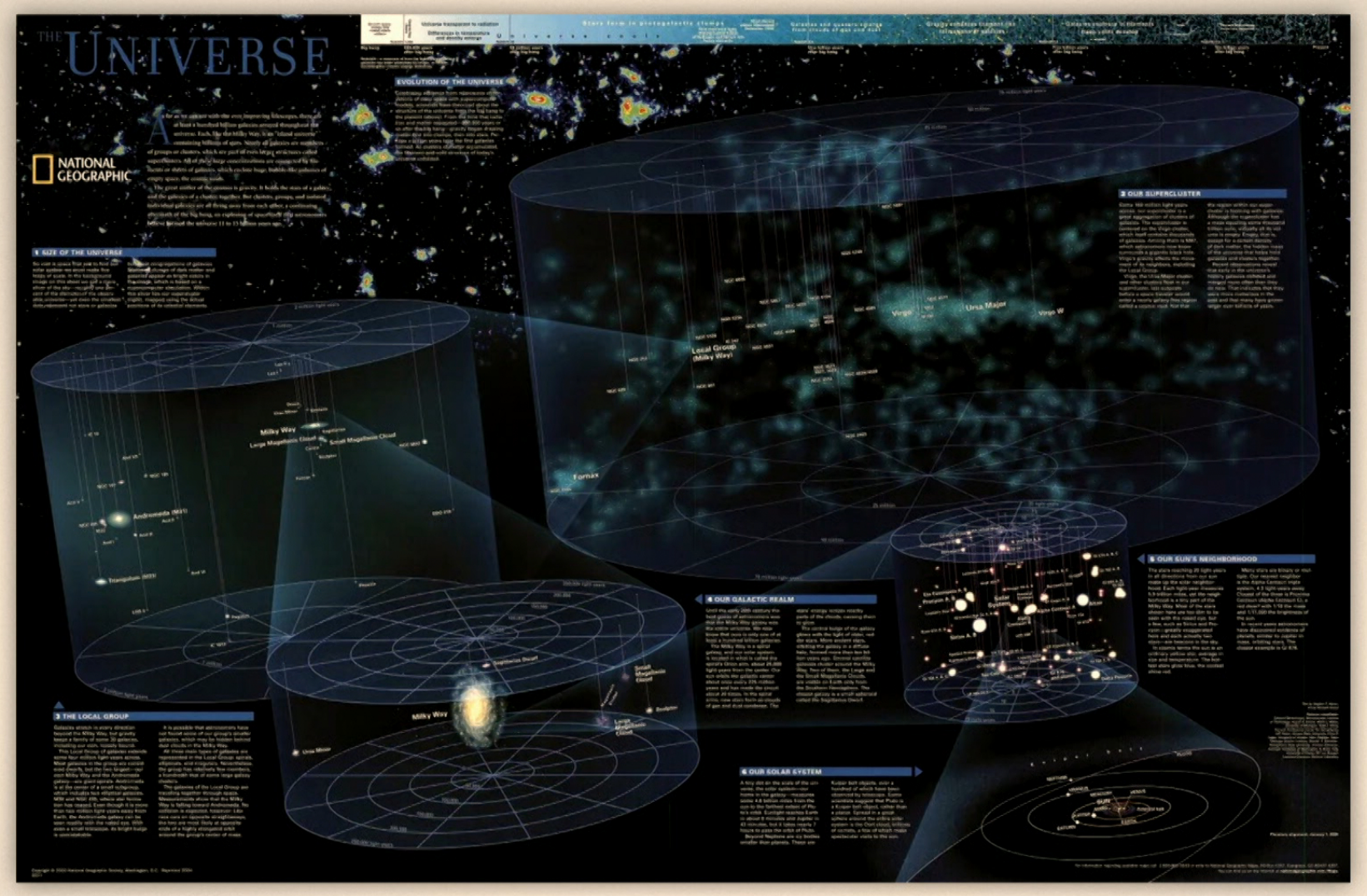



1. The "rules" for arranging words or phrases within a language

2. The meanings implied by those arrangements

*Syntax: structure and interactions at various scales*




THE UNIVERSE
NATIONAL GEOGRAPHIC
EVOLUTION OF THE UNIVERSE
1 SIZE OF THE UNIVERSE
2 OUR SUPERCLUSTER
3 THE LOCAL GROUP
4 OUR GALACTIC REALM
5 OUR SUN'S NEIGHBORHOOD
6 OUR SOLAR SYSTEM
Milky Way
Large Magellanic Cloud
Small Magellanic Cloud
Andromeda (M31)
Triangulum (M33)
Local Group (Milky Way)
Virgo
Ursa Major
Virgo W
Fornax

# What does syntax do?

- Provides standardized relationships between concepts
- Helps guide the reader's comprehension and thoughts

# Syntax examples

- "Alice meets Bob"
- "Bob meets Alice"
- "Alice and Bob meet"
- "Alice gives Bob a book"
- "Alice gives a book to Bob, then eats - nay, devours - three cookies: the best dessert."
- "The girl blew down the tube of the horn"
- "The wind blew down the house of the girl"
- "Eve wrote a book."
- "Eve wrote a friend."

# There's visual syntax, too

- Provides standardized relationships between concepts
- Helps guide the viewer's comprehension and thoughts
- Also helps guide the viewer's eye
- Assigns meaning and connection between otherwise unrelated visual elements

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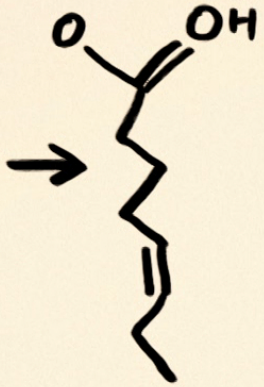
e⁻
P


O
OH

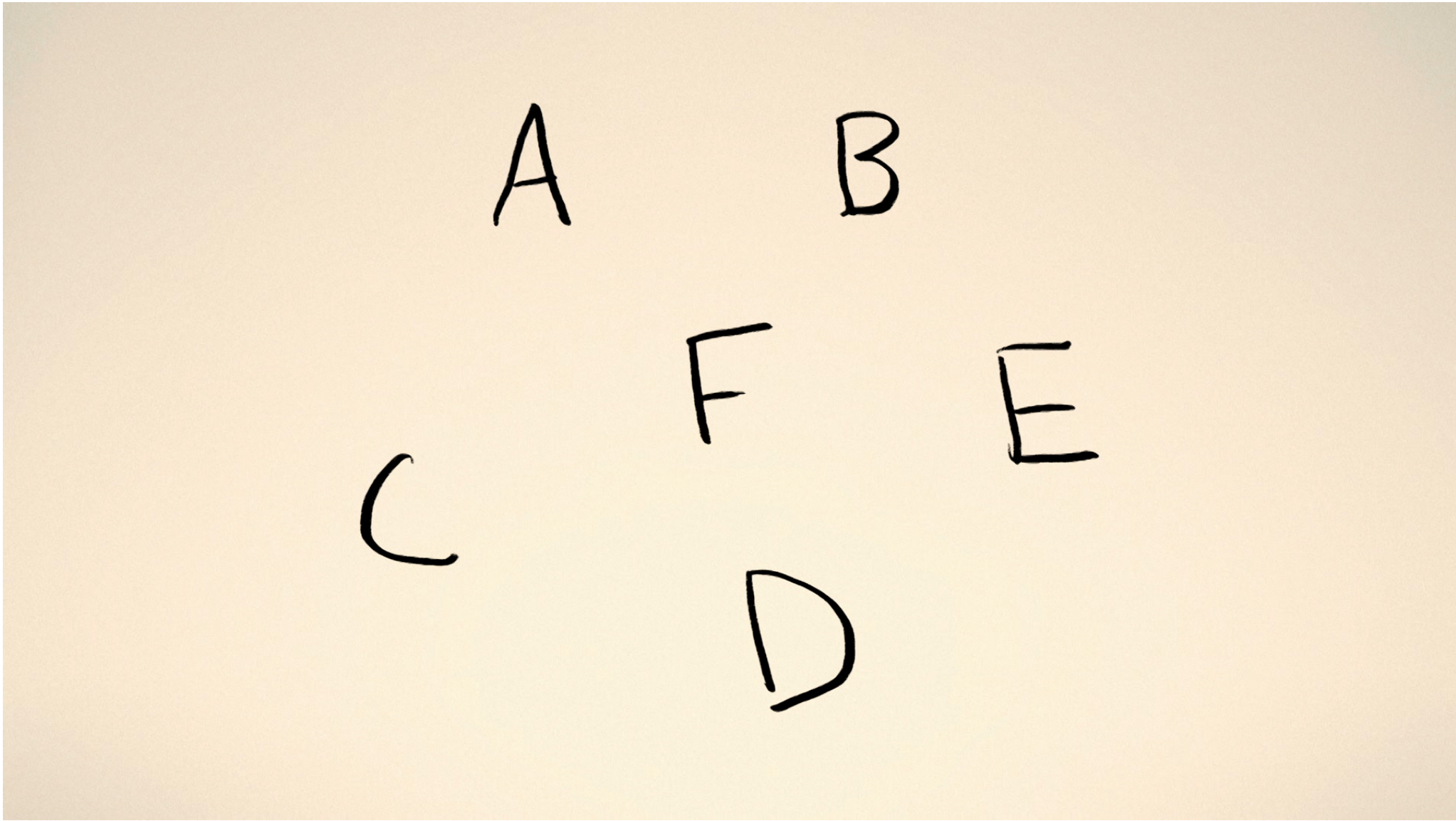
O
OH
e⁻
P

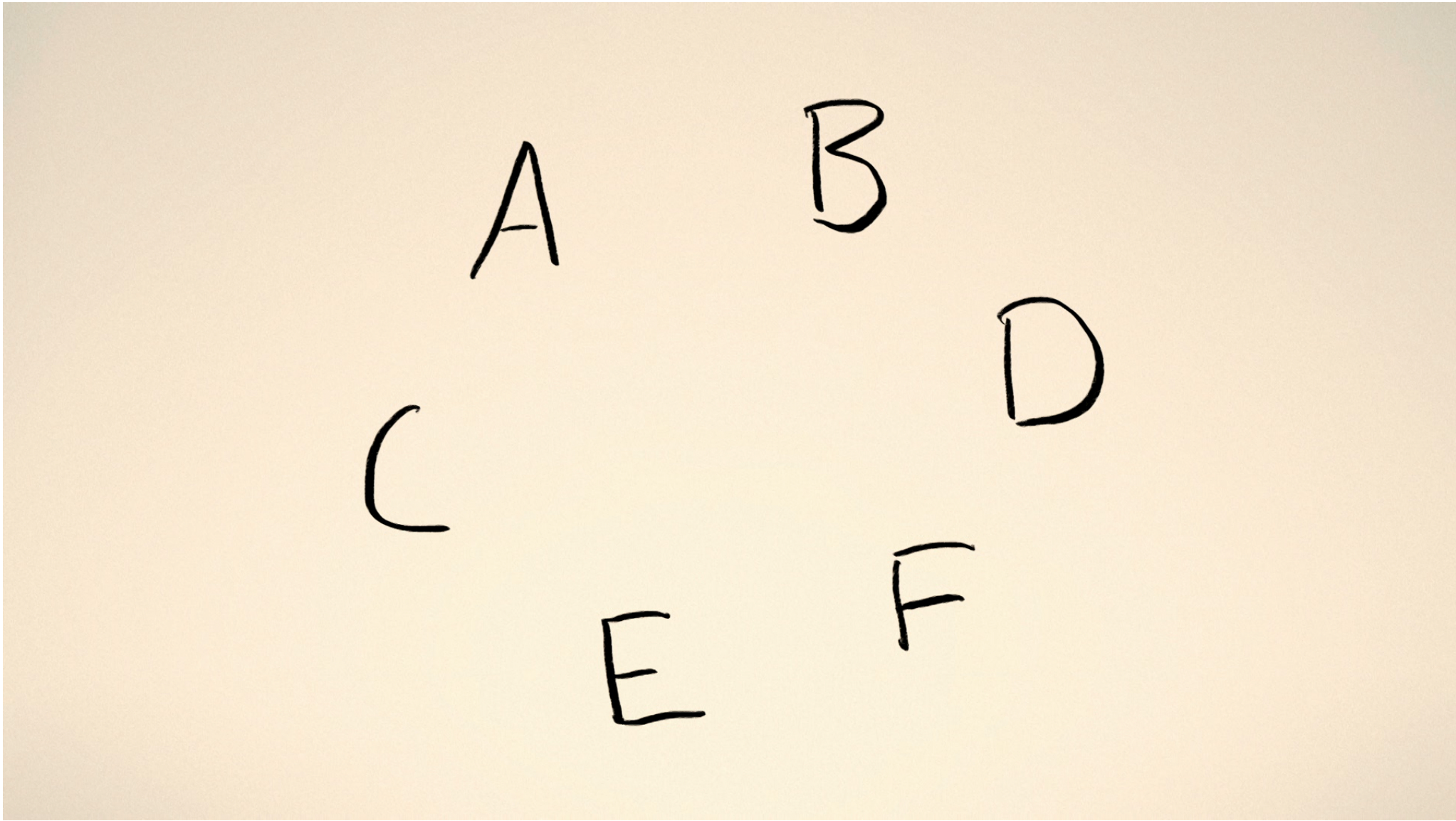
# Syntactic hierarchy/importance

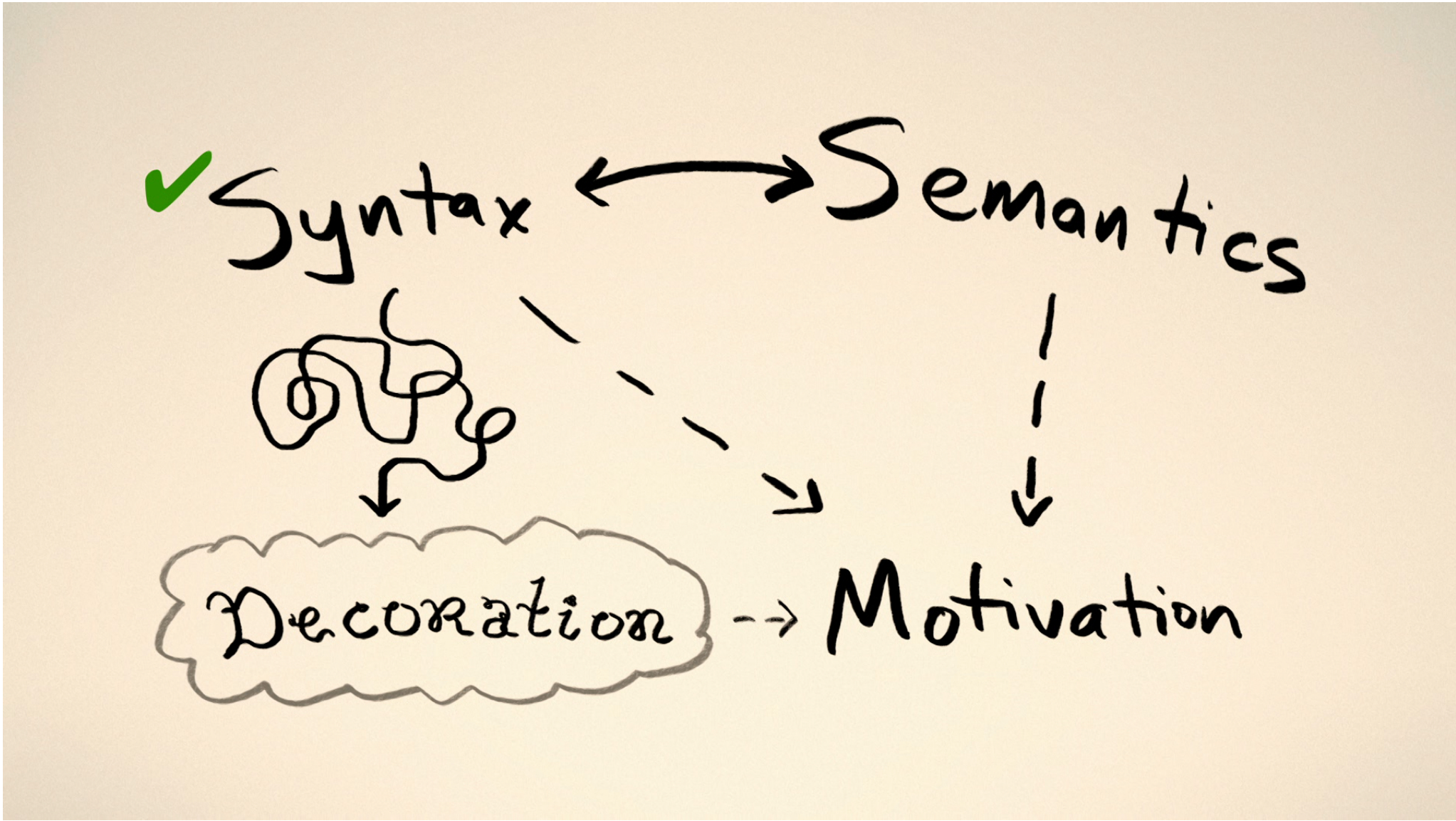
- In a sentence: independent clause, subject rather than object, etc
- In visuals: center, top, left of screen (at least for left-right reading cultures)

# Example: verbal syntactic hierarchy/ importance

- "While he was working on brownian motion, Einstein was a patent clerk."
- "While he was a patent clerk, Einstein was working on brownian motion."
- "Einstein, a patent clerk, was working on brownian motion."
- "While a patent clerk, brownian motion was the subject of Einstein's work."


A
B
F
E
C
D


A
B
D
C
F
E


✔Syntax
Semantics
Decoration
Motivation

# What is Semantics?

The meaning or intellectual content of a word, phrase, sentence, chapter, visual element, etc

# When syntax and semantics disagree

**Problematic:**

By blowing down the chimney, the girl was chilled by the wind.

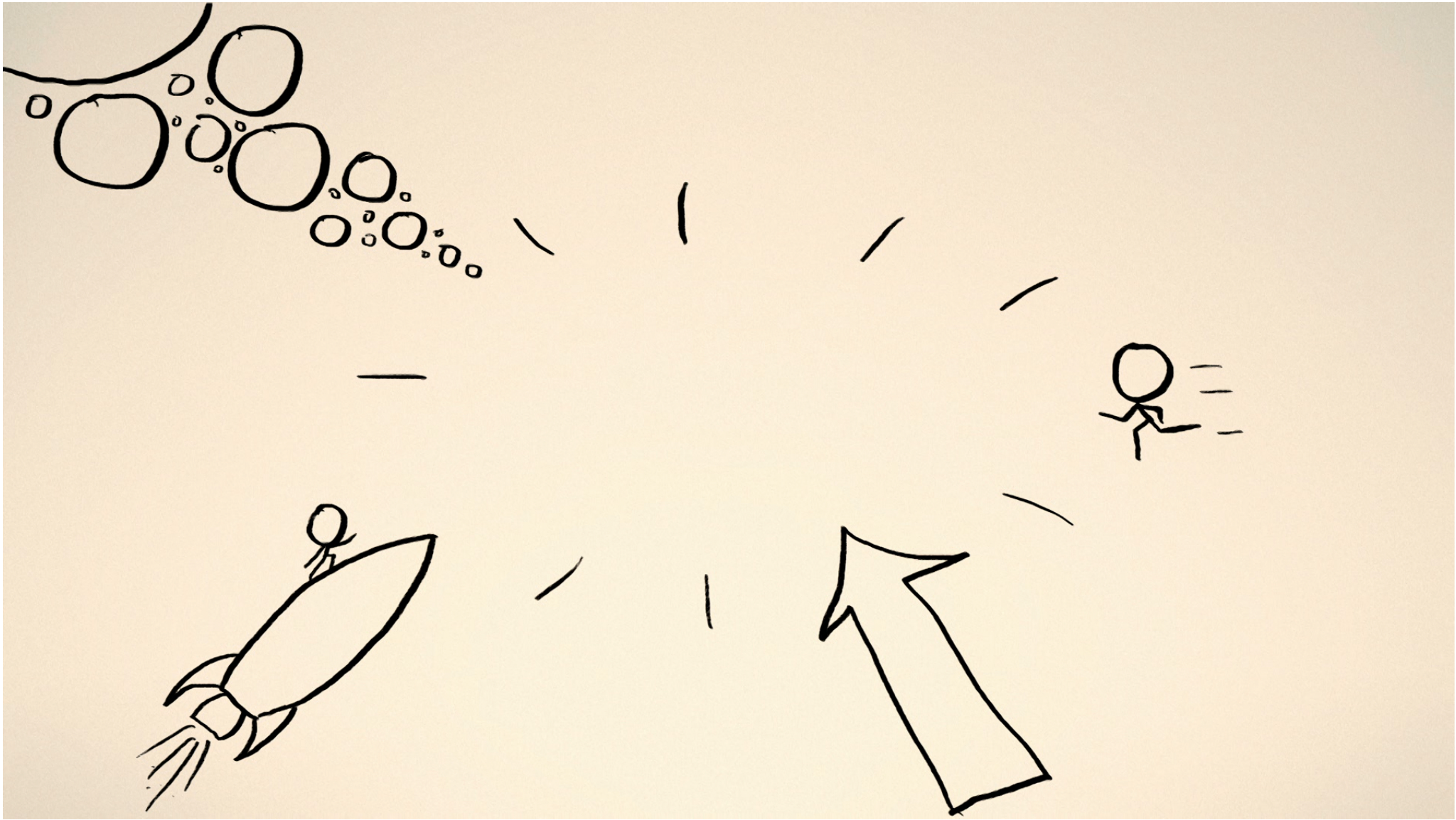
By blowing down the chimney, the girl…

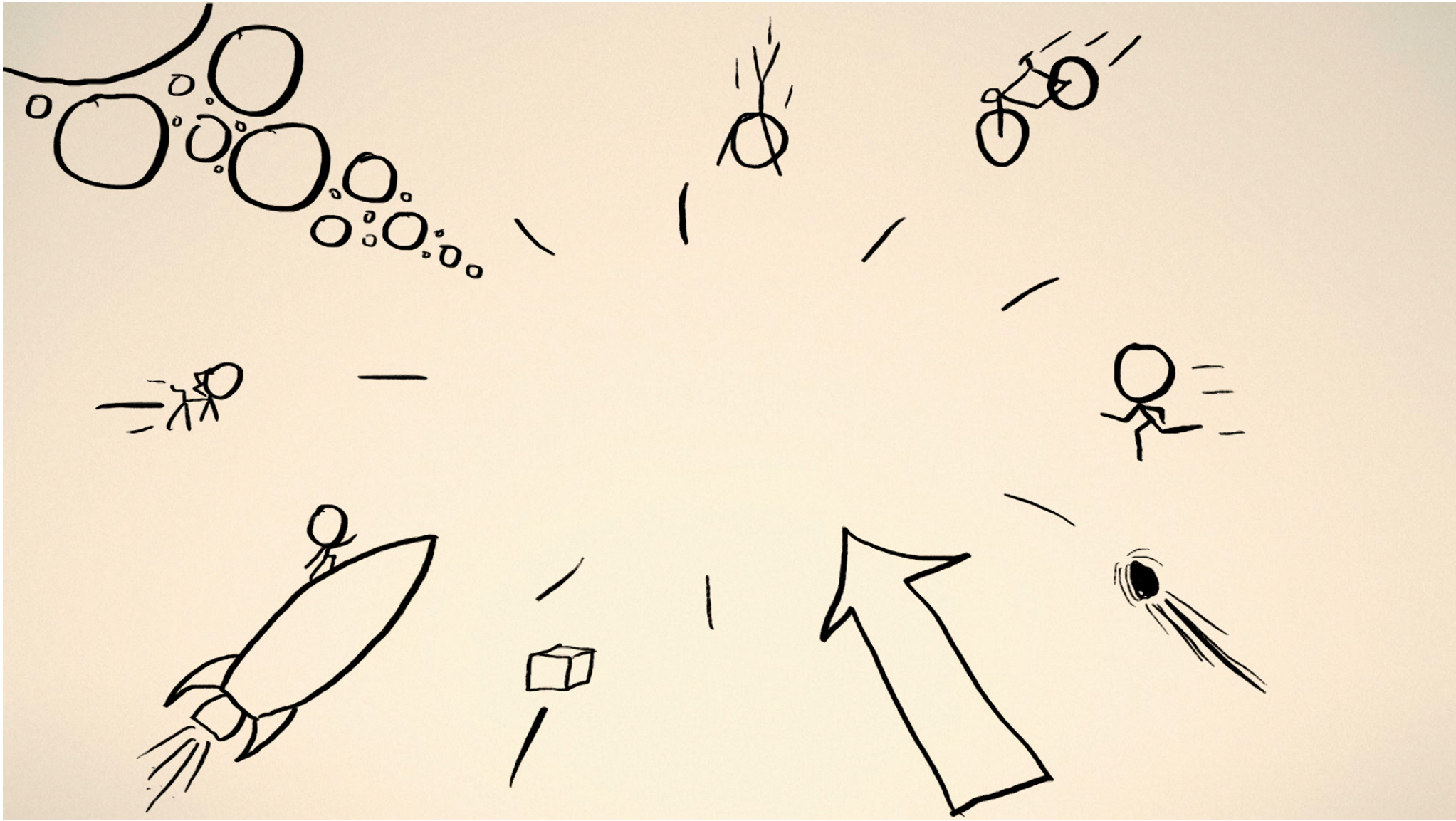
**Potential fixes:**

By blowing down the chimney, the wind chilled the girl.

The girl was chilled by the wind blowing down the chimney.

The girl was chilled by the wind when it blew down the chimney.



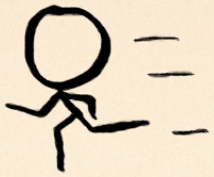


Motivation

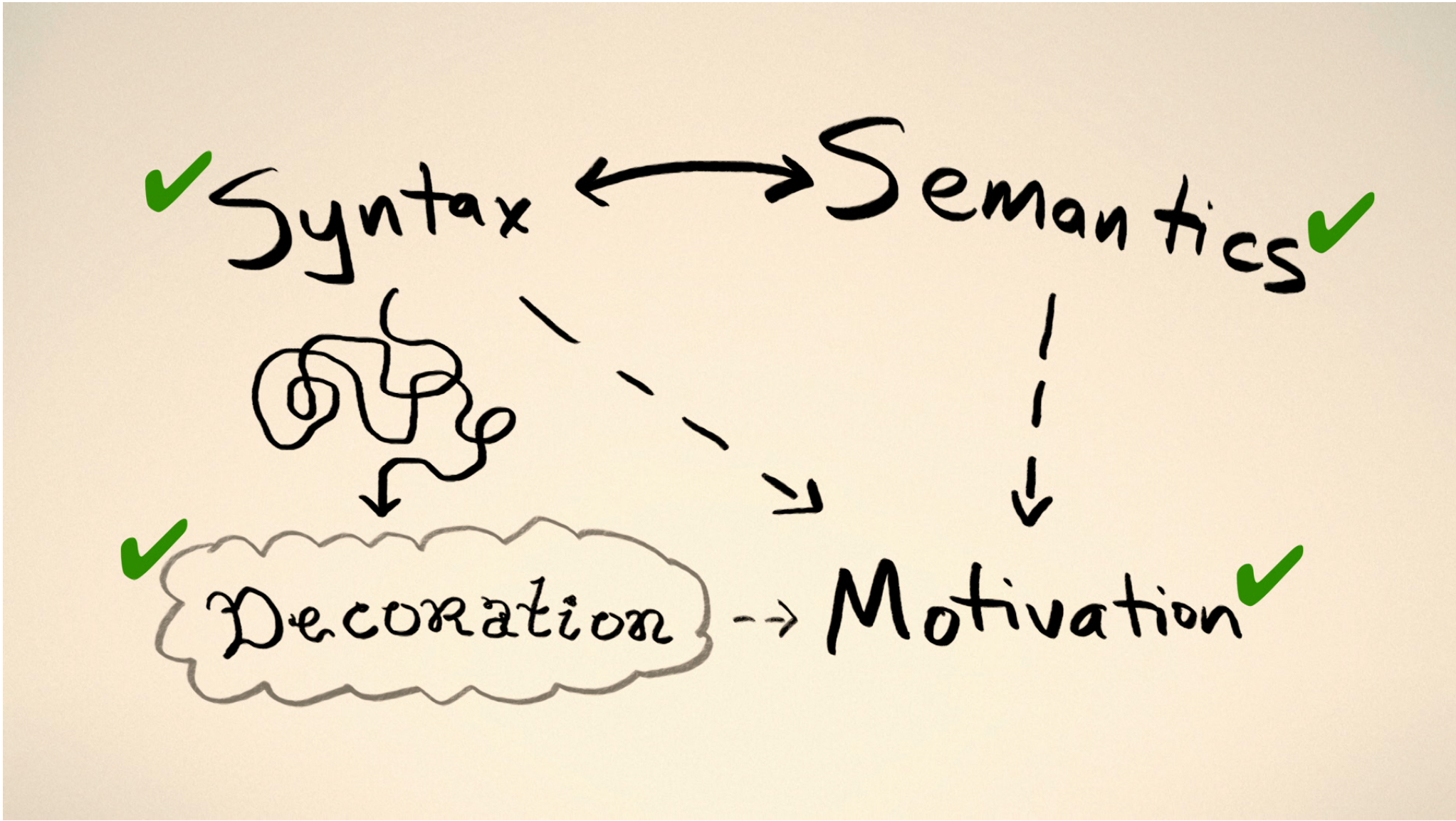
# Motivation

- What a viewer might at some level reasonably anticipate or want to see, based only on what **they've** already experienced
- Not the creator's motivation (ie, not because **you** want to say it)

# Decoration



Decoration is the end-all, be-all, magnificent, splendid art of ornamentation: you know, like, everything that doesn't have direct, um… semantic function. Yeah.


Syntax
Semantics
Decoration
Motivation

# Examples of Visual Syntax

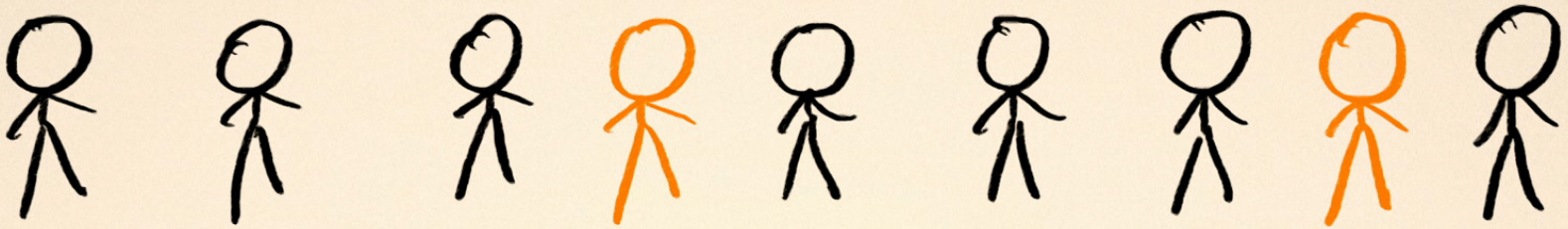
Arrangements and "interactions" between visual elements

What those interactions mean

# Is visual syntax just "composition"?

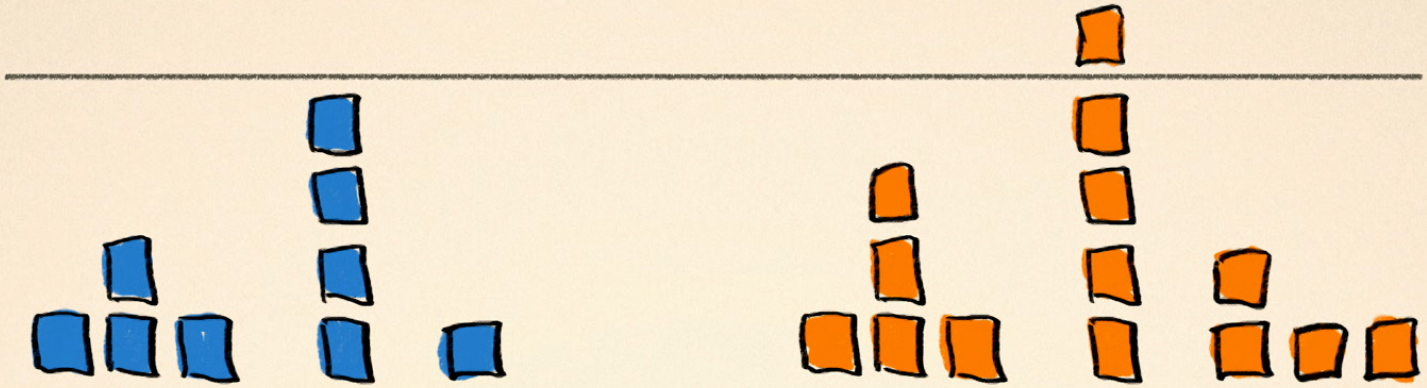
- It's more: it includes color, shape, groupings, character reactions, etc.
- And composition is more than syntax: can be both functional and/or aesthetic

# Color

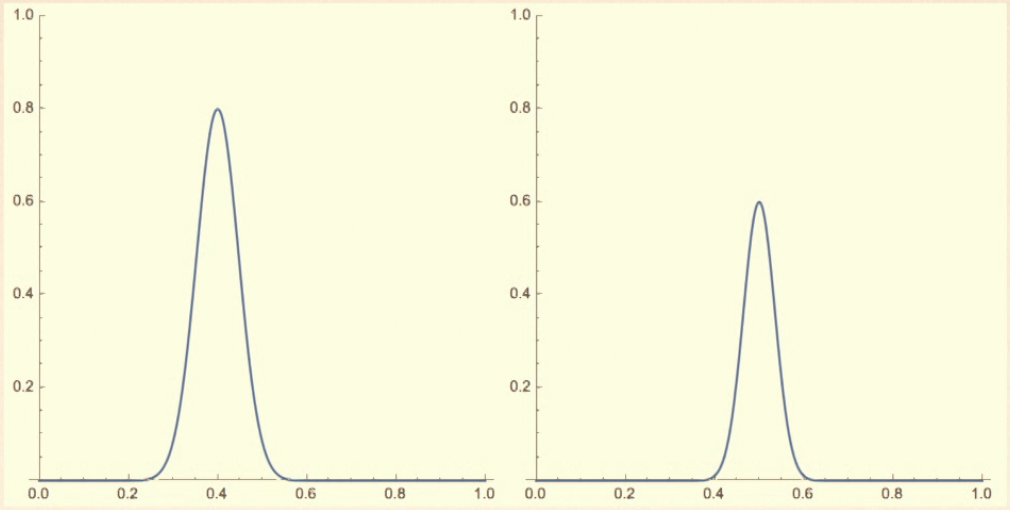


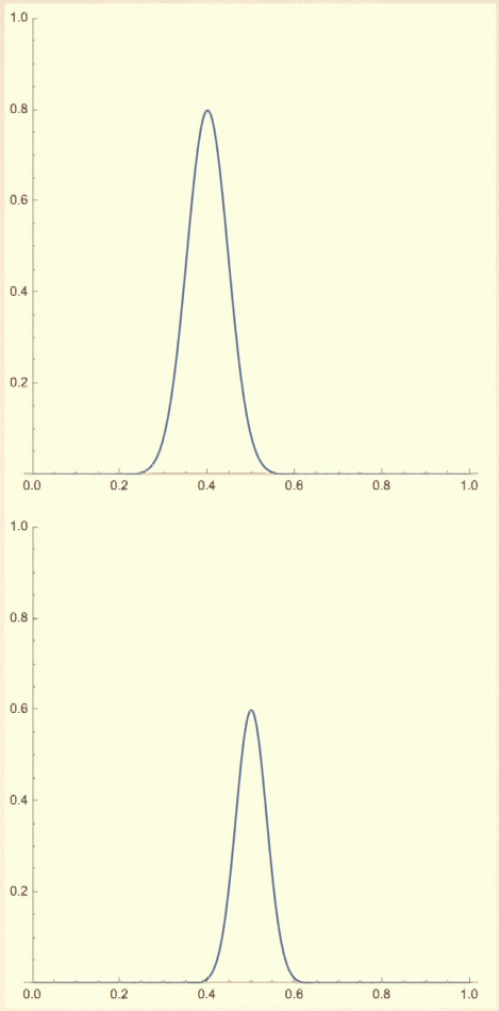
# Shape

# Horizontal comparison

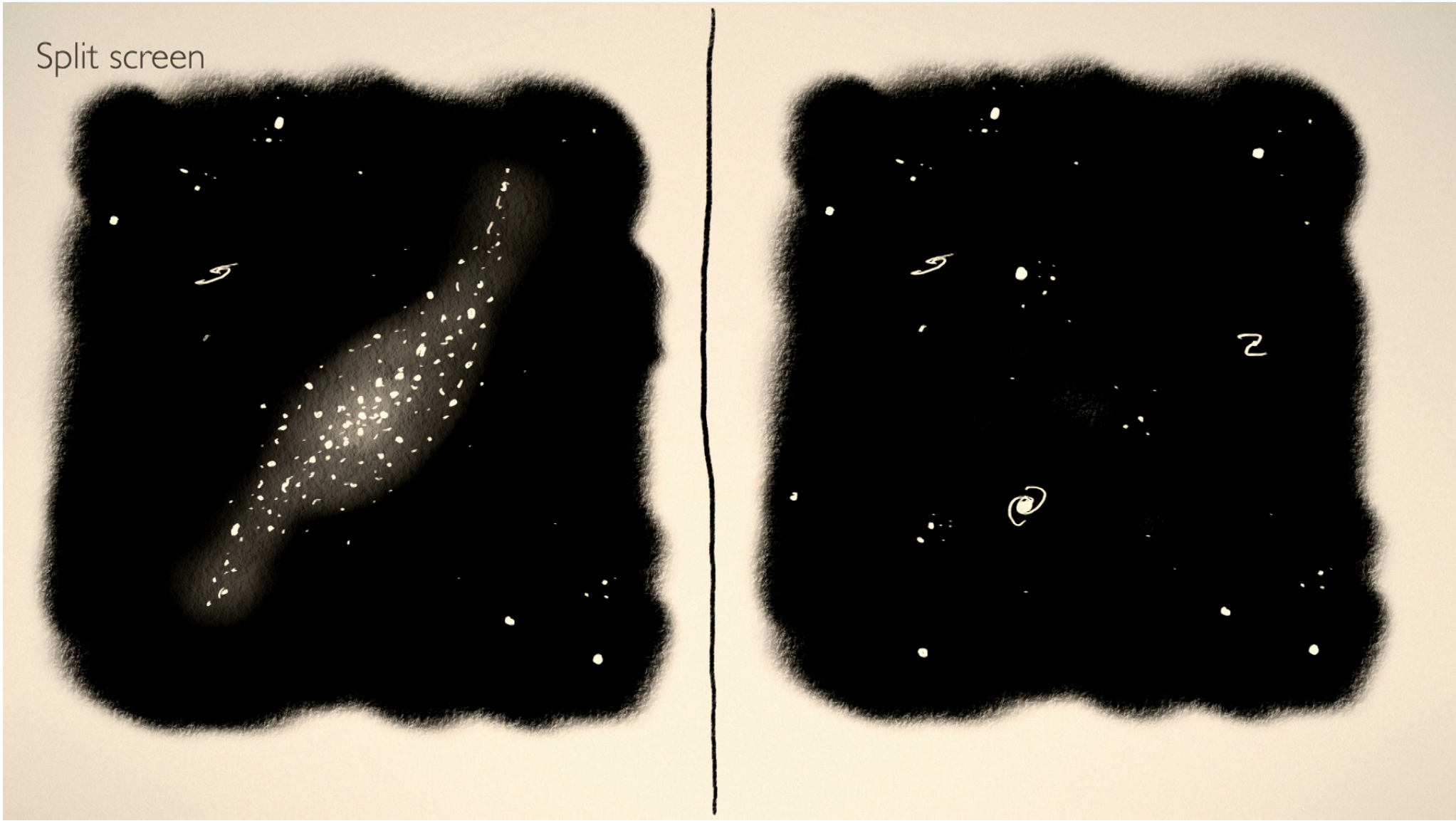


# Horizontal

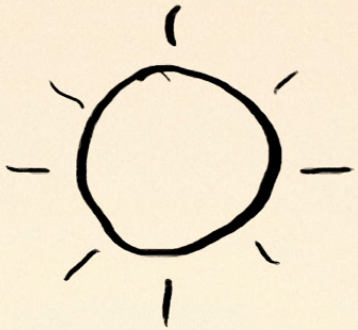




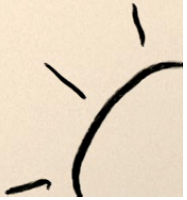

Vertical


Split screen

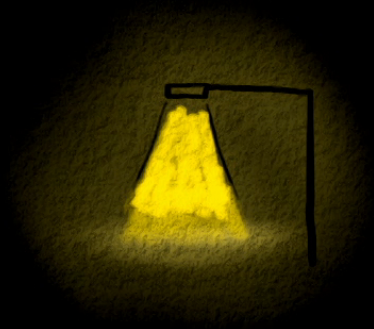
# General composition - framing



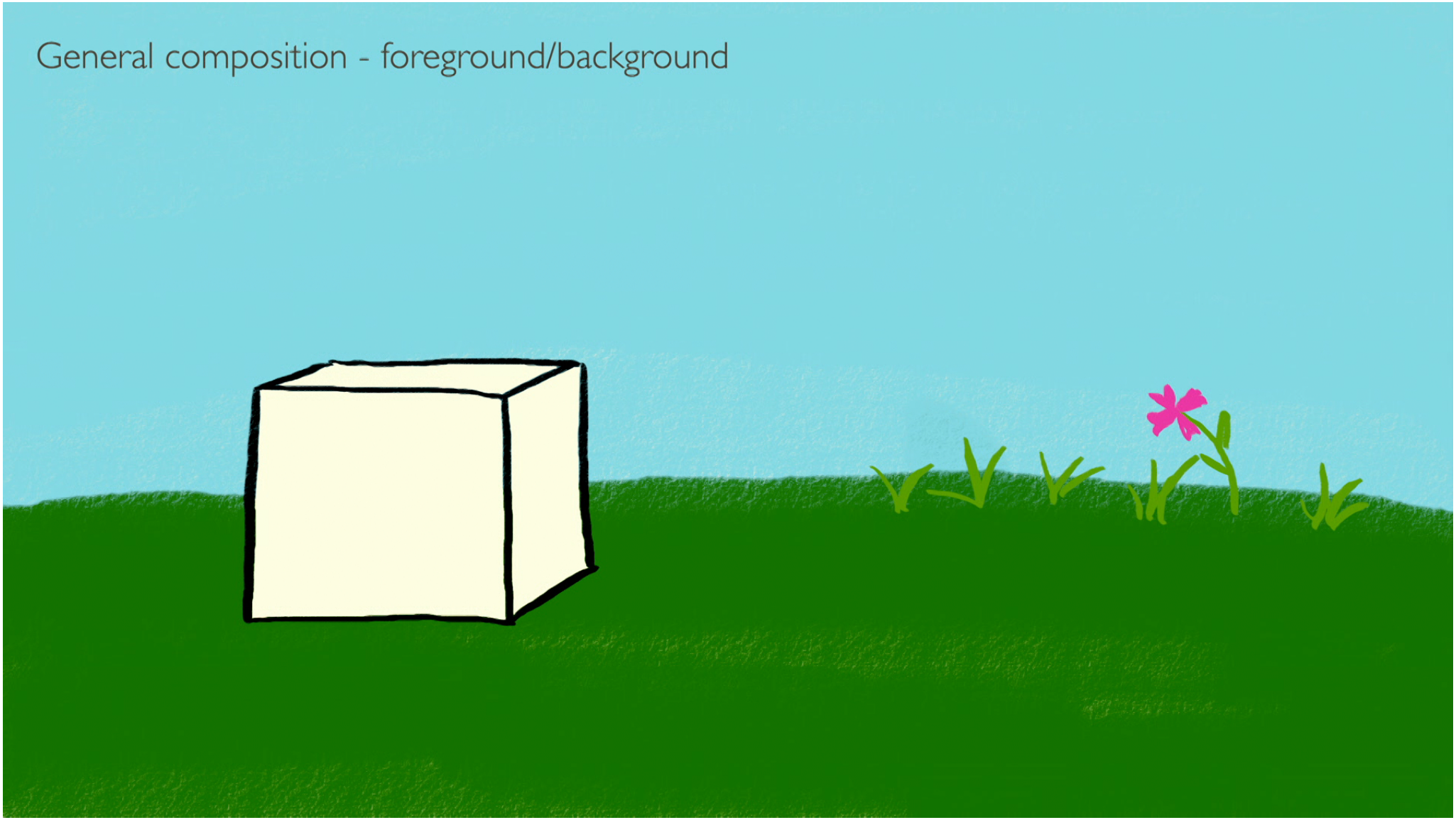
# General composition - framing

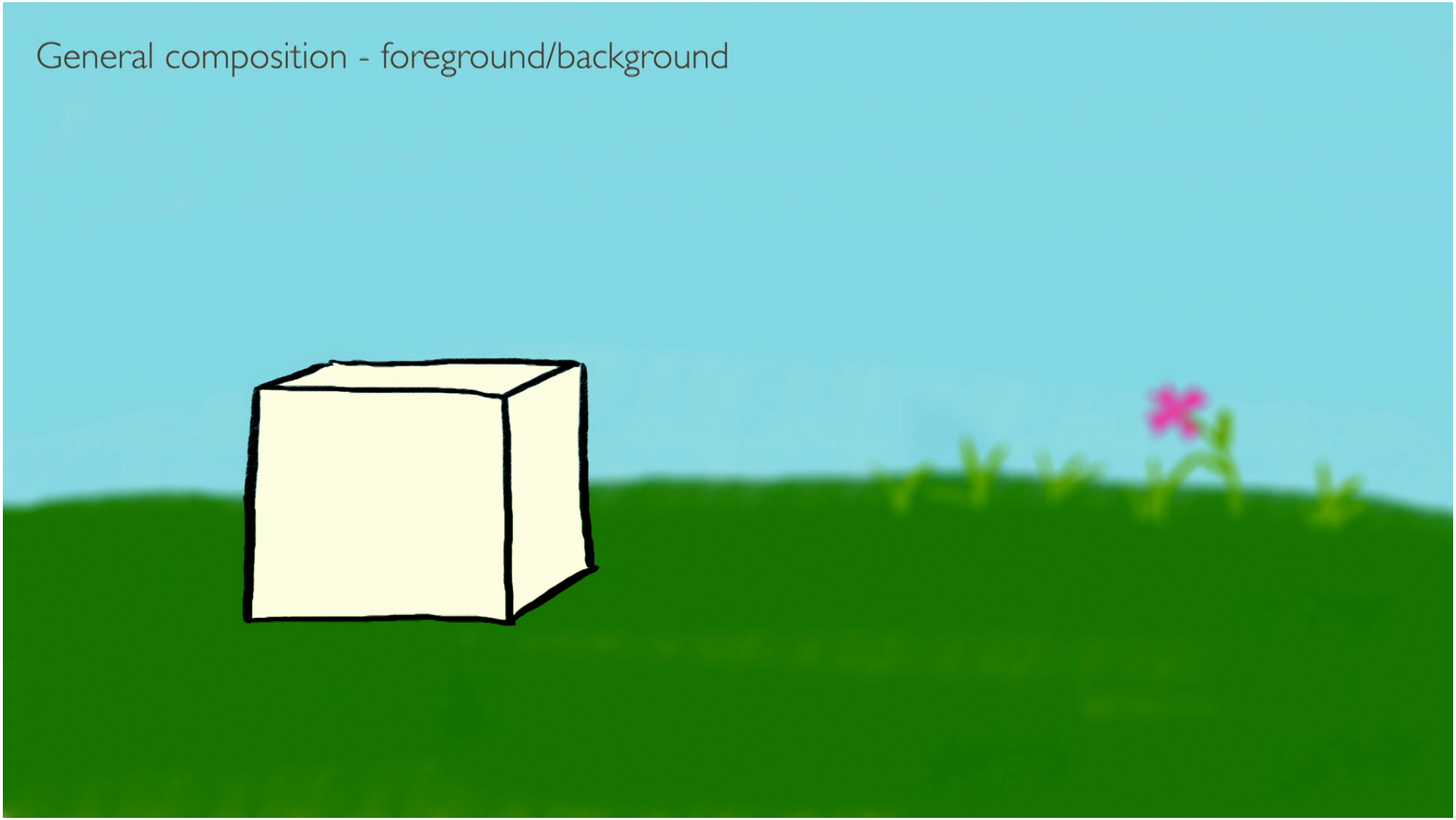


# General composition - light and shadow

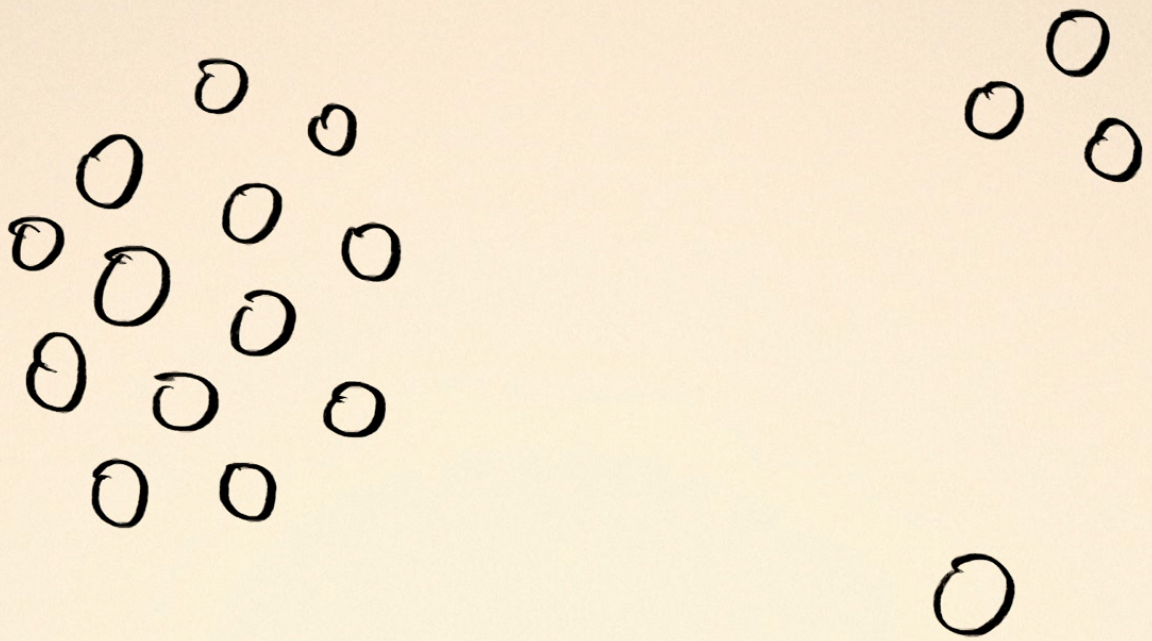


# General composition - foreground/background

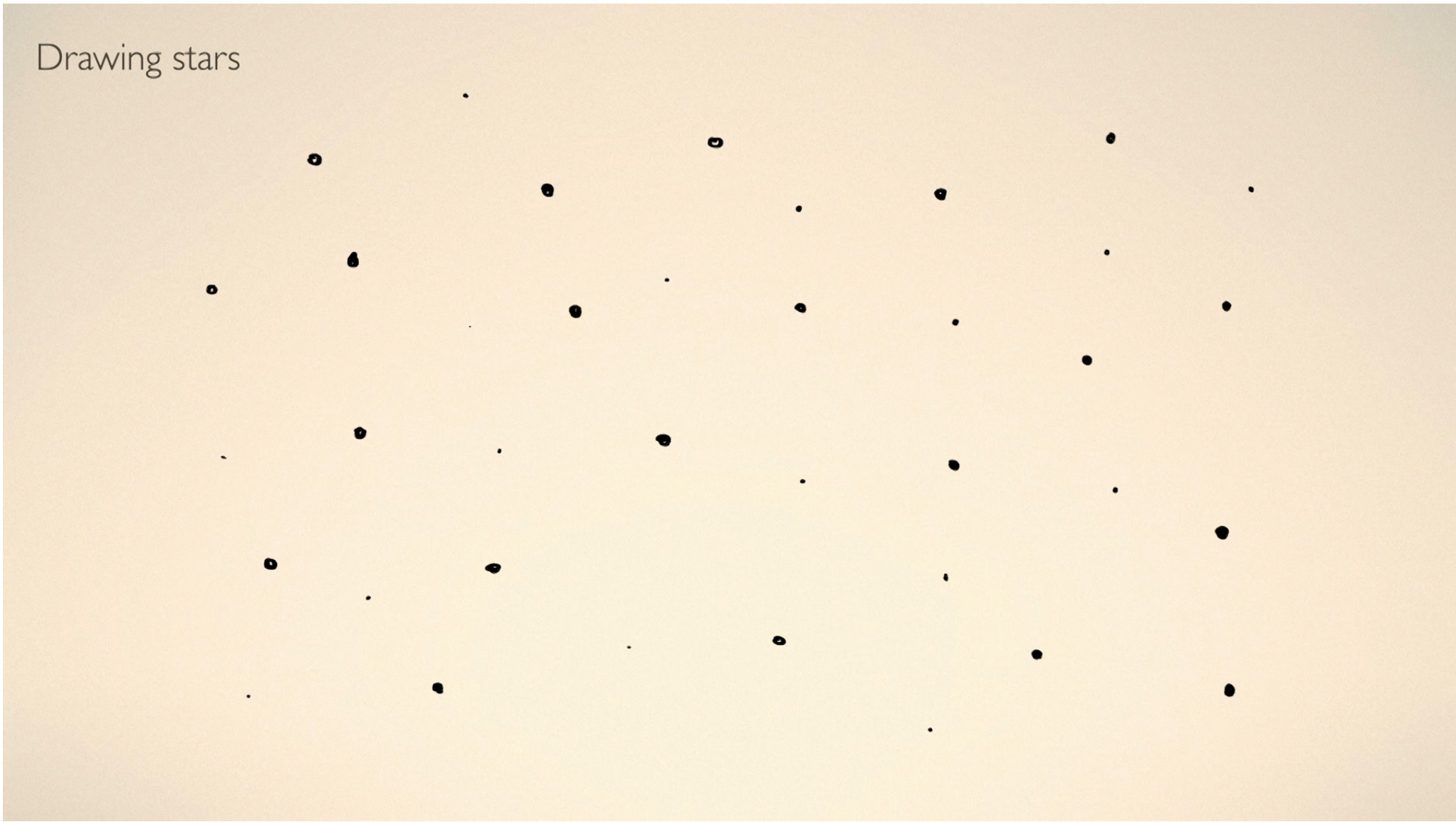



General composition - foreground/background

# Grouping and space

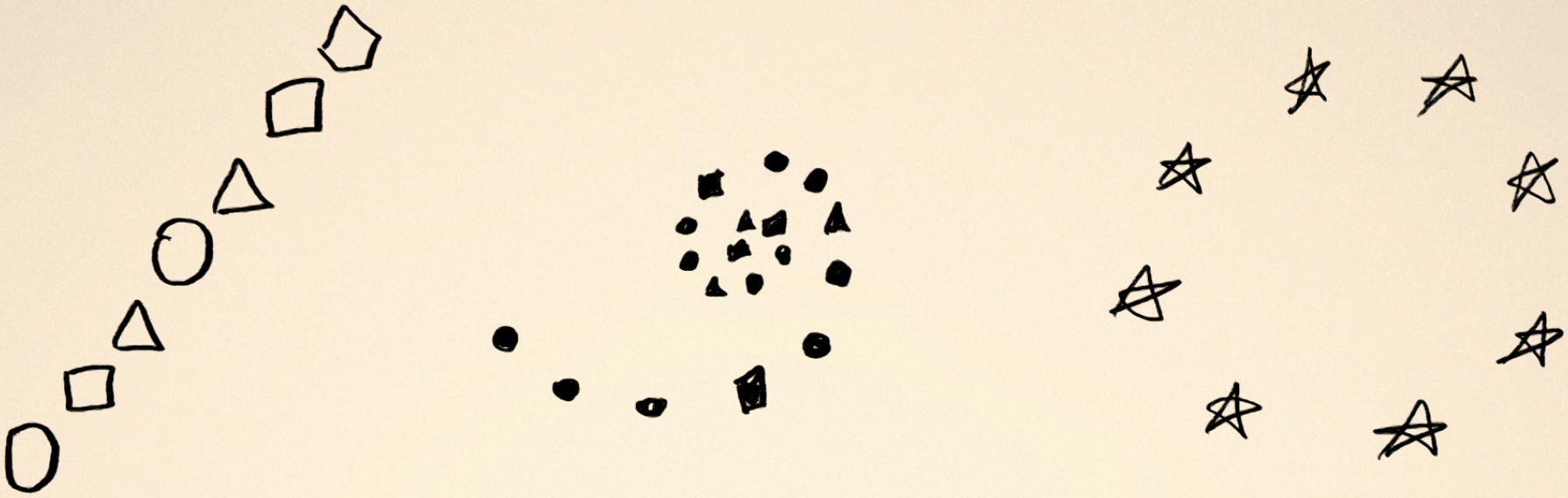


# Drawing stars

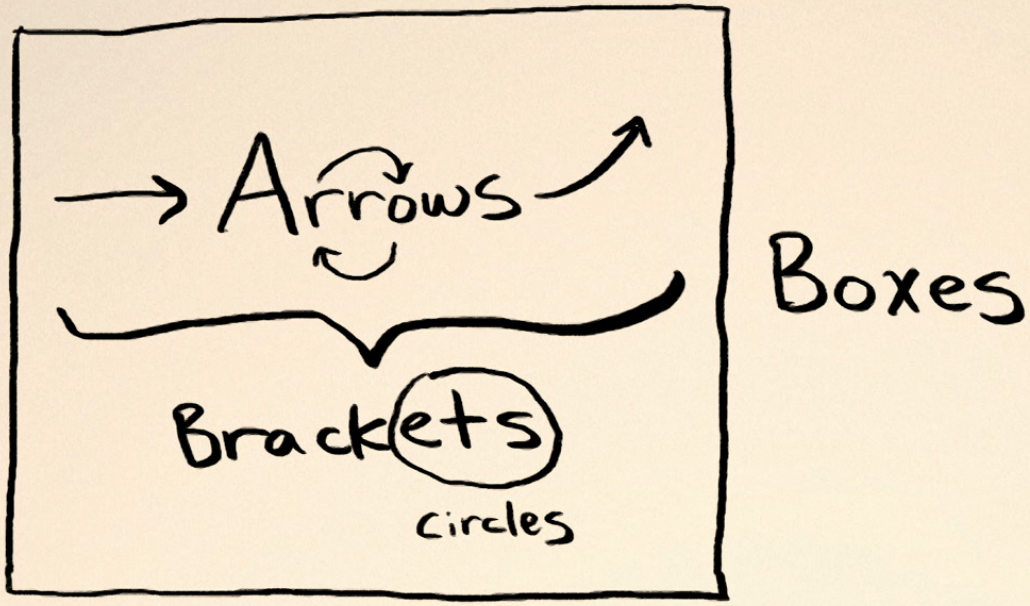


# Drawing stars

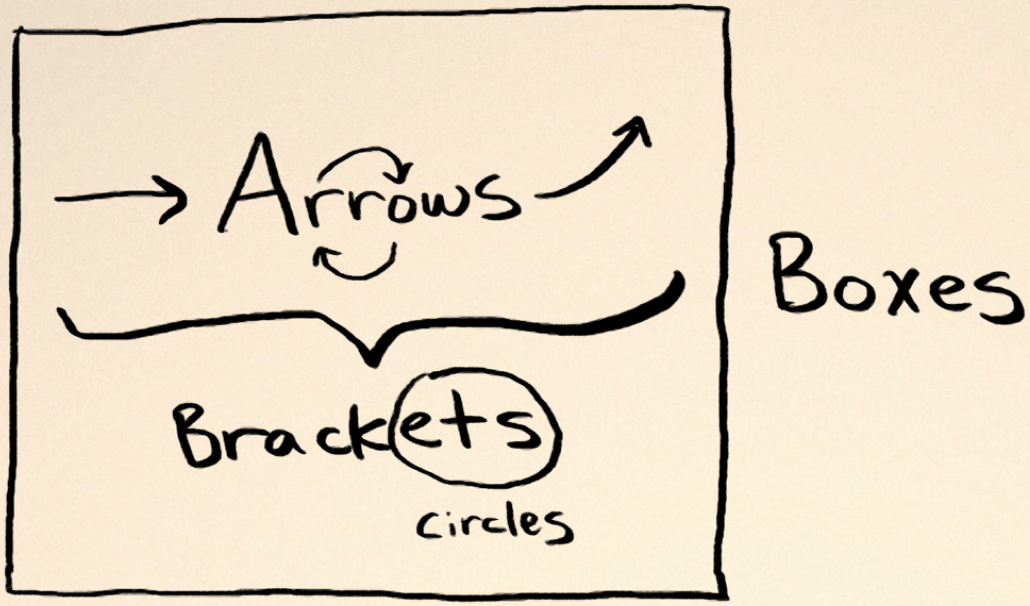
# Directionality



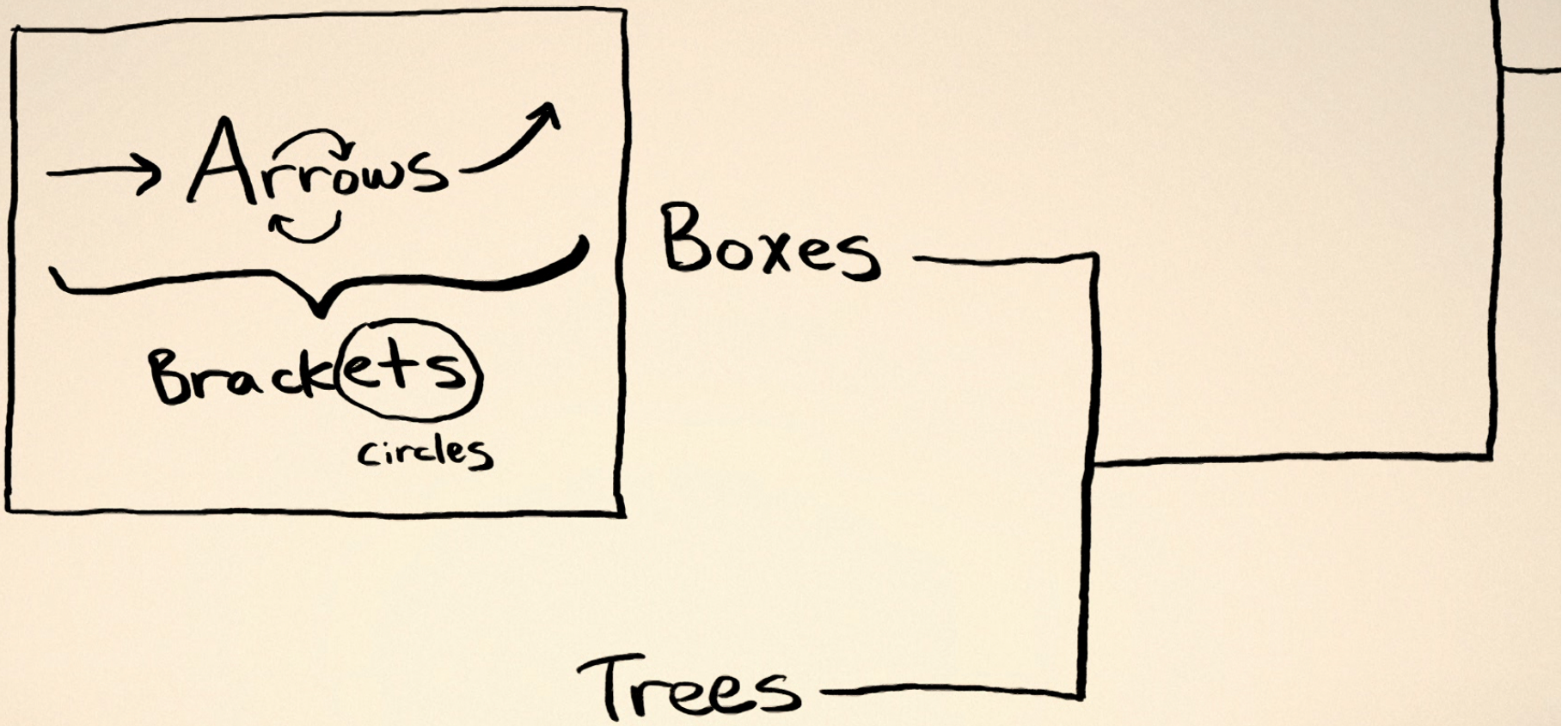
Arrows, etc



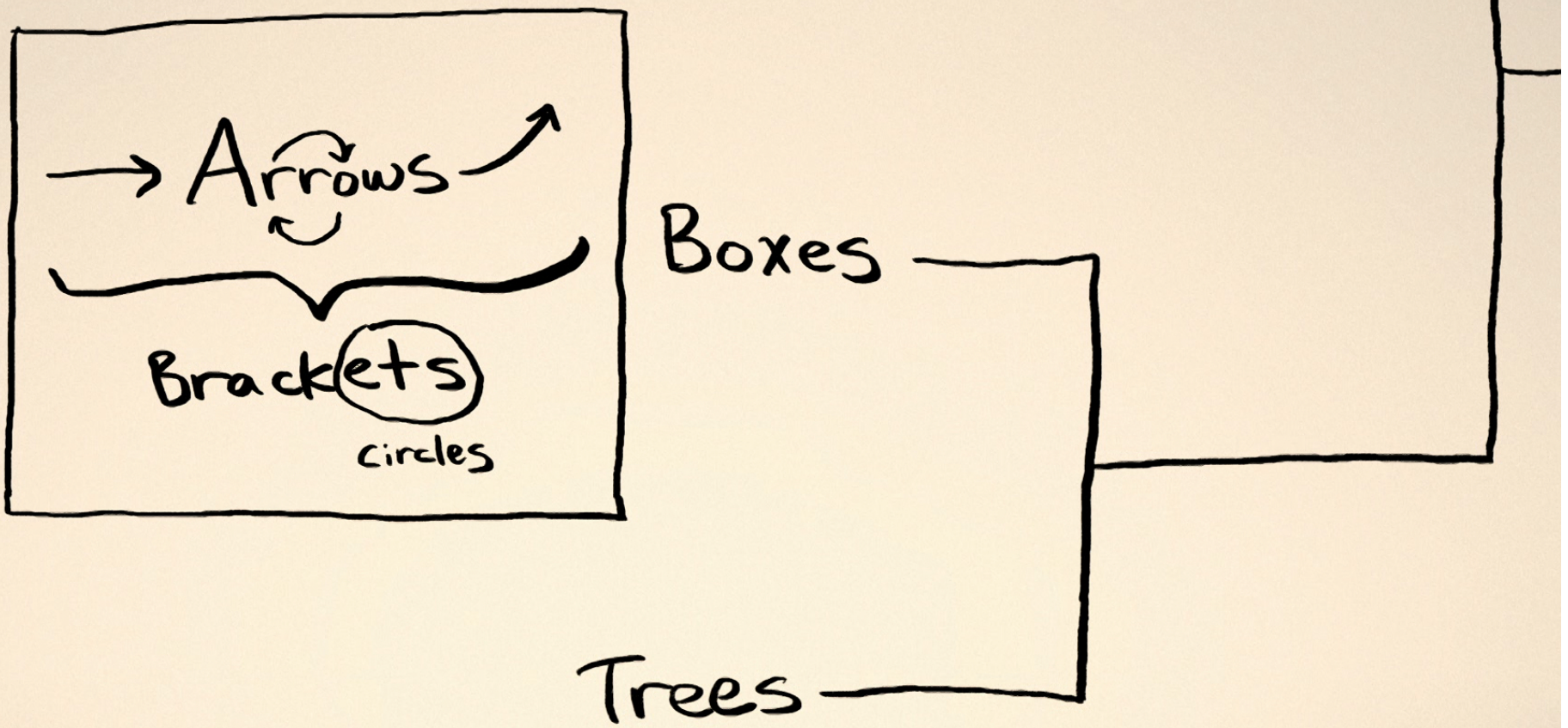
# Arrows, etc



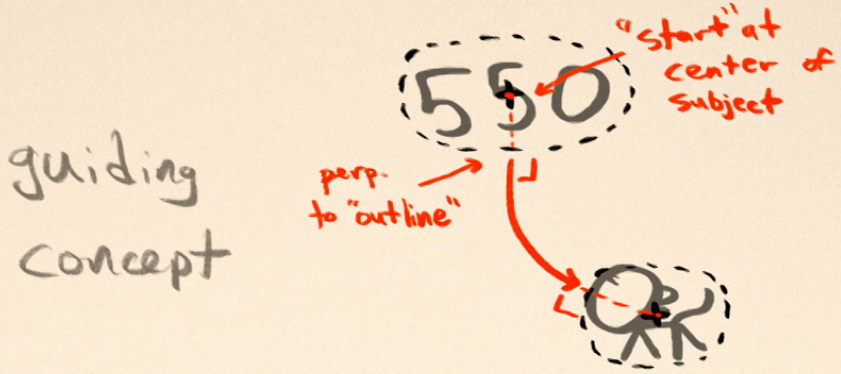
Arrows, etc



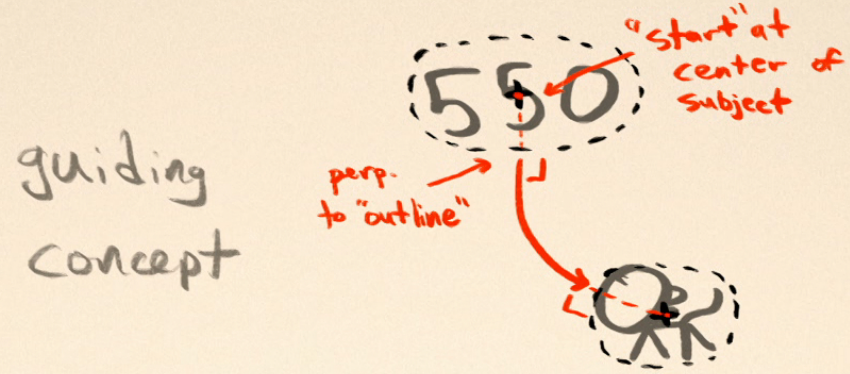
# Arrows, etc


extending off the screen
Arrows
Brackets
circles
Boxes
Trees

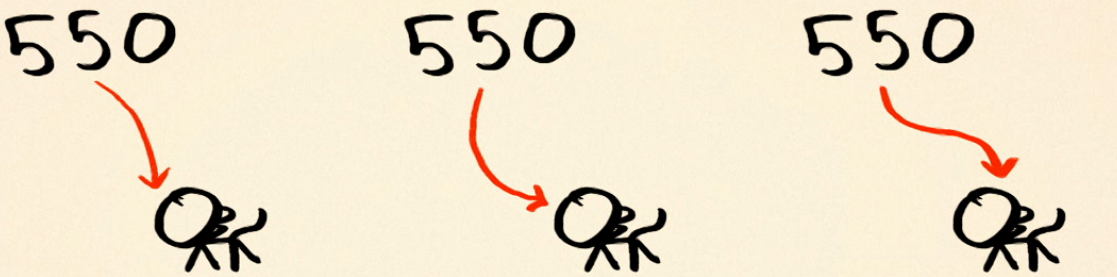
# Arrow-specific syntax



# Arrow-specific syntax




Ex:

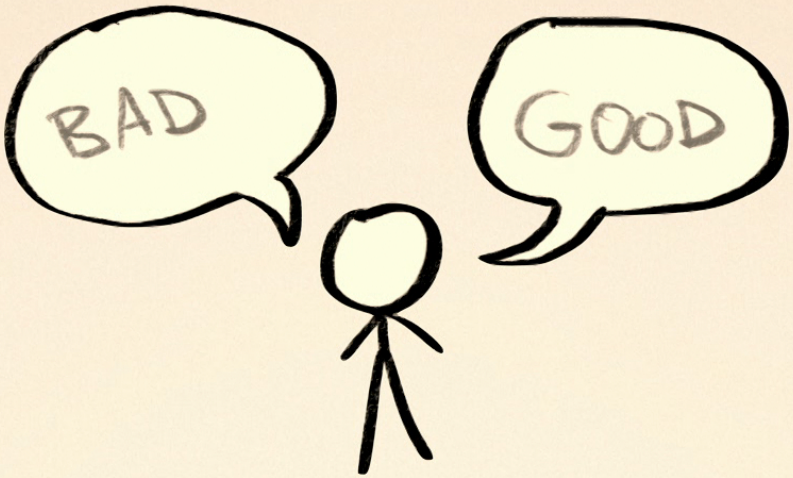



bad
(or pointing at a flea)

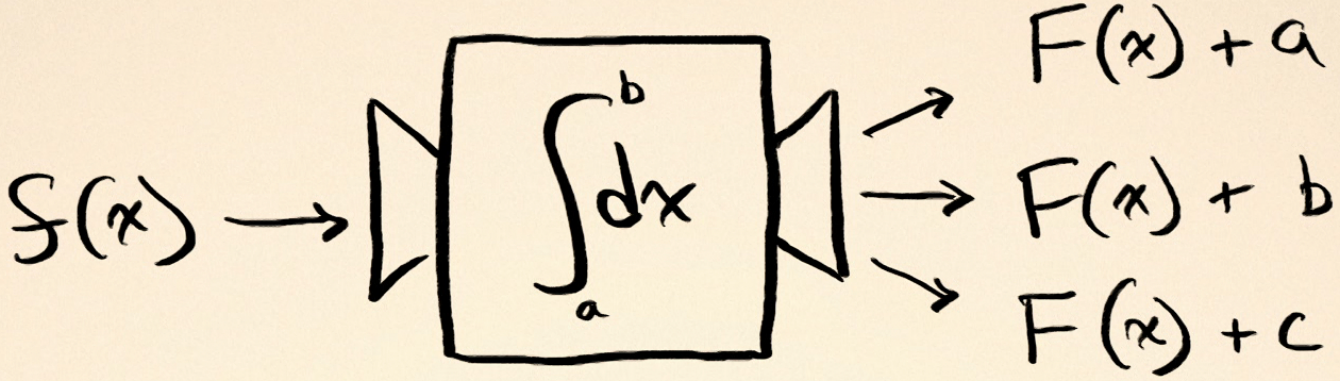
better

also good

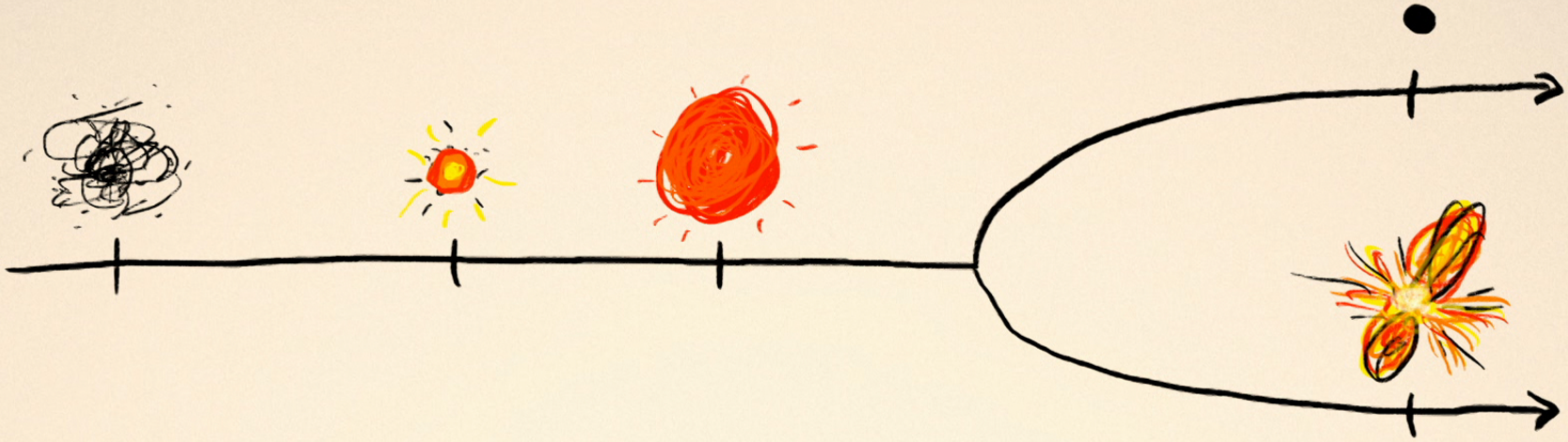
# Arrow-specific syntax



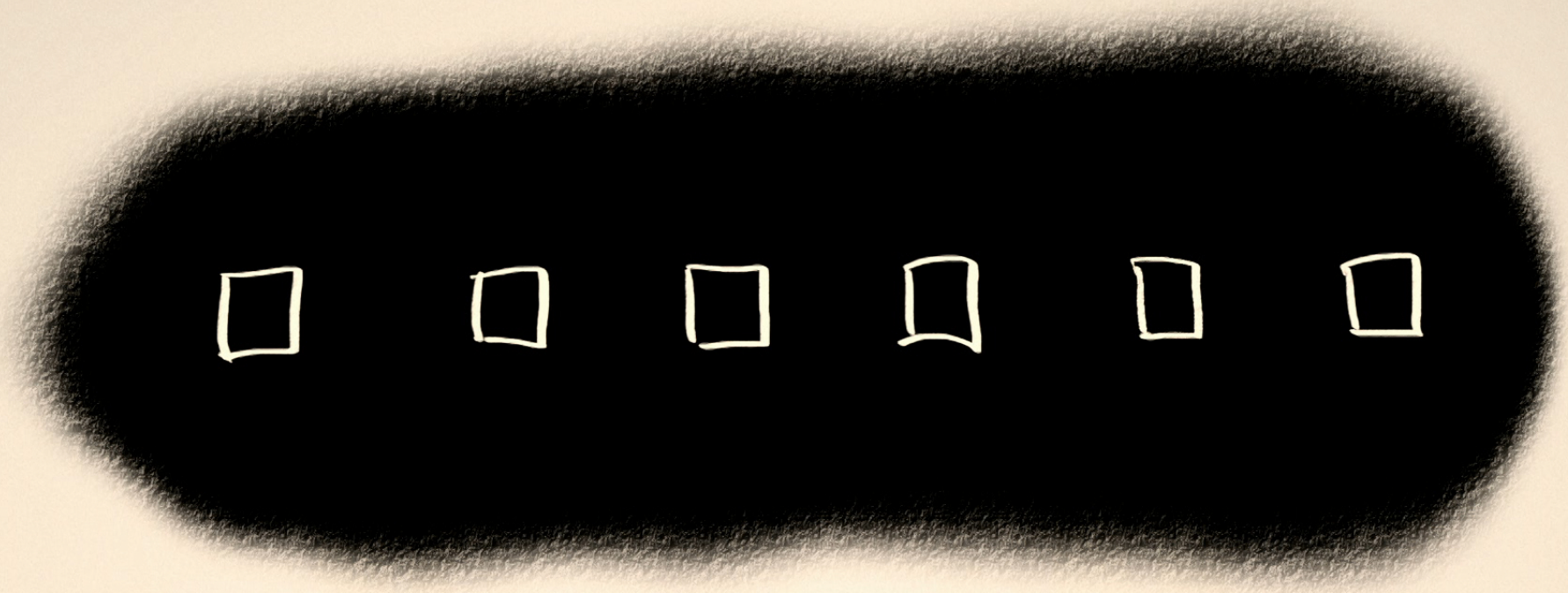
In/out "machines"



# Timelines



# Highlighting (“pointing at”)



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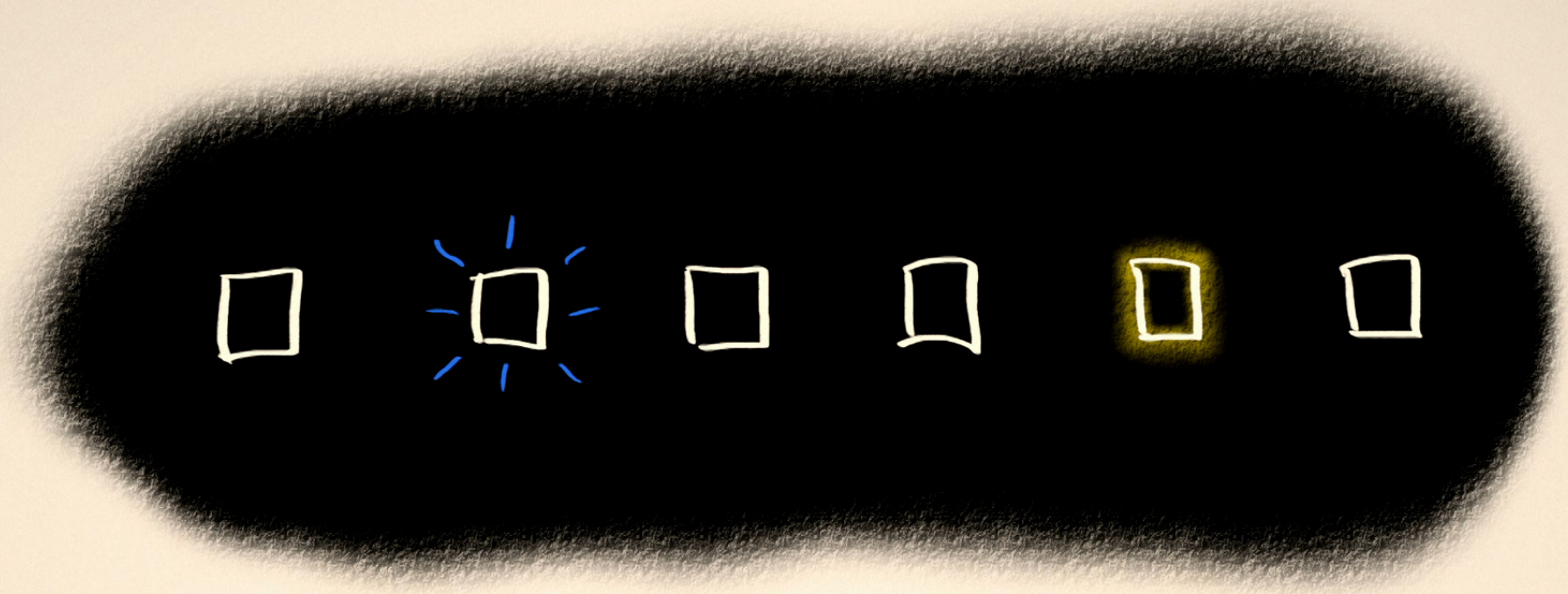
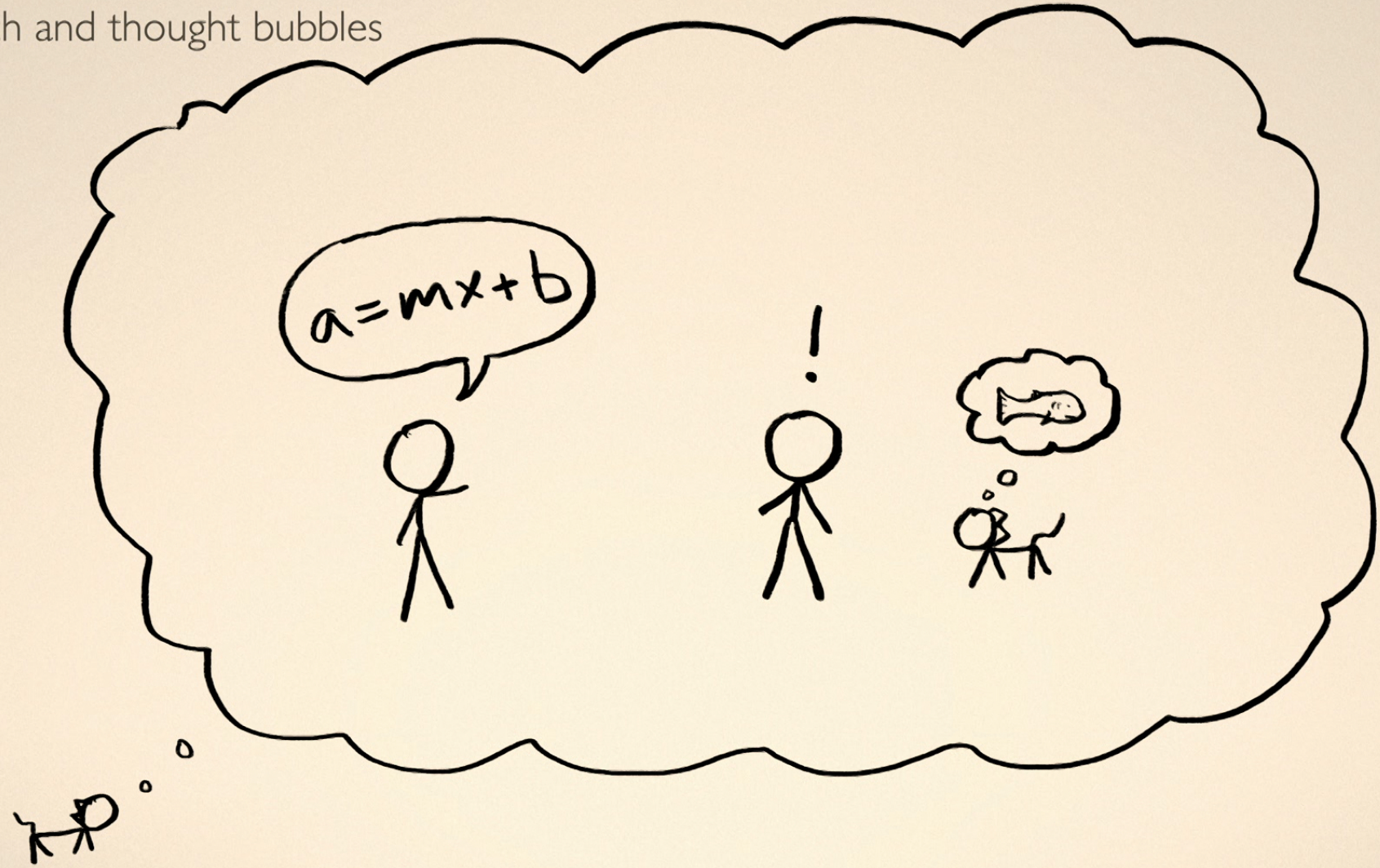


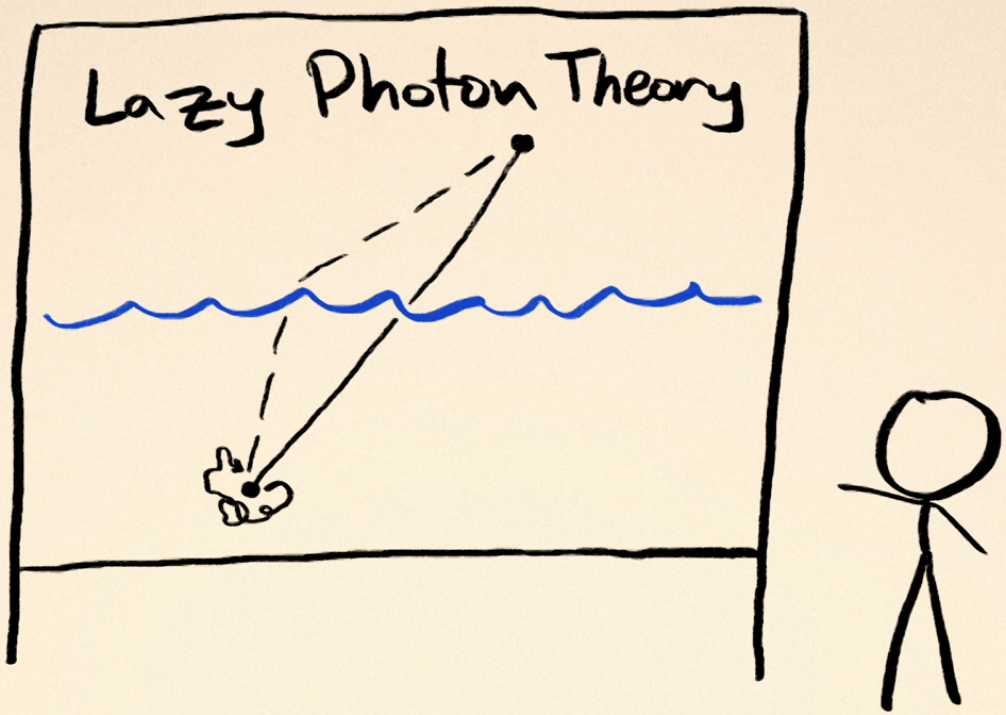
## Characters and character reactions

$$\vec{F} = \frac{d\vec{p}}{dt}$$

# Speech and thought bubbles



Chalkboard/Screen/Whiteboard

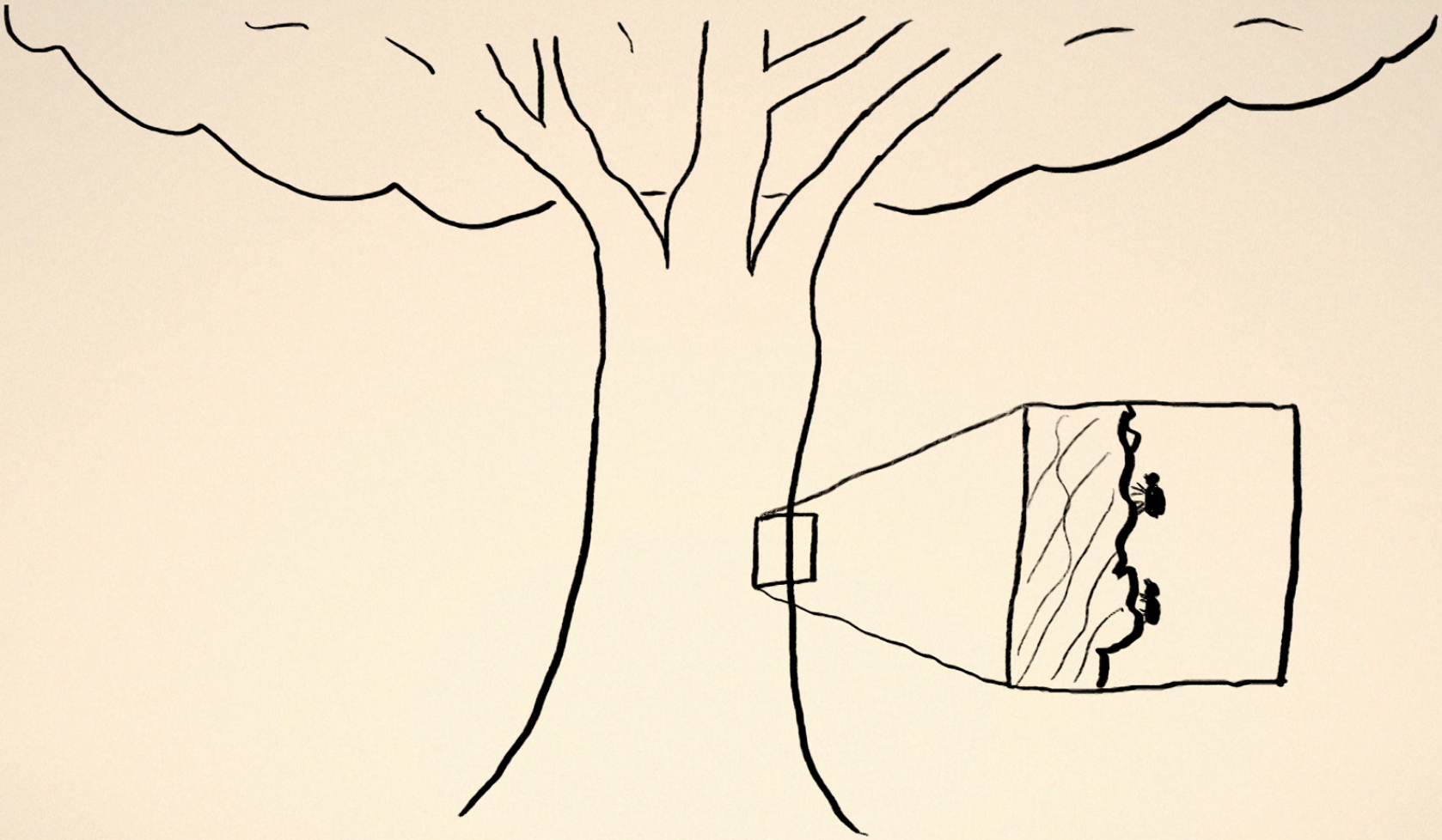


## Crossing out

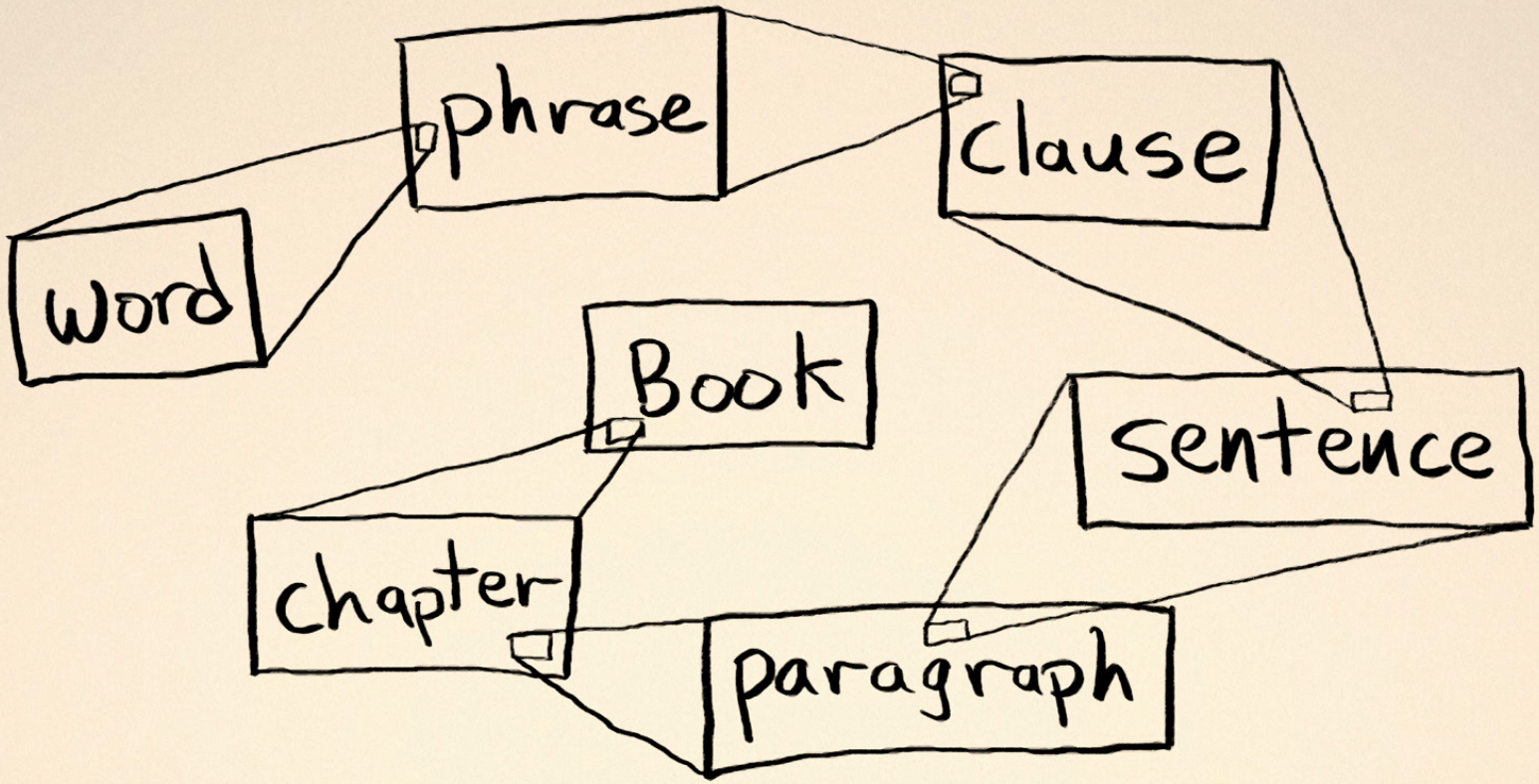
$$8\pi T_{\mu\nu} = G_{\mu\nu} + \cancel{\Lambda}$$

Piling on top

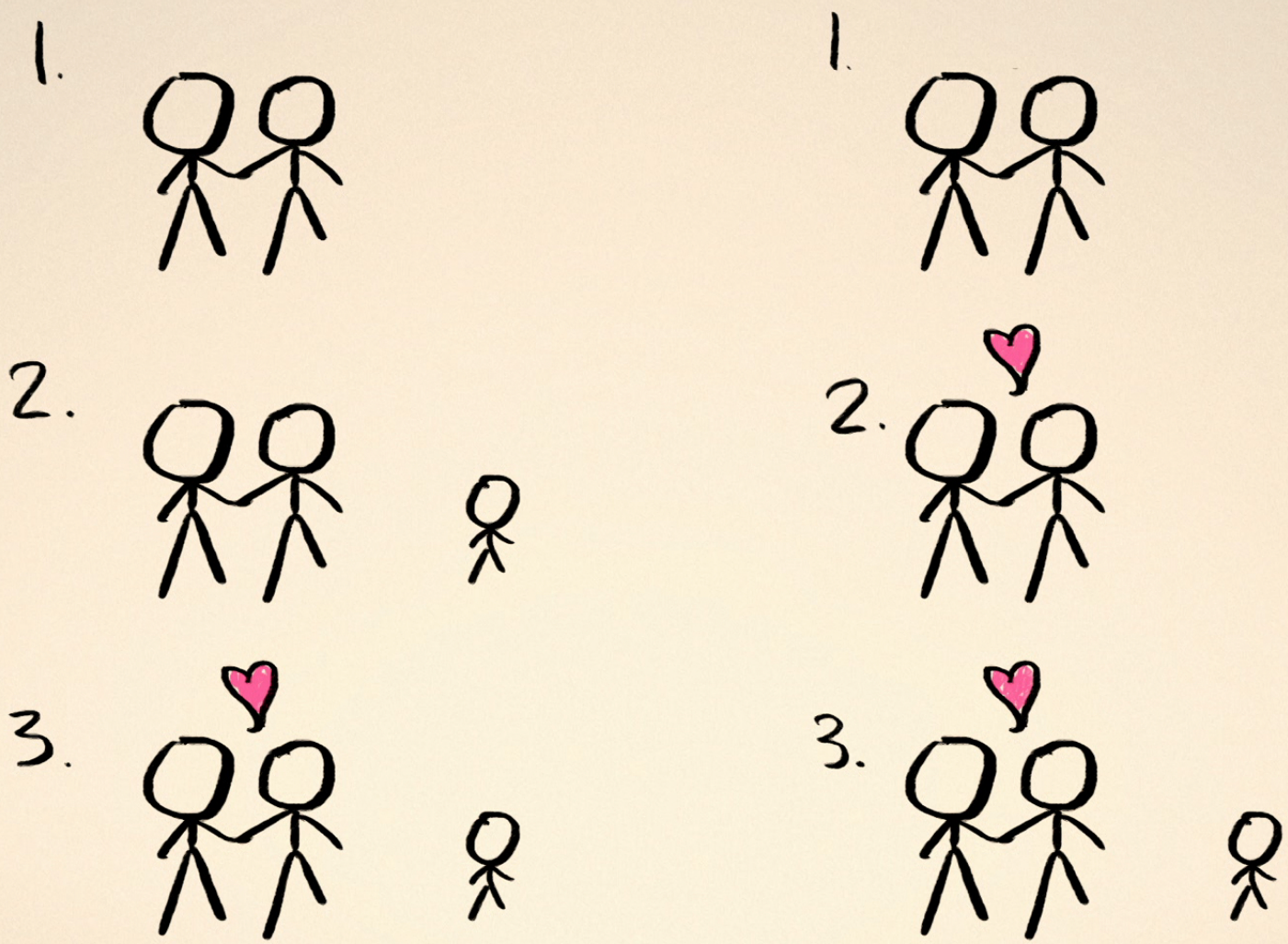
Insets



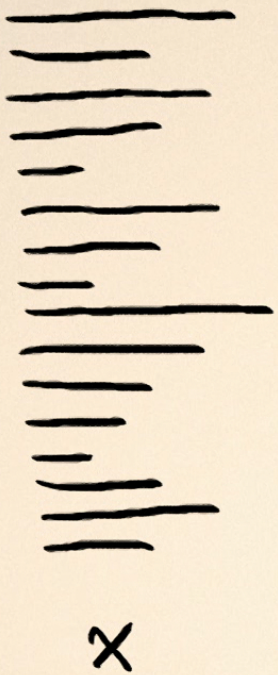
Insets

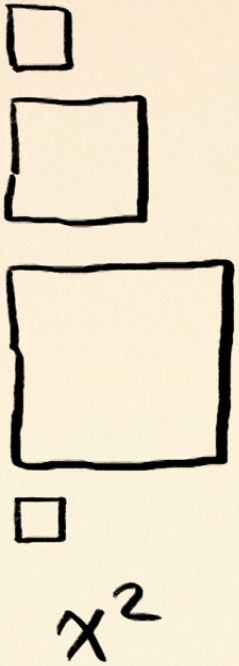


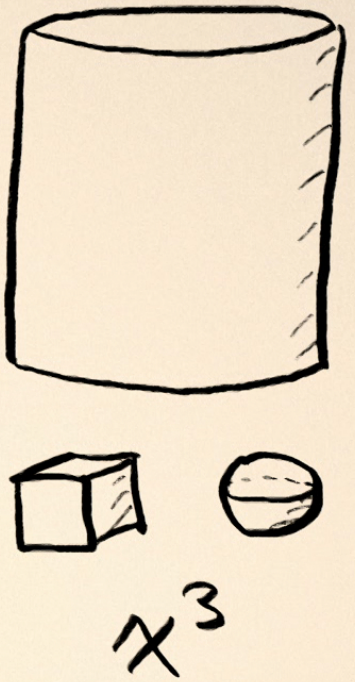
Order



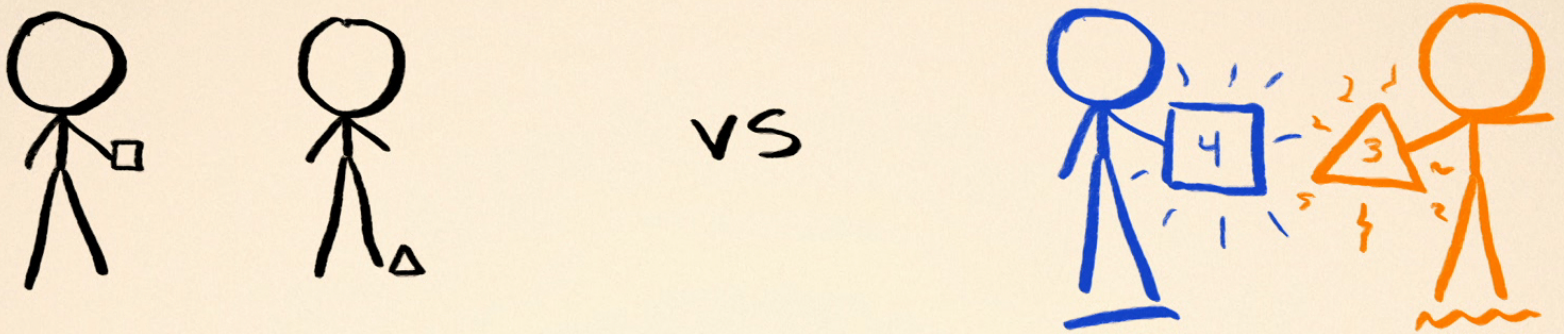
"Natural" scaling



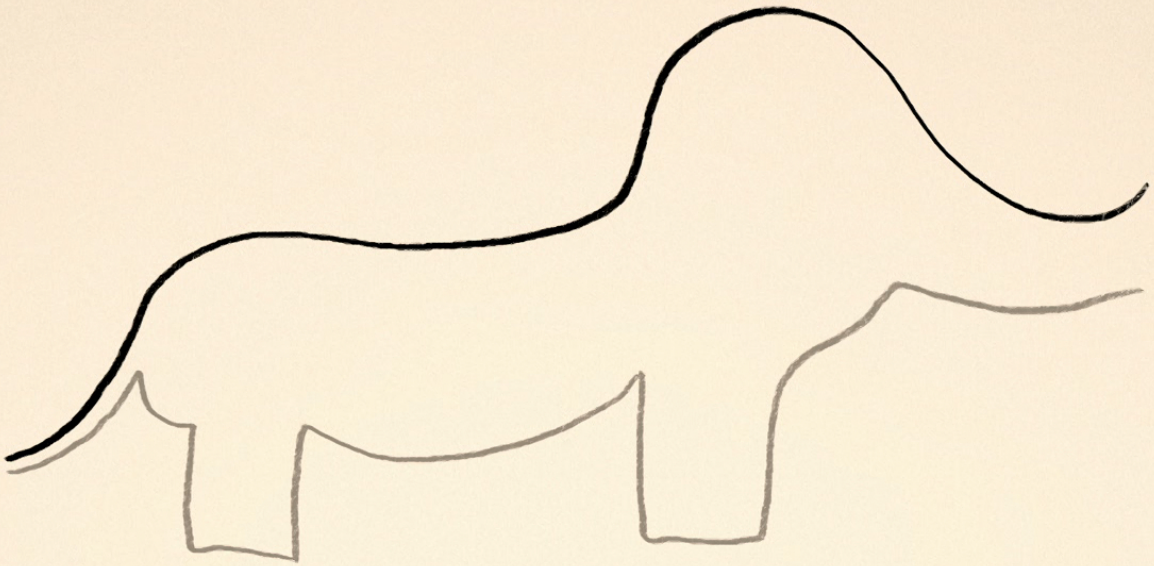
# Contrast



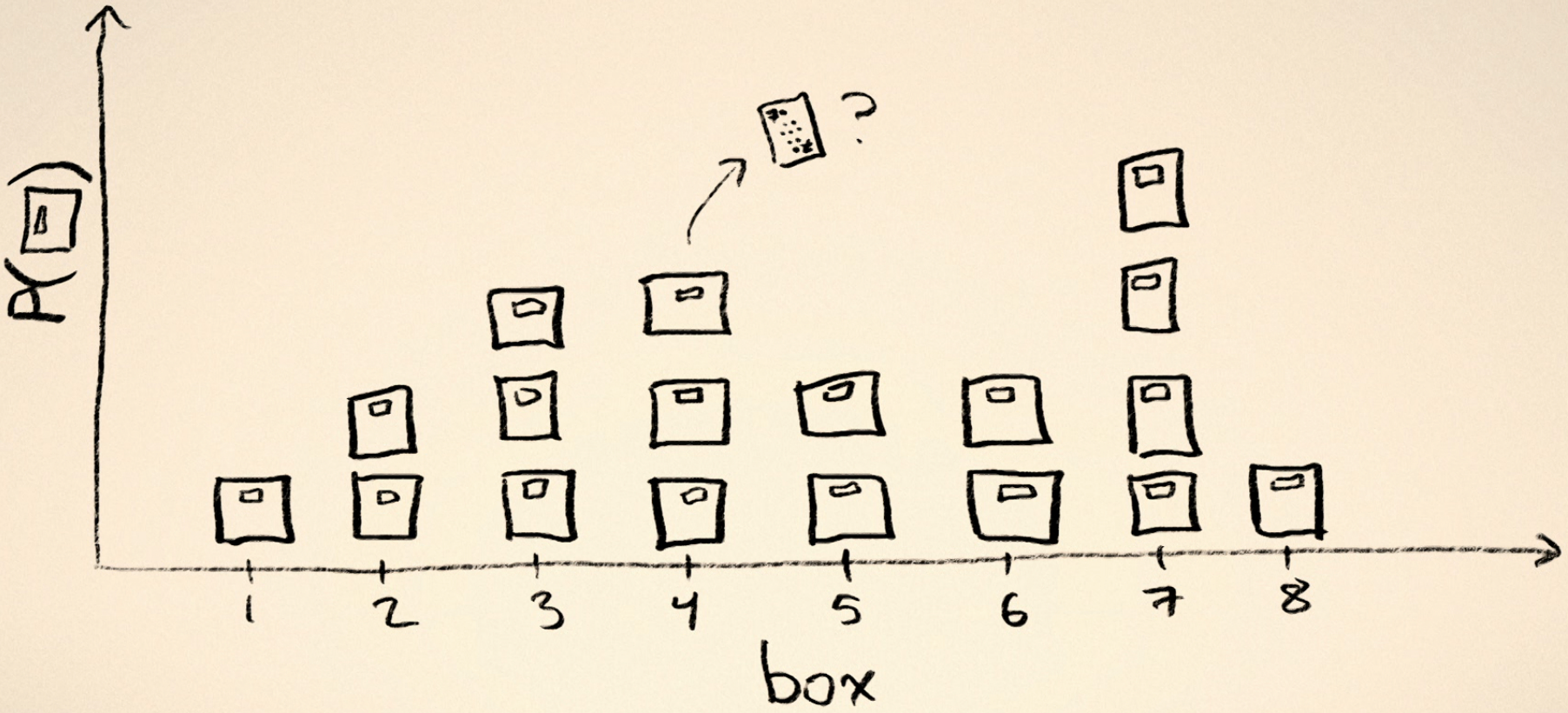
# Semantic & Syntactic Contrast

- Use syntactic parallelism to highlight differences
- Everything is the same other than the things that need to be different

# The elephant in the room…



Natural Graph: probability of pulling a card from a given stack of boxes

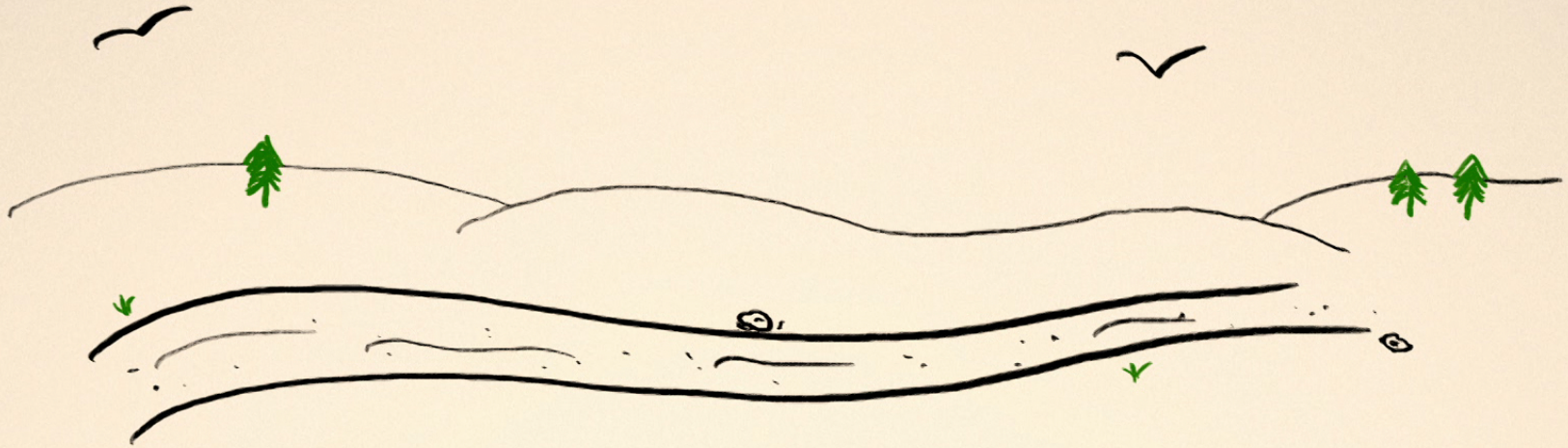


The other elephant in the room…

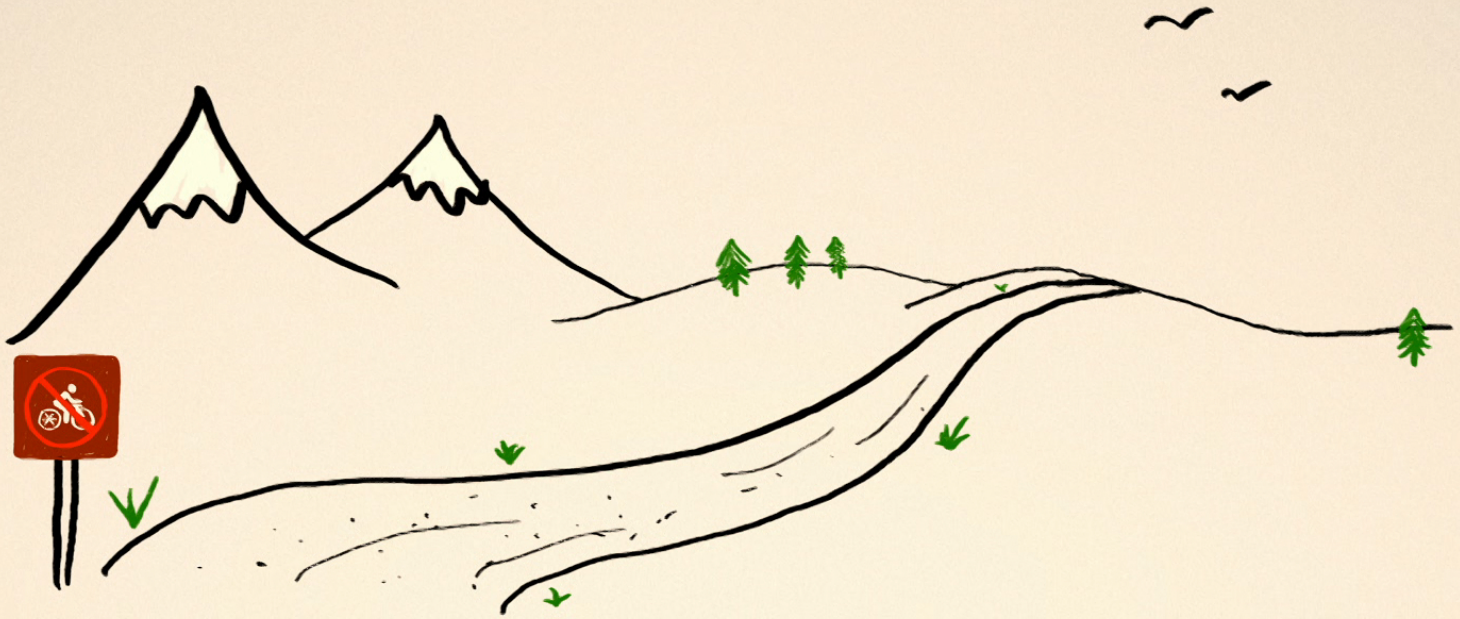
The other elephant in the room…
Animation

# 1. Transitions.

# Transitions

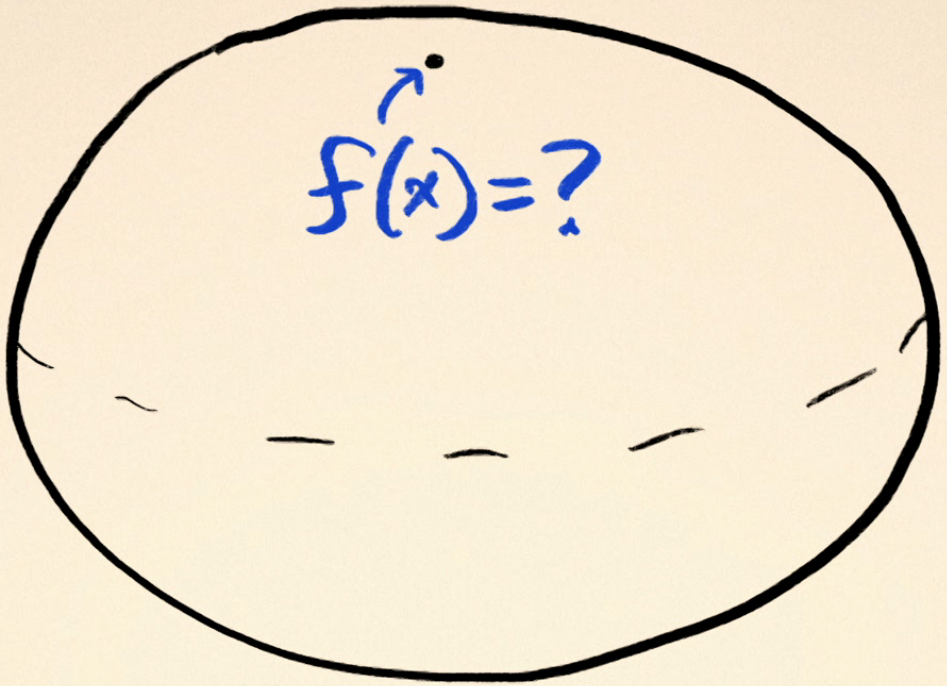


# Transitions

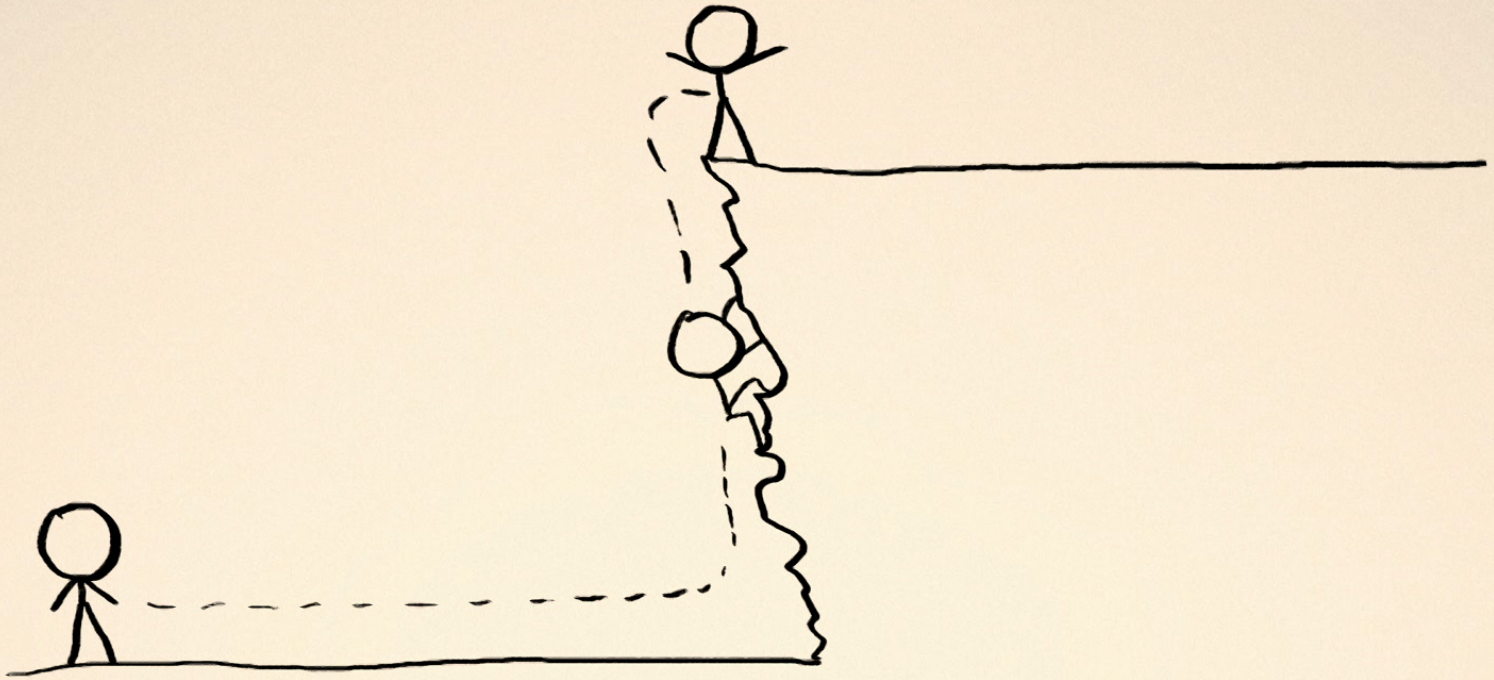


# Holonomy: The Peril of Animation

# Holonomy

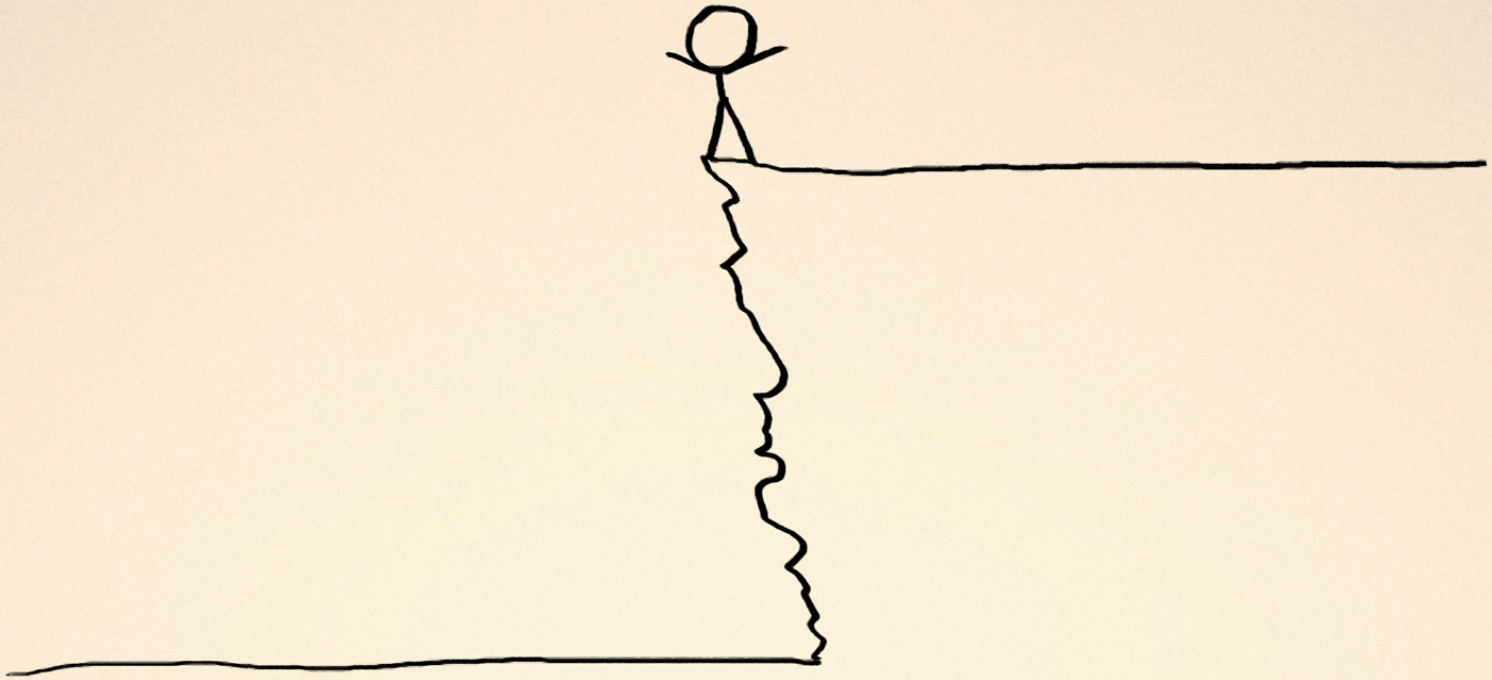


# Holonomy



Non-holonomic

# Holonomy



Holonomic

# Holonomy: The Peril of Animation

- Animation & subtractive techniques <==> holonomic visuals (ie, *you don't know how you got where you are*)
- Additive techniques <==> non-holonomic visuals (ie, *you can see how you got to where you are*)
- You don't "blink and miss it" with additive techniques

# Animation & Holonomy

## Animation & Holonomy

Holonomic

Animation & Holonomy

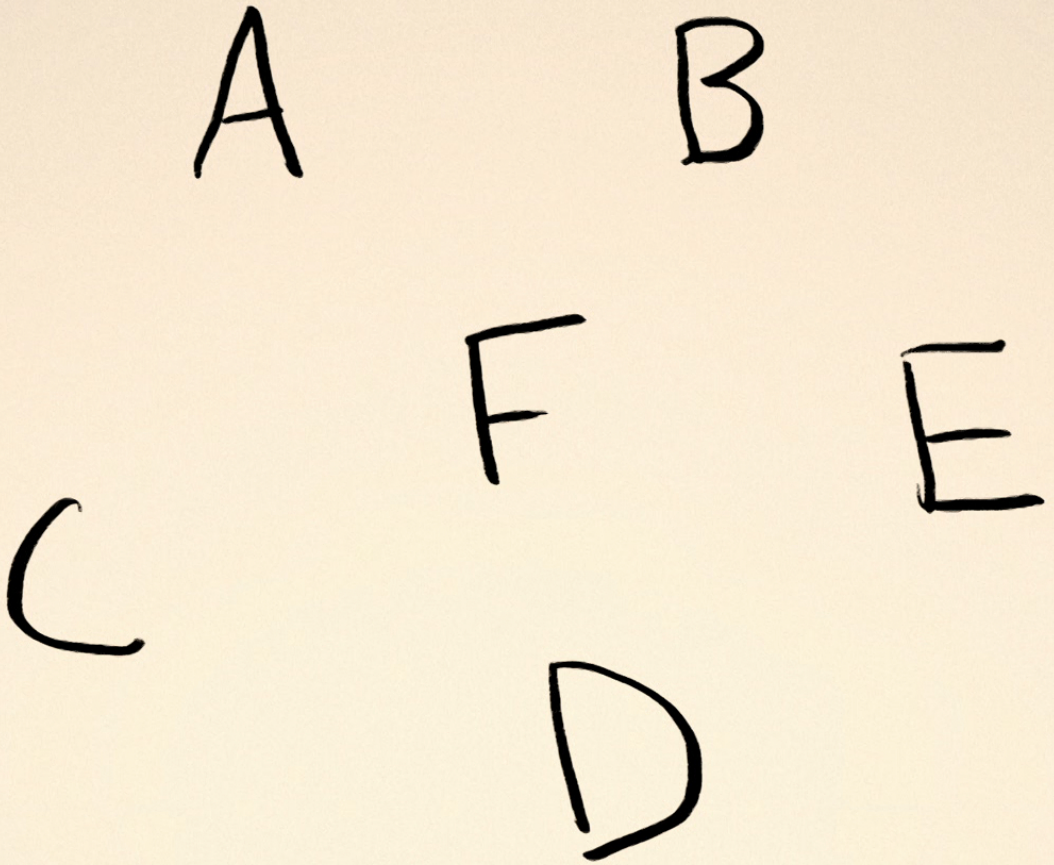
Non-holonomic

# Spatial & temporal coherence

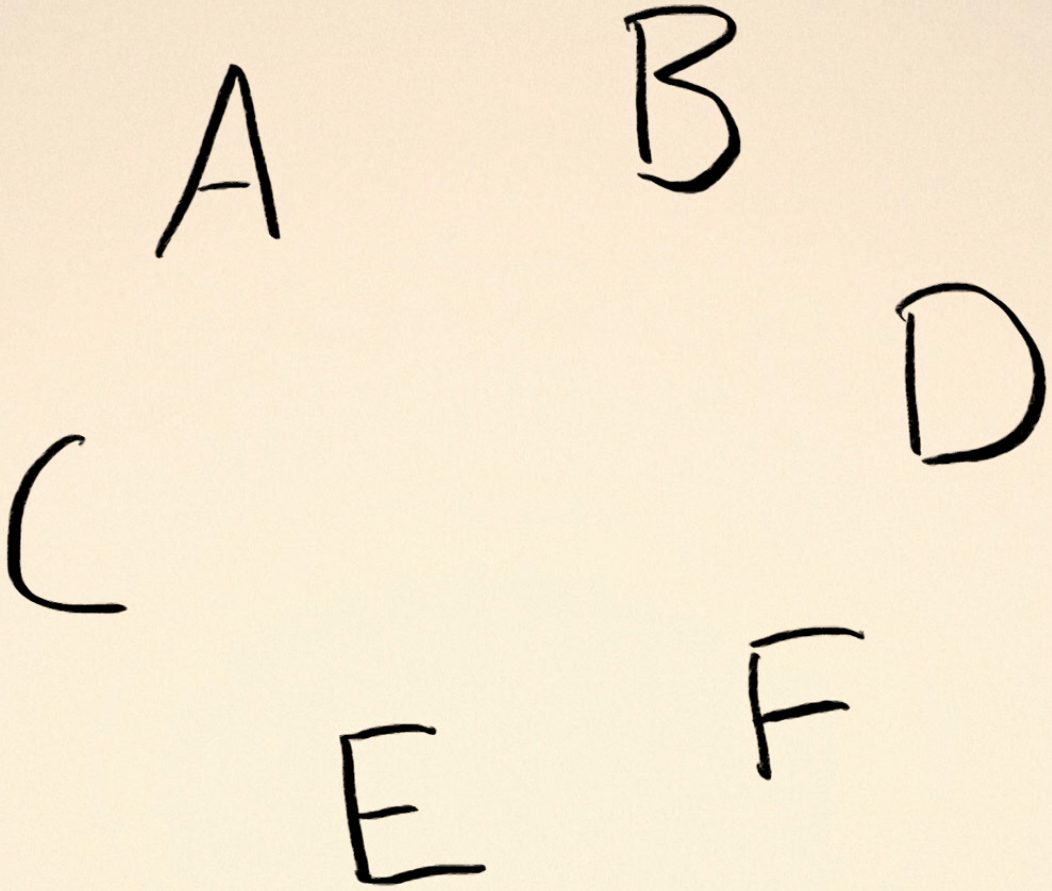
- Because syntax is the "rules of arrangement," it's important to be consistent throughout a single work (book, video, infographic, etc)
- If the rules change, change them intentionally and thoughtfully

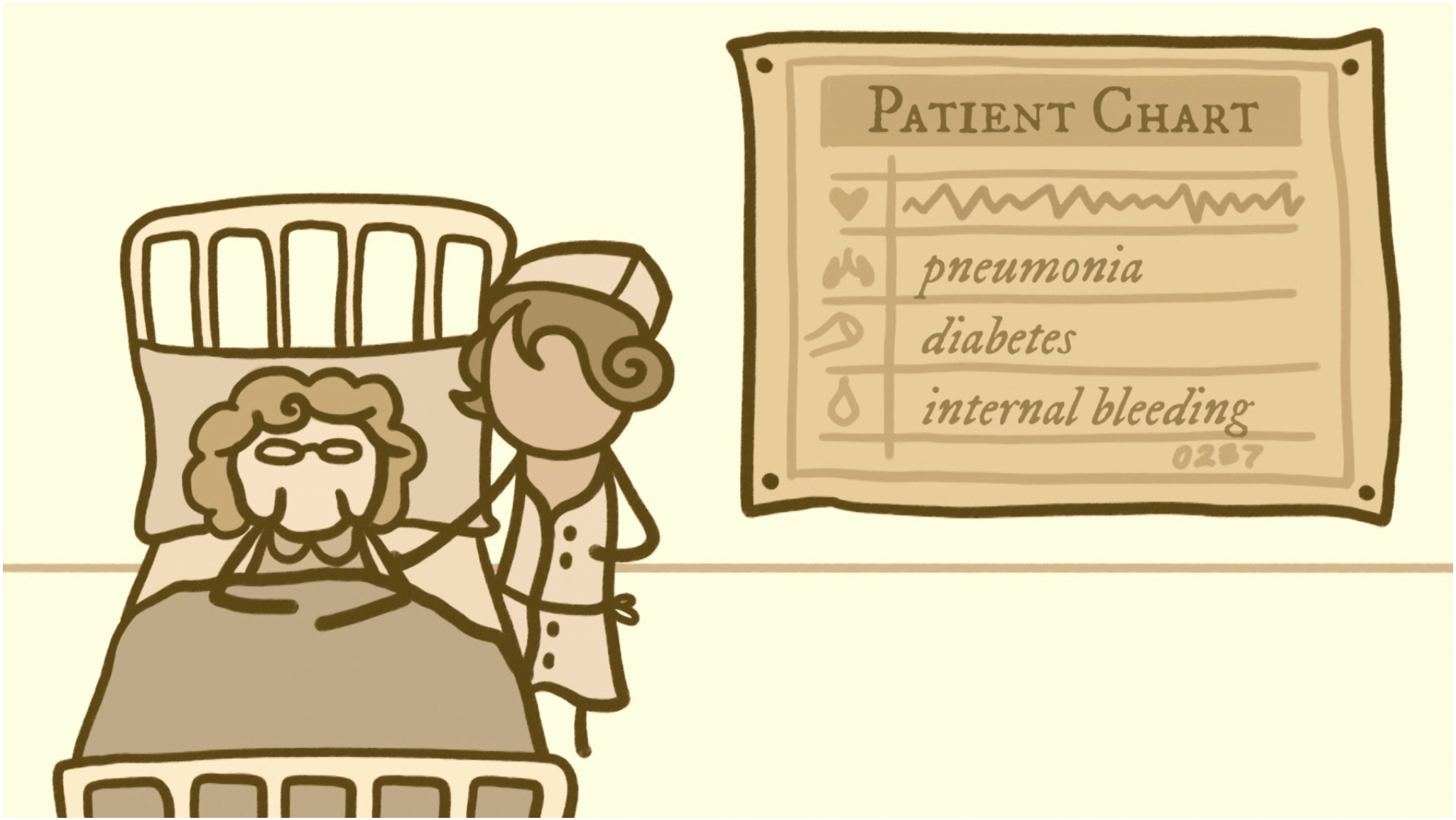
# When visual syntax and semantics conflict

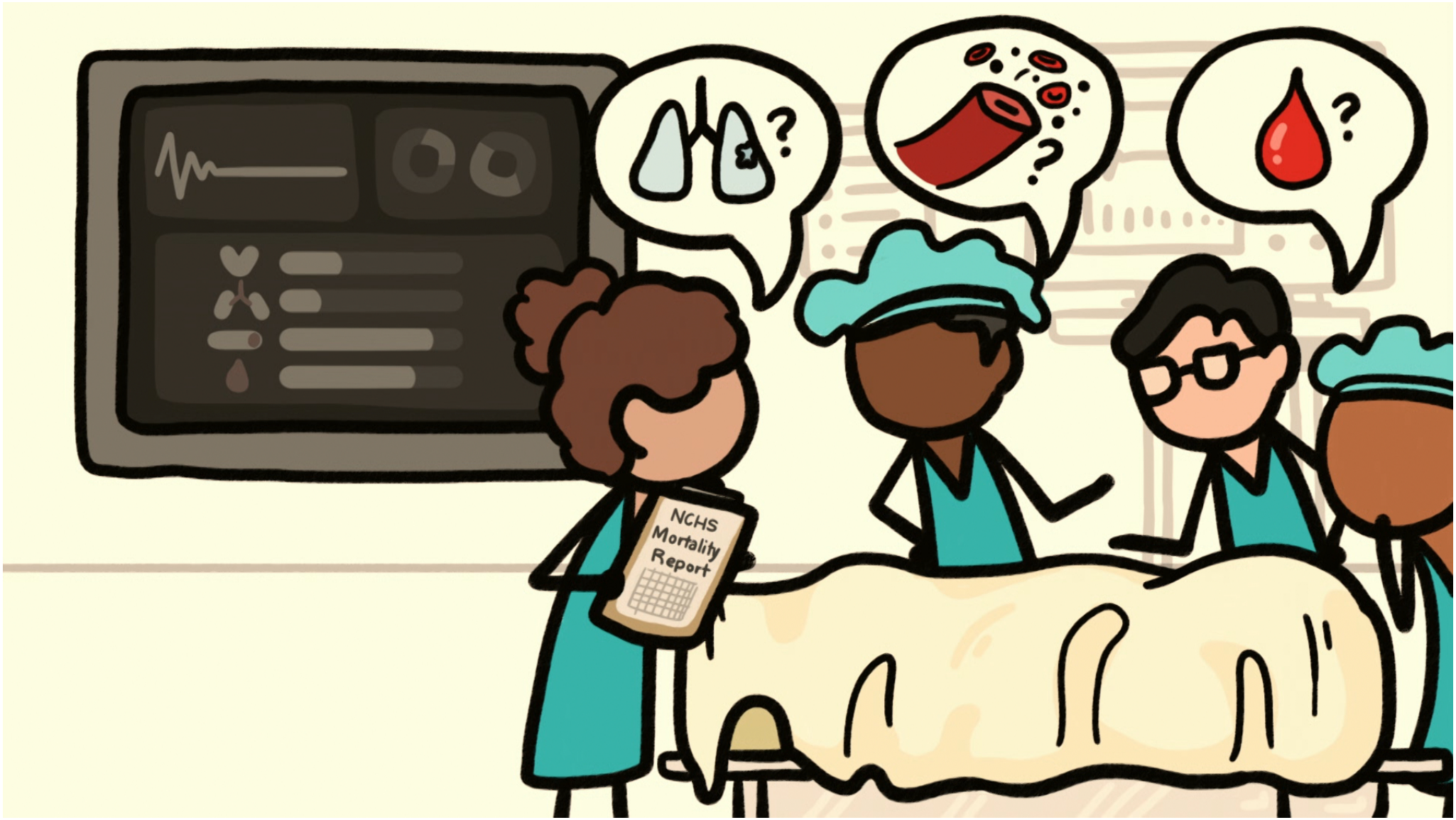
Syntax ≠ Semantics

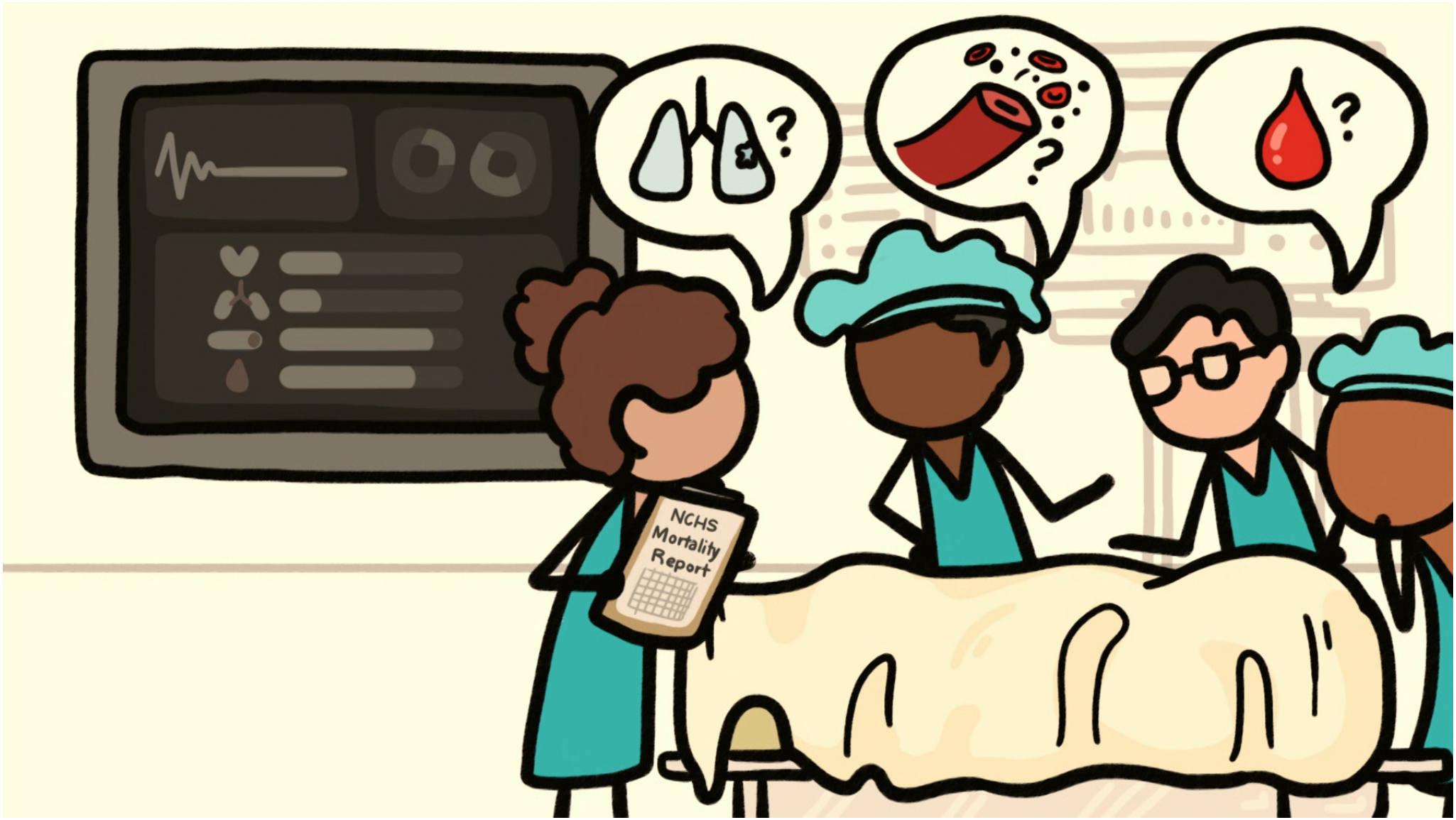


Syntax = Semantics

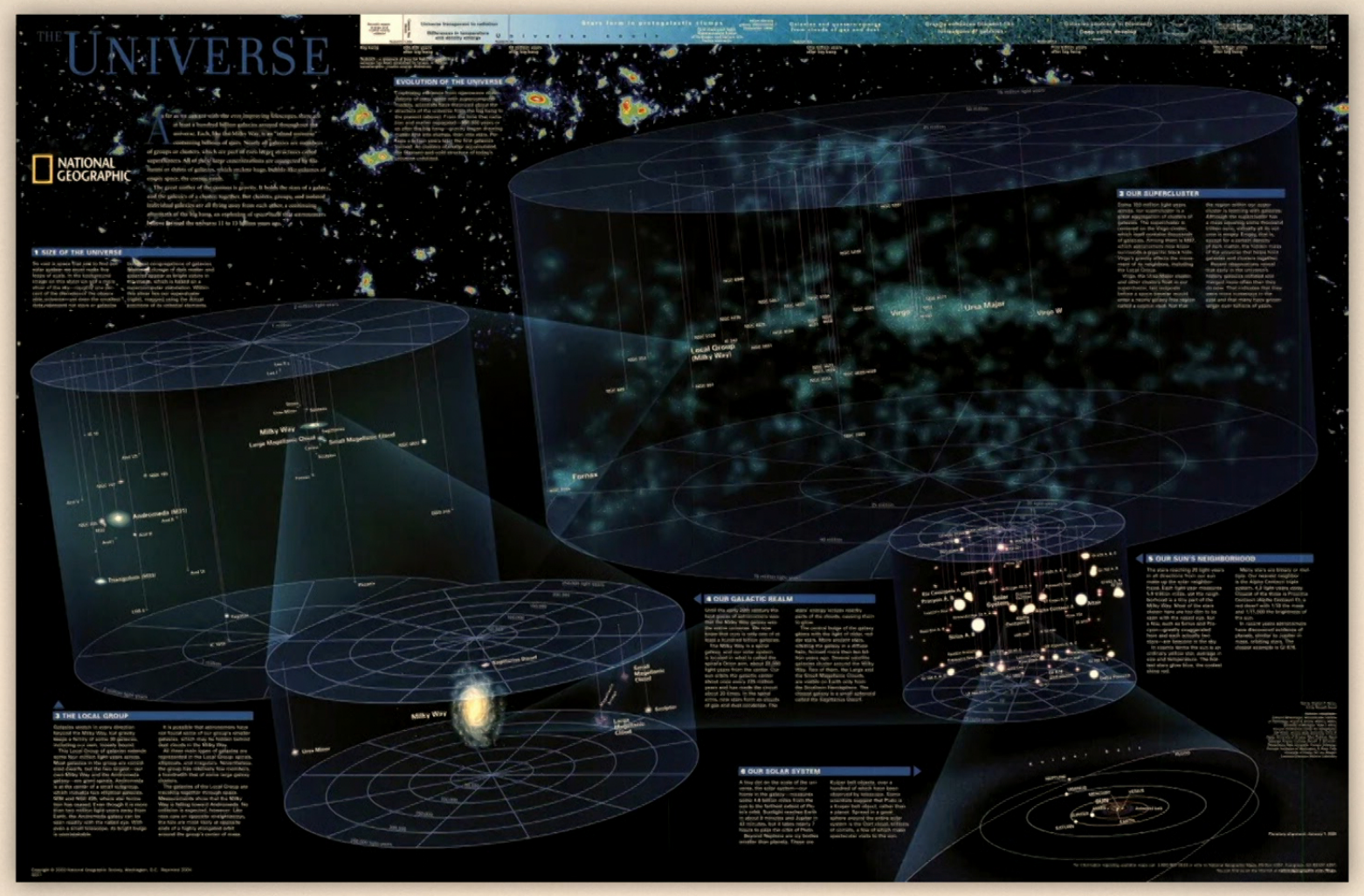



Patient Chart
pneumonia
diabetes
internal bleeding
0287


NCHS
Mortality
Report


NCHS
Mortality
Report

# How can the syntax of this visual be improved?


THE UNIVERSE
NATIONAL GEOGRAPHIC
EVOLUTION OF THE UNIVERSE
1 SIZE OF THE UNIVERSE
2 OUR SUPERCLUSTER
3 THE LOCAL GROUP
4 OUR GALACTIC REALM
5 OUR SUN'S NEIGHBORHOOD
6 OUR SOLAR SYSTEM
Local Group (Milky Way)
Virgo
Ursa Major
Virgo W
Fornax
Milky Way
Large Magellanic Cloud
Small Magellanic Cloud
Andromeda (M31)
Triangulum (M33)
Sagittarius Dwarf
Sculptor
Ursa Minor
Solar System
Alpha Centauri A
Alpha Centauri B
Proxima Centauri
Sirius A
Sirius B
Procyon A
Procyon B
Epsilon Eridani
Tau Ceti
Epsilon Indi
Barnard's Star
Wolf 359
Lalande 21185
Luyten 726-8 A
Luyten 726-8 B
Ross 154
Ross 248
Epsilon Eridani
Lacaille 9352
Ross 128
Luyten 789-6
Kapteyn's Star
Kruger 60 A
Kruger 60 B
Ross 614 A
Ross 614 B
Wolf 1061
Van Maanen's Star
Wolf 424 A
Wolf 424 B
Gliese 725 A
Gliese 725 B
Gliese 570 A
Gliese 570 B
Gliese 570 C
Gliese 628
Gliese 644 A
Gliese 644 B
Gliese 644 C
Gliese 676 A
Gliese 676 B
Gliese 682
Gliese 687
Gliese 693
Gliese 694
Gliese 695
Gliese 699
Gliese 701
Gliese 702 A
Gliese 702 B
Gliese 705
Gliese 713
Gliese 720 A
Gliese 720 B
Gliese 721
Gliese 723
Gliese 724
Gliese 725 A
Gliese 725 B
Gliese 729
Gliese 731
Gliese 733
Gliese 735
Gliese 736 A
Gliese 736 B
Gliese 738
Gliese 739
Gliese 740
Gliese 741
Gliese 742
Gliese 743
Gliese 744
Gliese 745 A
Gliese 745 B
Gliese 746
Gliese 747
Gliese 748
Gliese 749
Gliese 750
Gliese 751
Gliese 752 A
Gliese 752 B
Gliese 753
Gliese 754
Gliese 755
Gliese 756
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Gliese 764
Gliese 765
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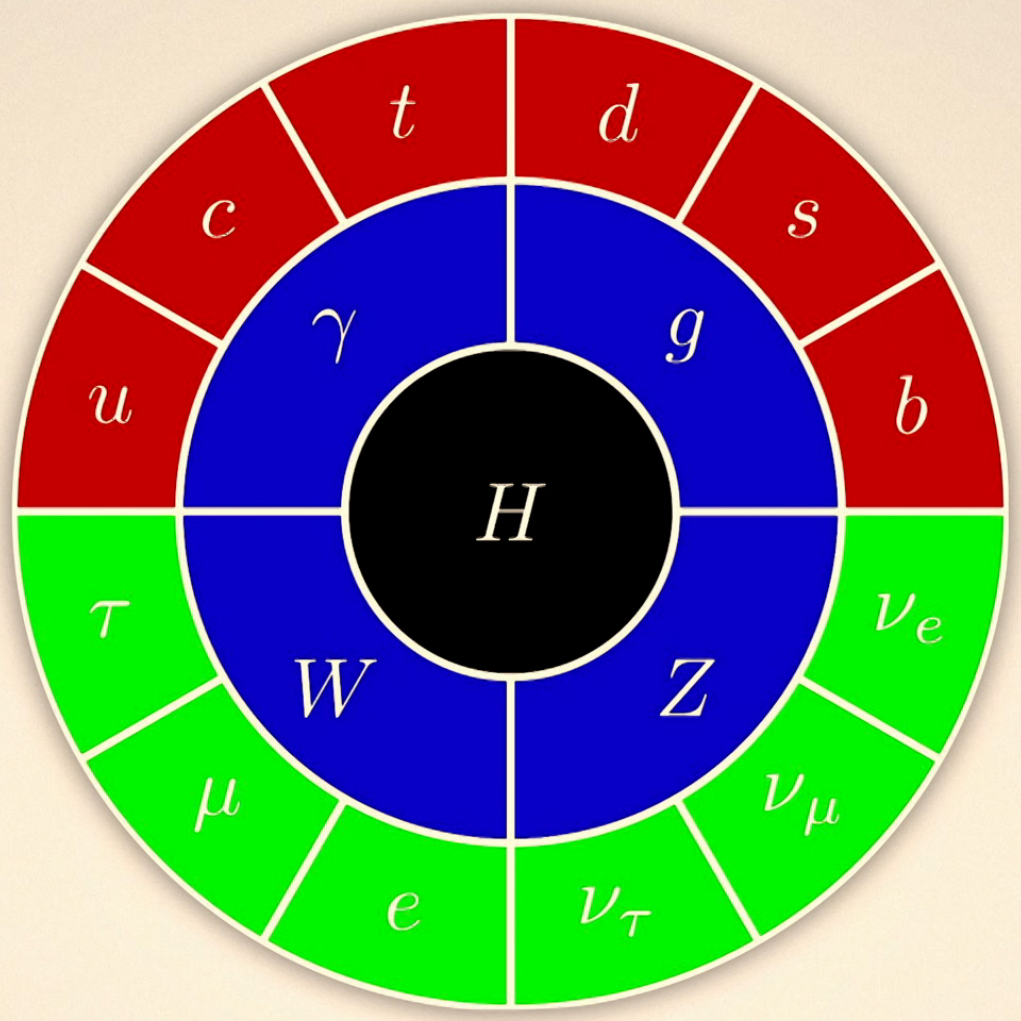
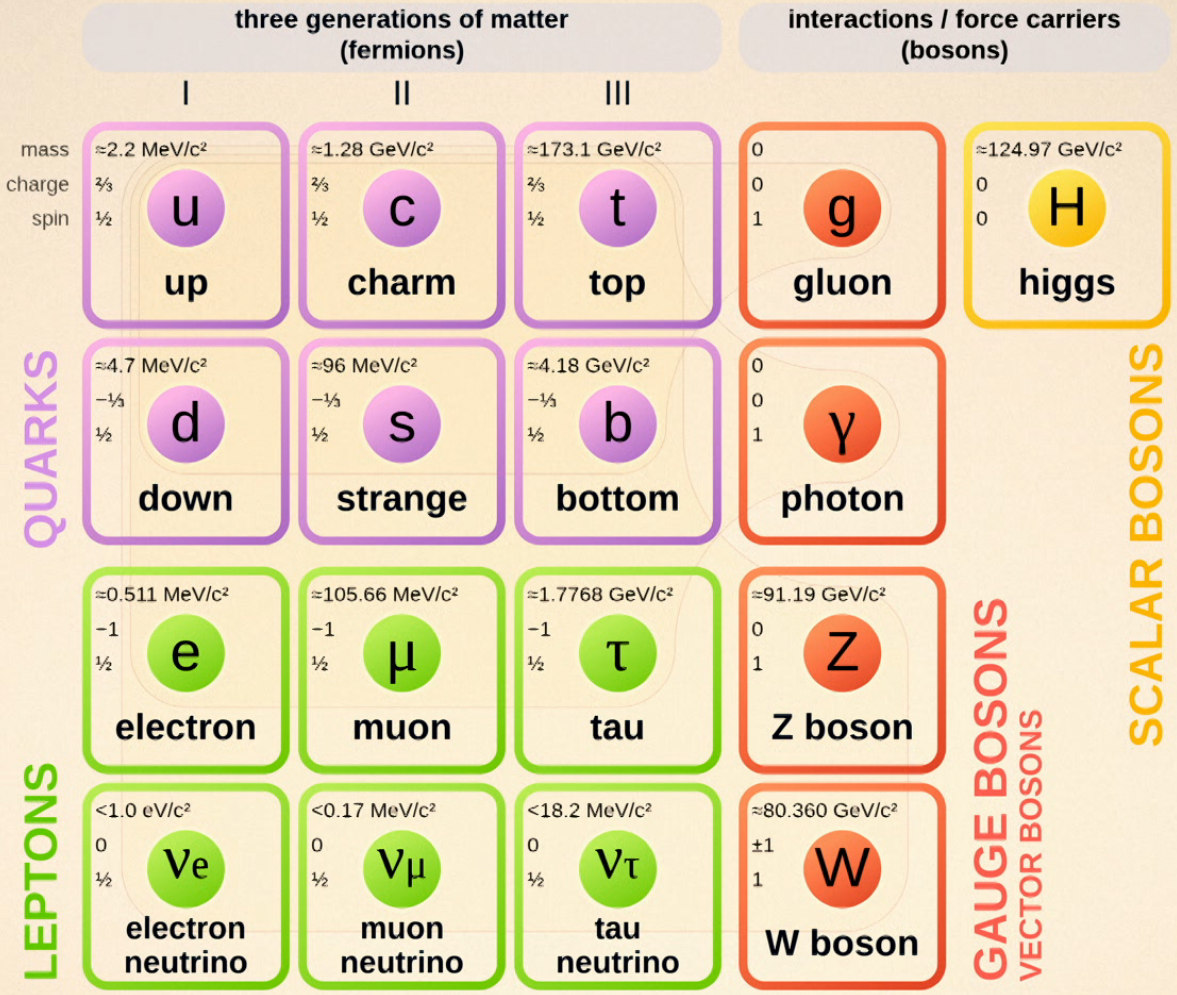
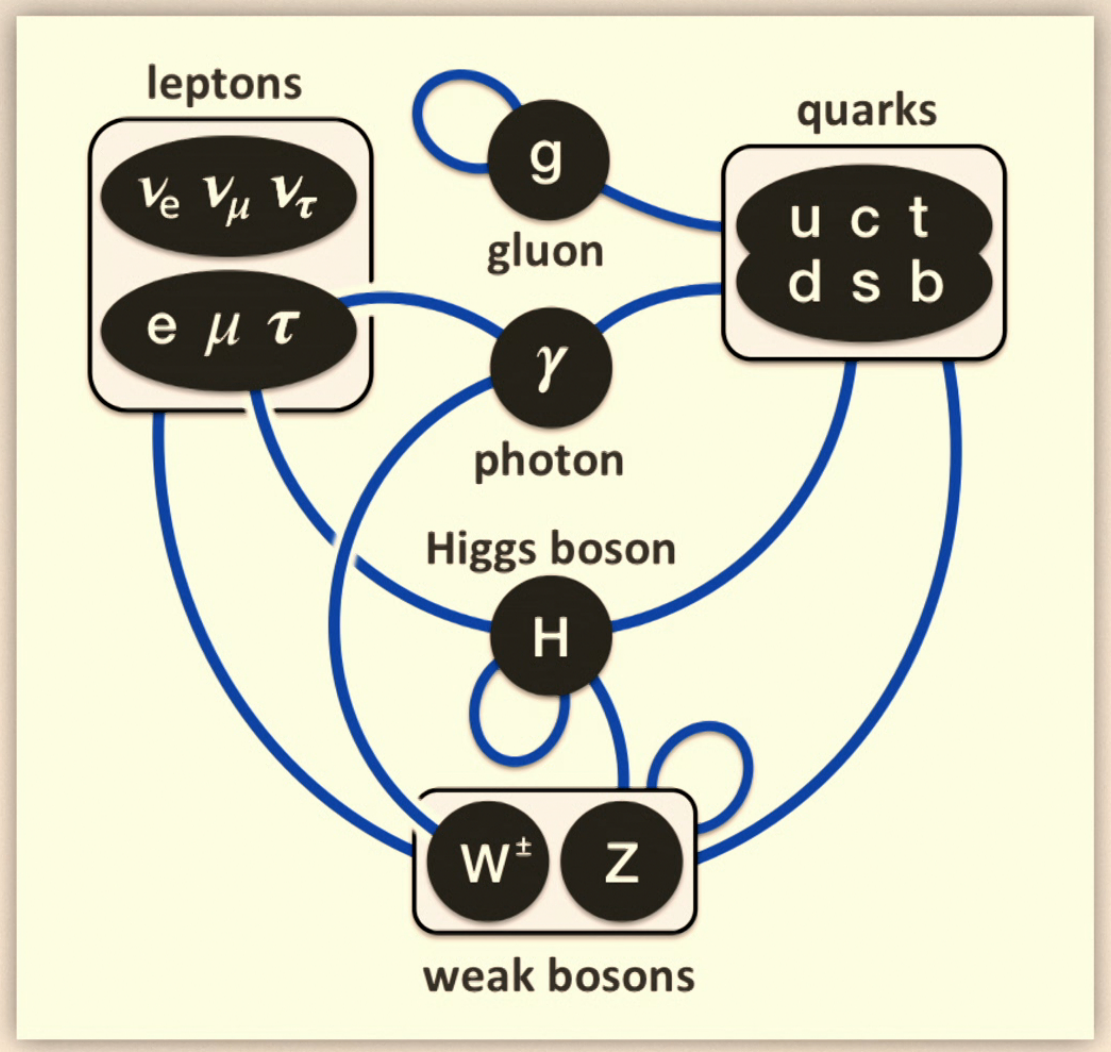
Gliese 771
Gliese 772
Gliese

Pablo Carlos Budassi


$t$
$d$
$c$
$s$
$\gamma$
$g$
$u$
$b$
$H$
$\tau$
$\nu_e$
$W$
$Z$
$\mu$
$\nu_\mu$
$e$
$\nu_\tau$

# Standard Model of Elementary Particles




leptons
$\nu_e$ $\nu_\mu$ $\nu_\tau$
e $\mu$ $\tau$
g
gluon
quarks
u c t
d s b
$\gamma$
photon
Higgs boson
H
W±
Z
weak bosons

# Standard Model Particle Content

- 3 pairs of quarks & antiquarks (ud, cs, tb & antiparticles)
- 3 pairs of leptons & antileptons ($e^- \nu_e$, $\mu^- \nu_\mu$, $\tau^- \nu_\tau$ & antiparticles)
- 1 photon ($\gamma$)
- 3 weak bosons (W+, W-, Z)
- 8 gluons (g g g g g g g g)
- 1 Higgs boson ($H^0$)

# Standard Model Particle Content

- 3 pairs of quarks & antiquarks (ud, cs, tb & antiparticles)
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- 1 Higgs boson ($H^0$)

$$
\begin{array}{ll}
(r\bar{b} + b\bar{r})/\sqrt{2} & -i(r\bar{b} - b\bar{r})/\sqrt{2} \\
(r\bar{g} + g\bar{r})/\sqrt{2} & -i(r\bar{g} - g\bar{r})/\sqrt{2} \\
(b\bar{g} + g\bar{b})/\sqrt{2} & -i(b\bar{g} - g\bar{b})/\sqrt{2} \\
(r\bar{r} - b\bar{b})/\sqrt{2} & (r\bar{r} + b\bar{b} - 2g\bar{g})/\sqrt{6}.
\end{array}
$$

# Standard Model Particle Content

- 3 pairs of quarks & antiquarks (ud, cs, tb & antiparticles)
- 3 pairs of leptons & antileptons ($e^-\nu_e$, $\mu^-\nu_\mu$, $\tau^-\nu_\tau$ & antiparticles)
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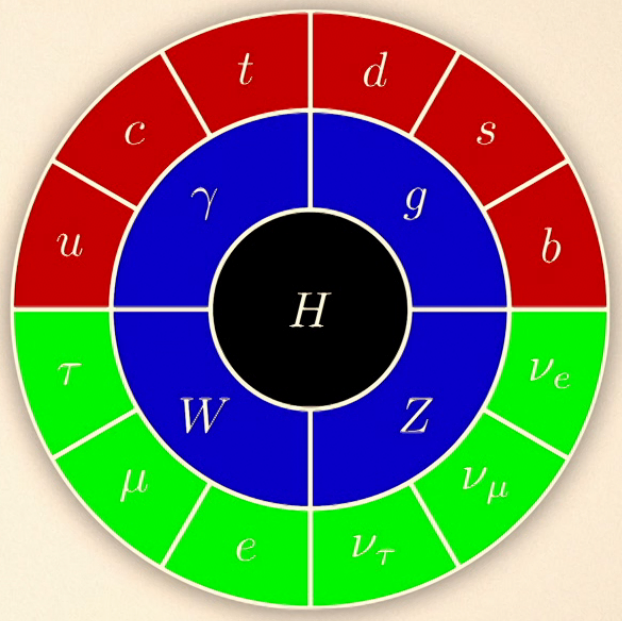
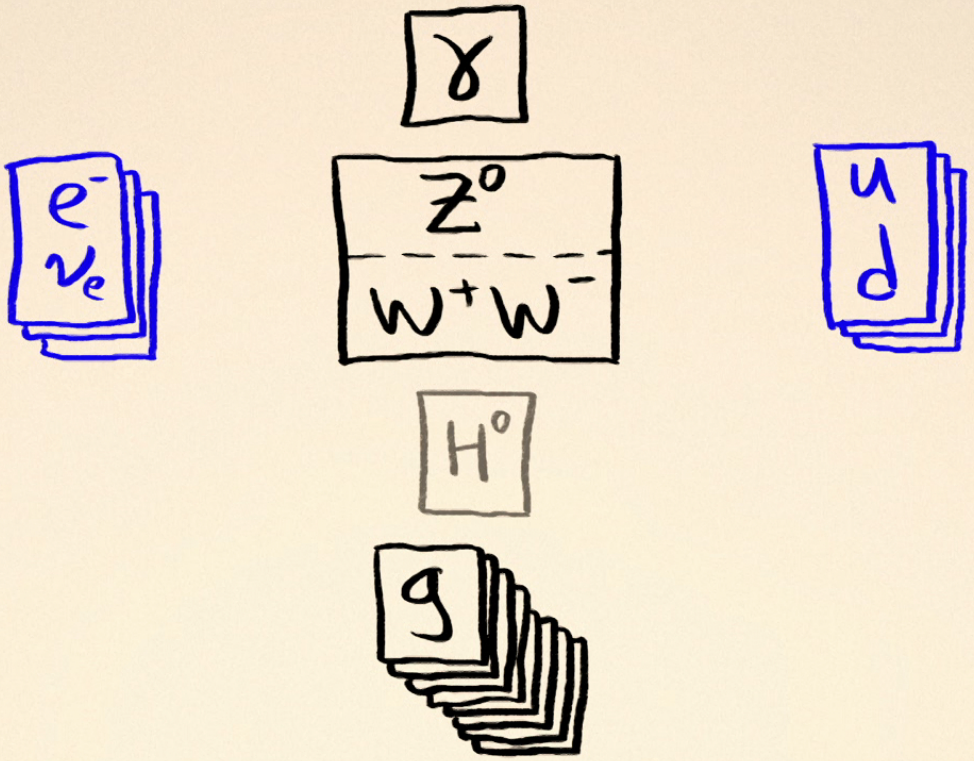
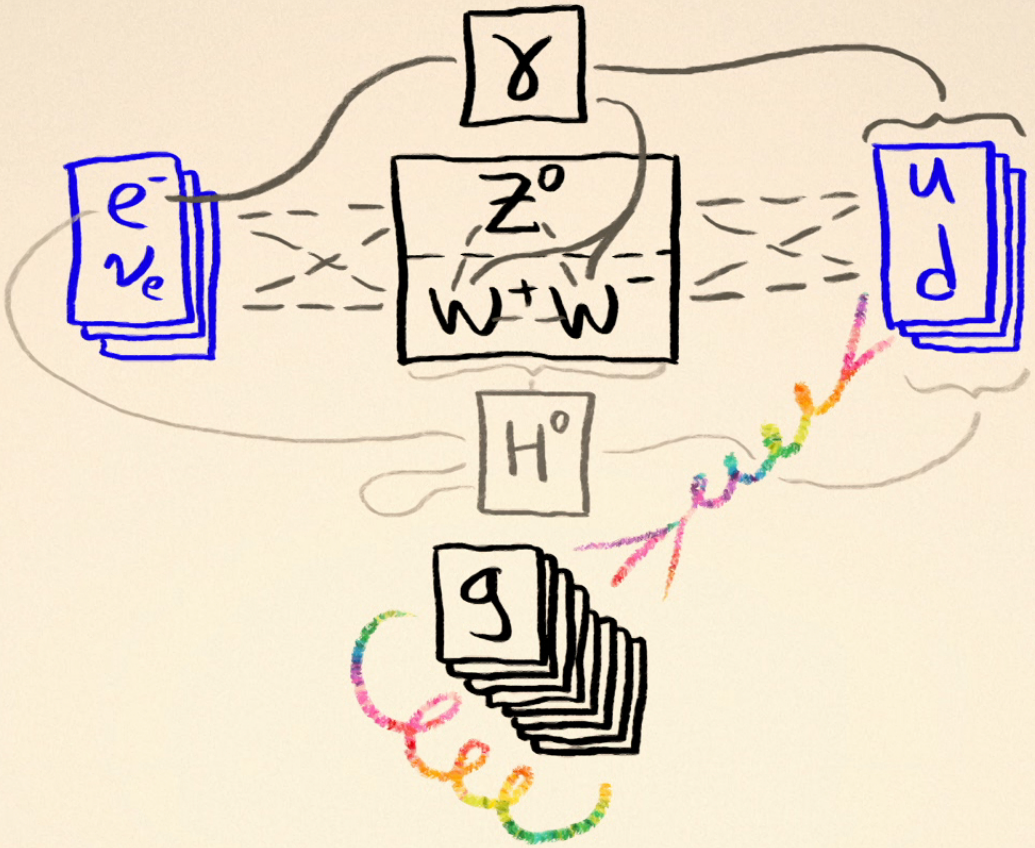
- 1 Higgs boson ($H^0$)




γ
$e^-$
$\nu_e$
$Z^0$
$W^+W^-$
u
d
$H^0$
g


γ
e⁻
νe
Z⁰
W⁺W⁻
u
d
H⁰
g

# A few common writing+visuals problems

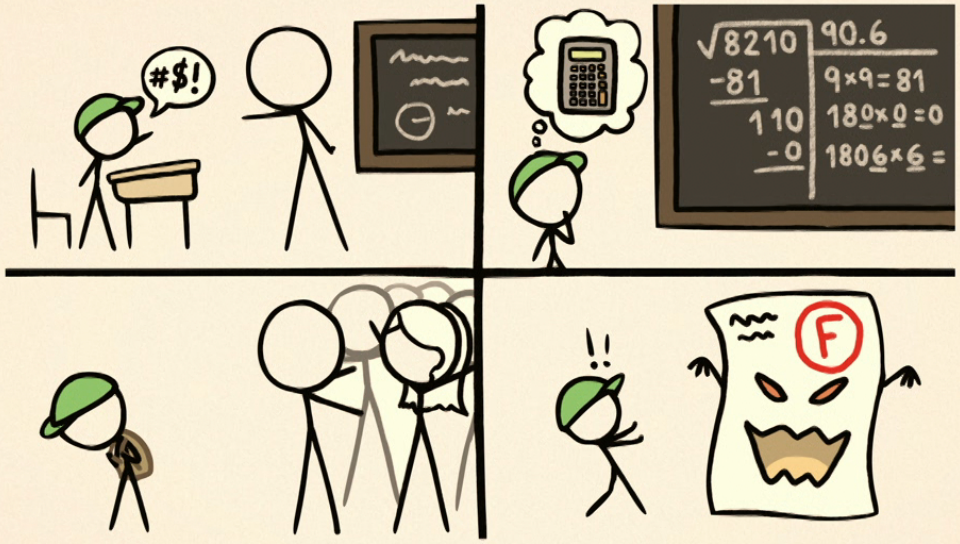
*(ie, when written and visual syntax conflict)*

- The topic sentence dilemma (we call it "Draw Before Draw")
- Subject interruption
- Temporal discontinuity
- Illustrating the abstract
- Conflicting figures of speech
- Reading off of your slides

# Topic sentence dilemma

aka "draw before draw"

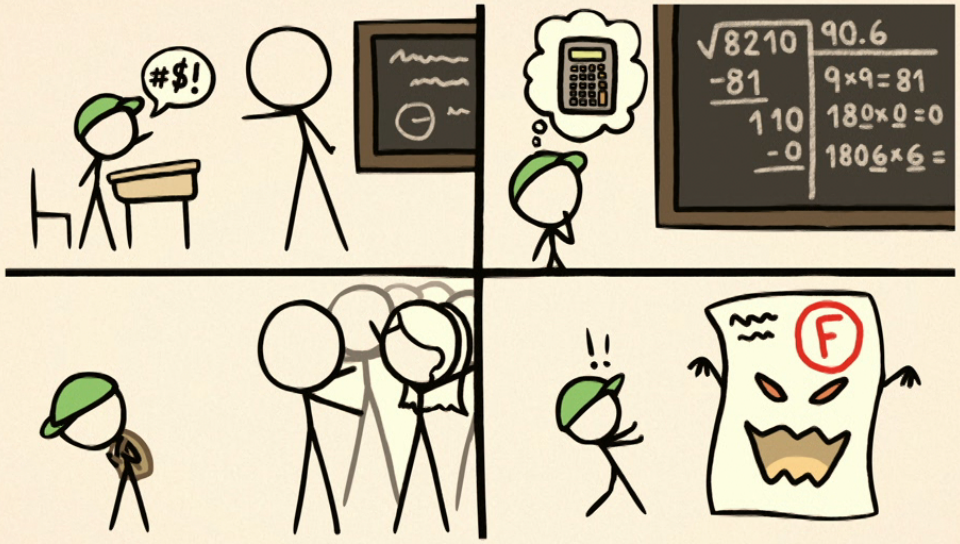
"**Many reasons for skipping school involve the school itself.** These include poor relations with teachers, classes that seem irrelevant to life in the 21st century, a sense that no one at school cares about them, and fear of tests."



# Topic sentence dilemma

aka "draw before draw"

**Solution:** "Kids might skip school because of poor relations with teachers, classes that seem irrelevant to life in the 21st century, a sense that no one at school cares about them, and fear of tests."

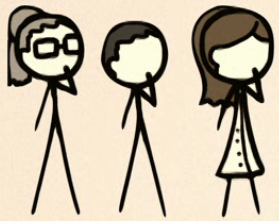


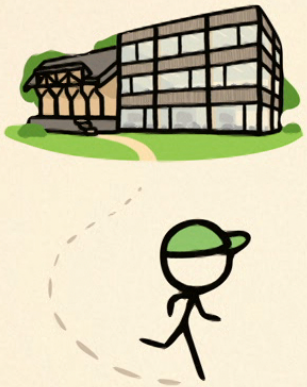
# Topic sentence dilemma

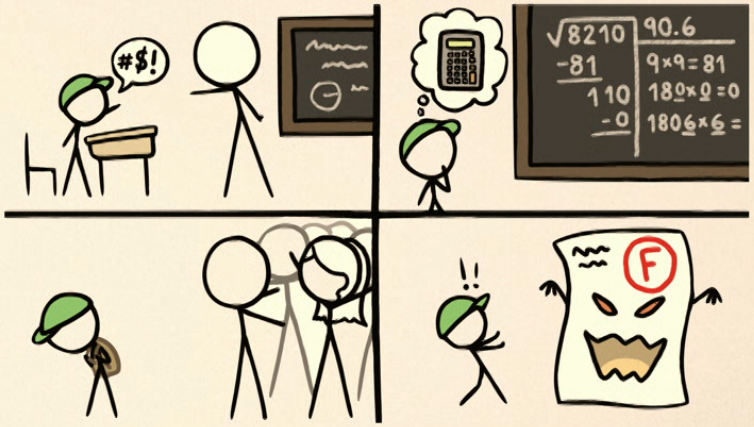
aka "draw before draw"

"Many reasons for skipping school involve the school itself. These include poor relations with teachers, classes that seem irrelevant to life in the 21st century, a sense that no one at school cares about them, and fear of tests."

**Solution:**







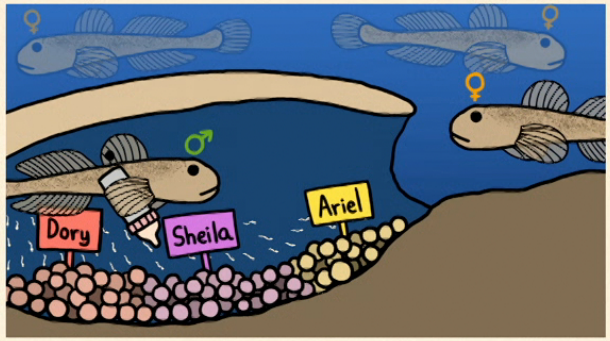
# Topic sentence dilemma

aka "draw before draw"

# Topic sentence dilemma

aka "draw before draw"

"**And sometimes offspring get in the way, so they just have to go.** The male sand goby fertilizes eggs from multiple females over a short period of time and cares for them all together in one nest. In order to mate again, he has to wait for all his eggs to hatch, so he sacrifices the slowpokes to free himself up for more baby-making."



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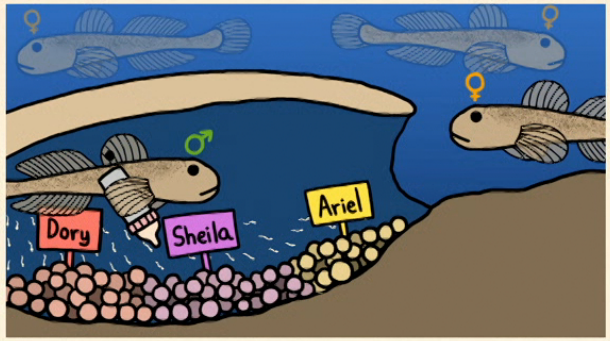


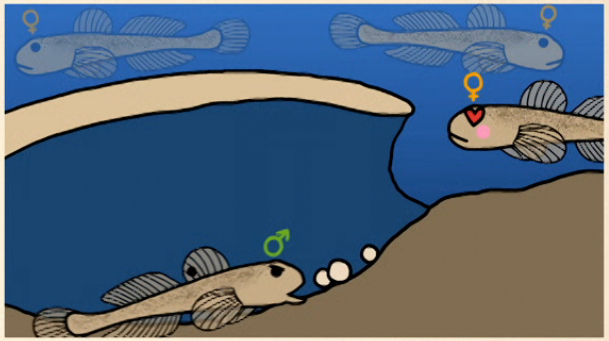

# Topic sentence dilemma

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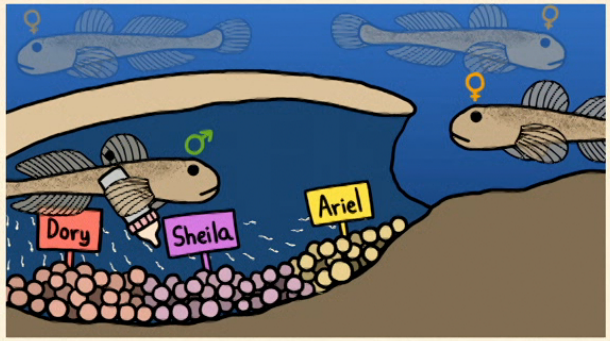
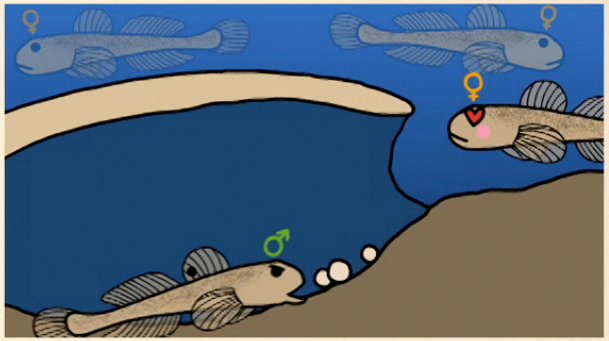
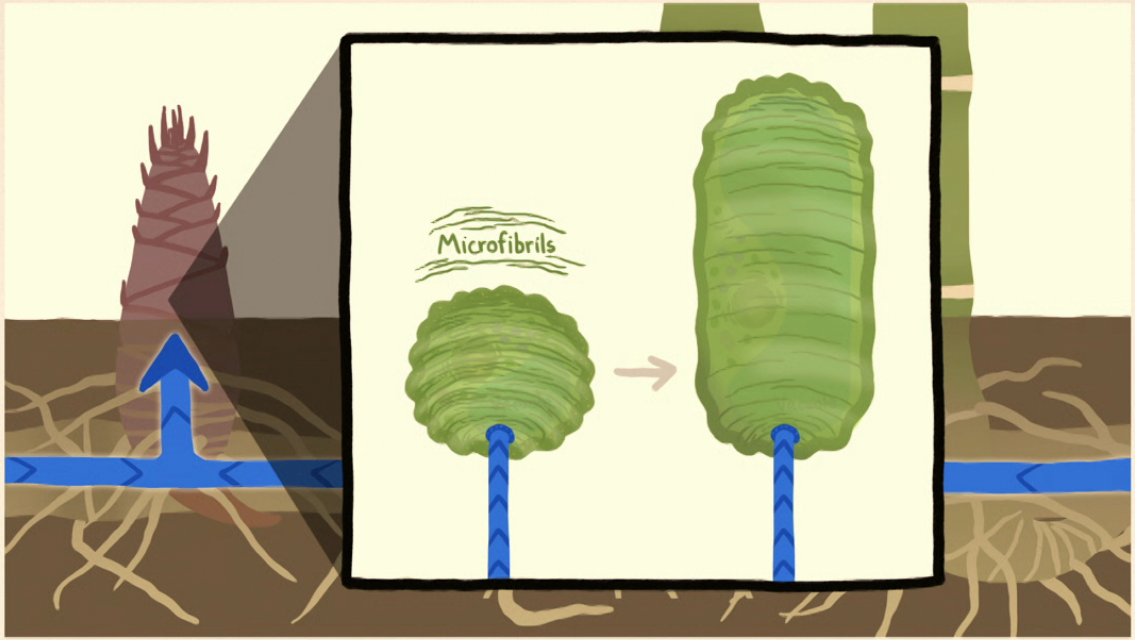


**Solution:** Silly generic representation of the topic sentence, then topic/video/subject-specific representation for the rest of the paragraph.

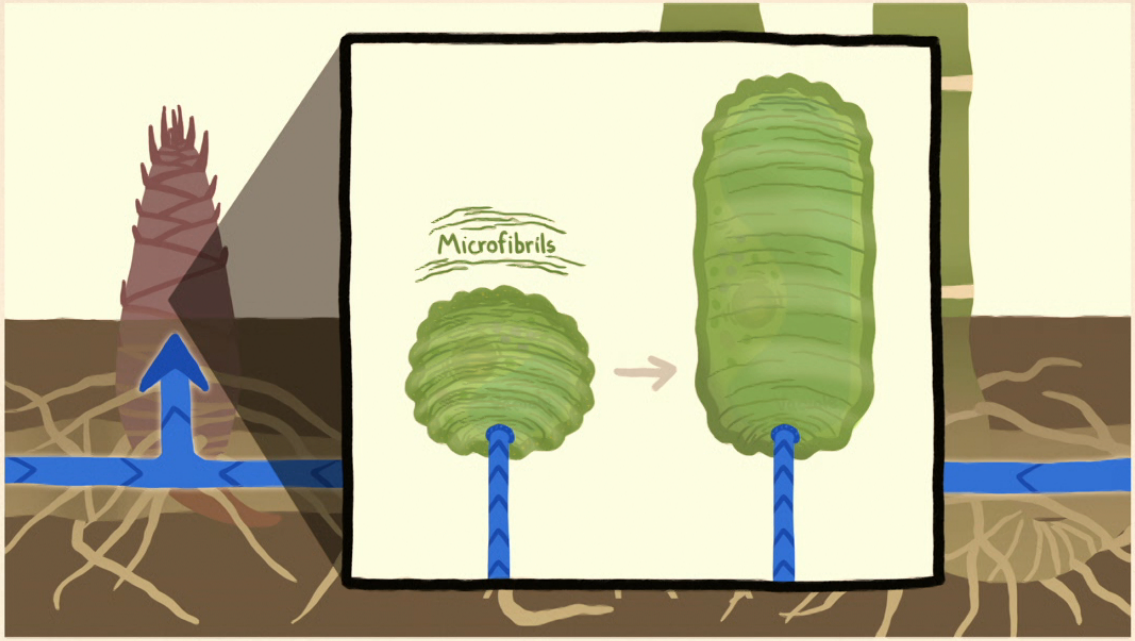
# Subject interruption

"On the cellular level, bamboo is basically made up of stretchy water balloons"



# Subject interruption

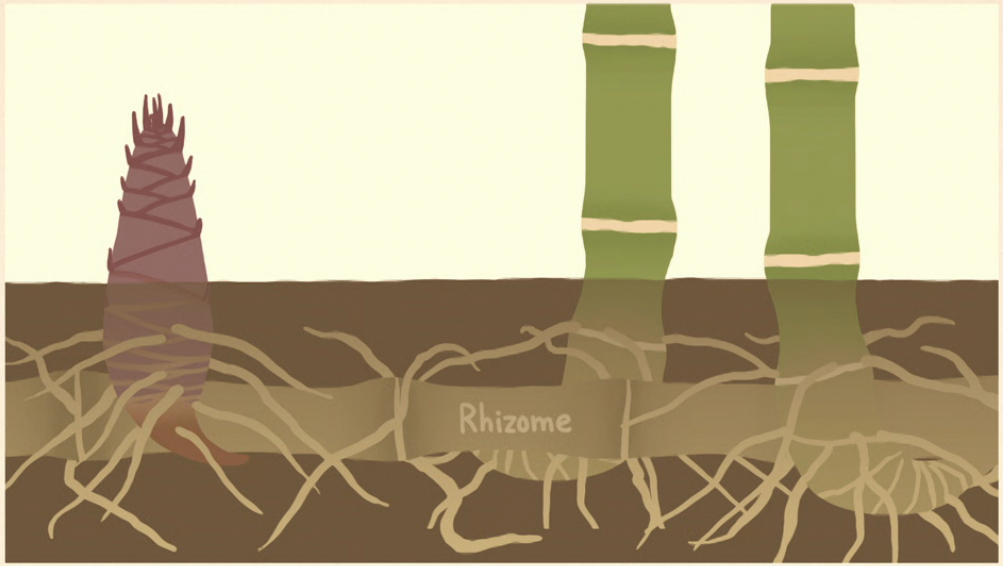
"On the cellular level, bamboo is basically made up of stretchy water balloons"




**Our Solution:** "Bamboo, on the cellular level, is basically made up of water balloons"

# Temporal Discontinuity

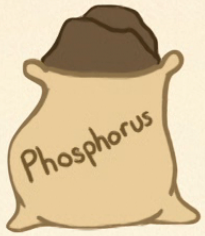
"When a bamboo bud peeks out of the ground, it's already as wide as it will be its entire life, meaning it will only grow upwards from here. Up until this point, the bamboo bud has been growing through cell division, but the bud now contains all the cells it needs to grow to its full height"




**Our Solution:** Rewrite to preserve chronology and scale

# Illustrating the Abstract

"The element phosphorus is critical for civilization: we couldn't eat without it, because plants (which are where most of our food comes from) need phosphorus in order to grow."



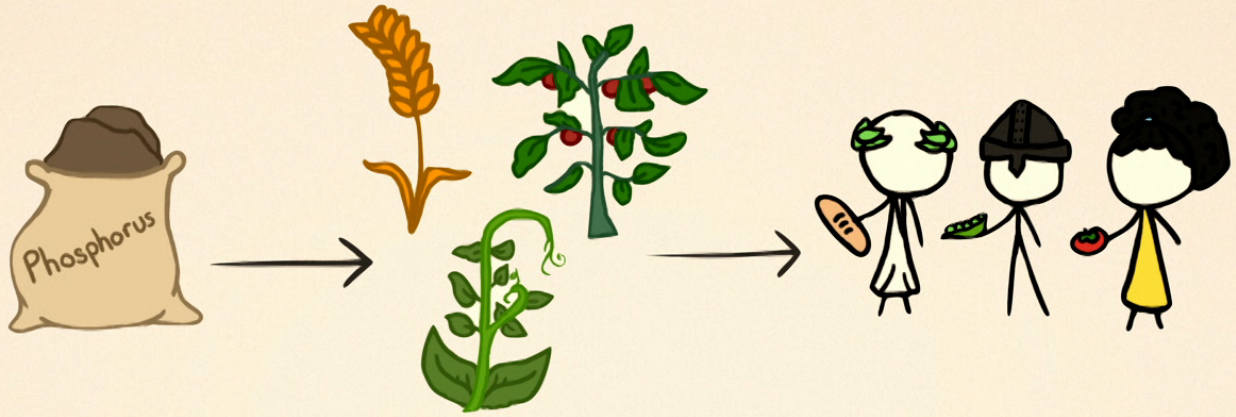
# Illustrating the Abstract

"The element phosphorus is critical for civilization: we couldn't eat without it, because plants (which are where most of our food comes from) need phosphorus in order to grow."

**Our Solution:** "The element phosphorus is important because without it we couldn't eat: plants need phosphorus in order to grow."

# Illustrating the Abstract

"The element phosphorus is critical for civilization: we couldn't eat without it, because plants (which are where most of our food comes from) need phosphorus in order to grow."



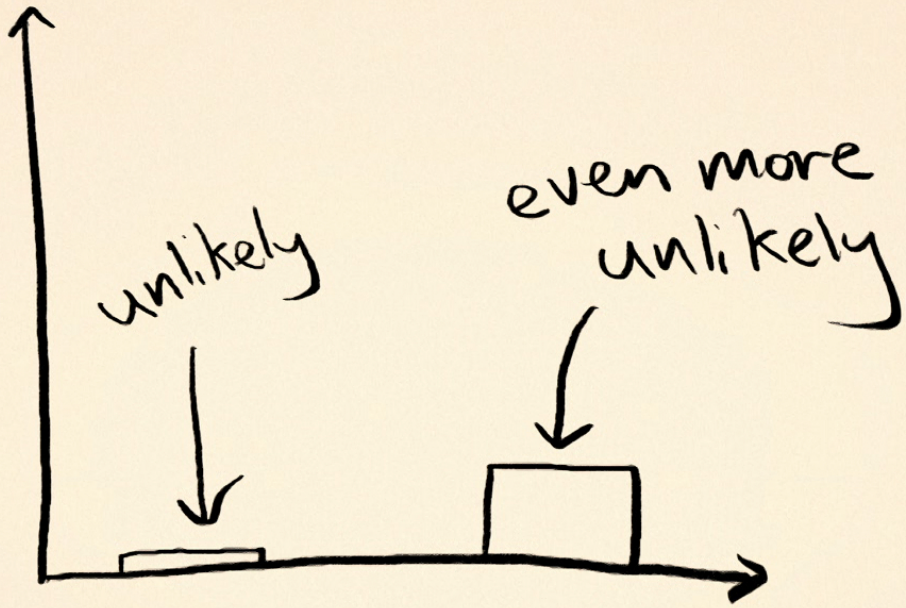

**Our Solution:** "The element phosphorus is important because without it we couldn't eat: plants need phosphorus in order to grow."

# Conflicting figures of Speech

"Getting struck by lightning is even more unlikely than string theory being right."

"Alice is not an eavesdropper."

"Bob is less amazing at Fourier decomposition than he would lead us to believe."



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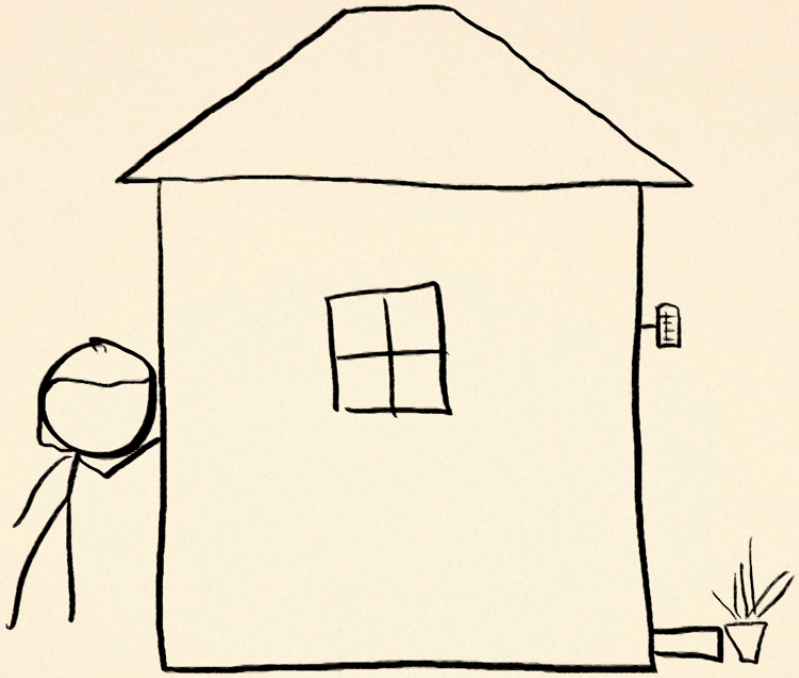

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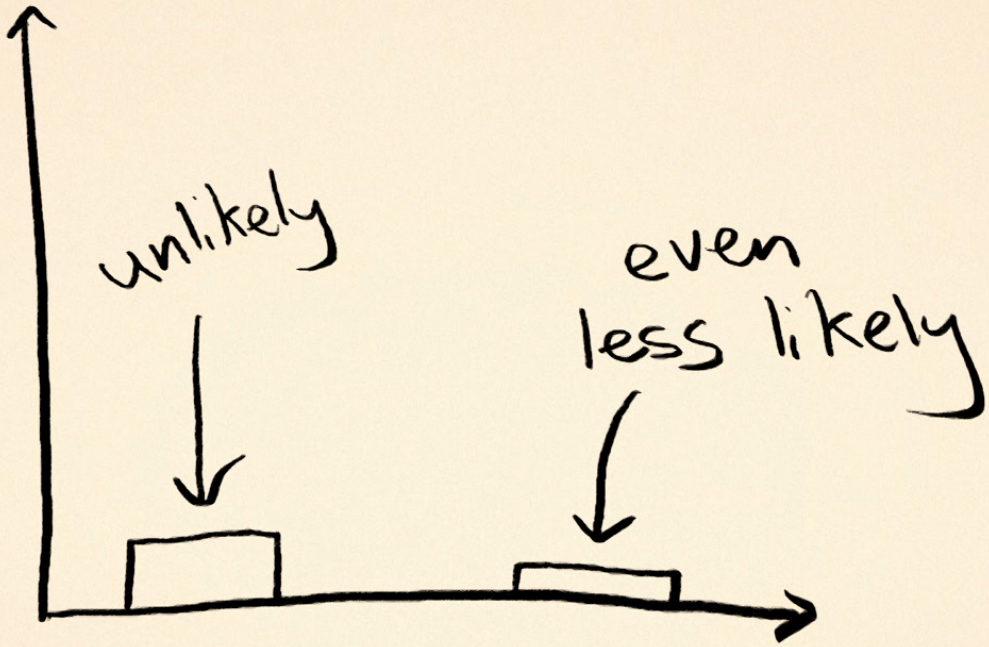
**Our Solutions:**

"Getting struck by lightning is even **less likely** than string theory being right."

"Unlike Eve, who *is* an eavesdropper, Alice is not."



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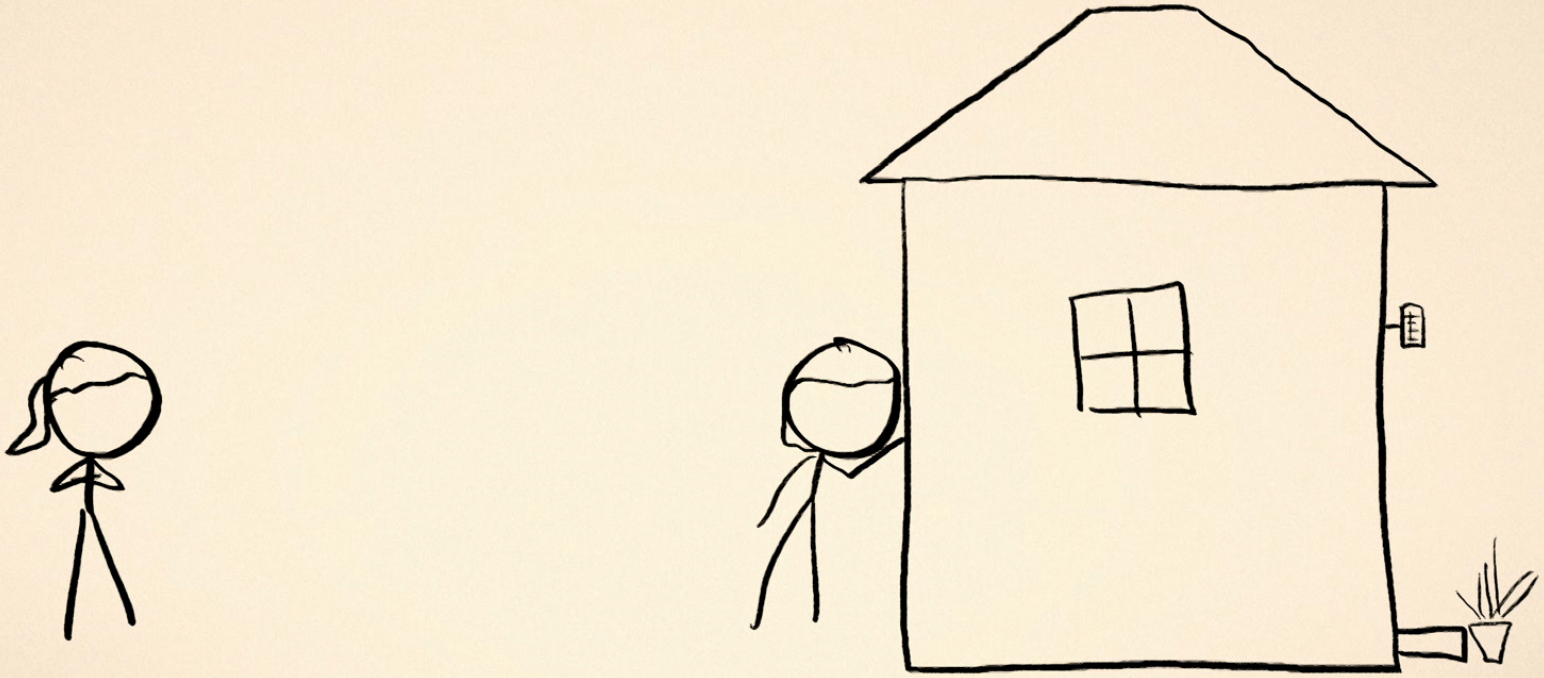
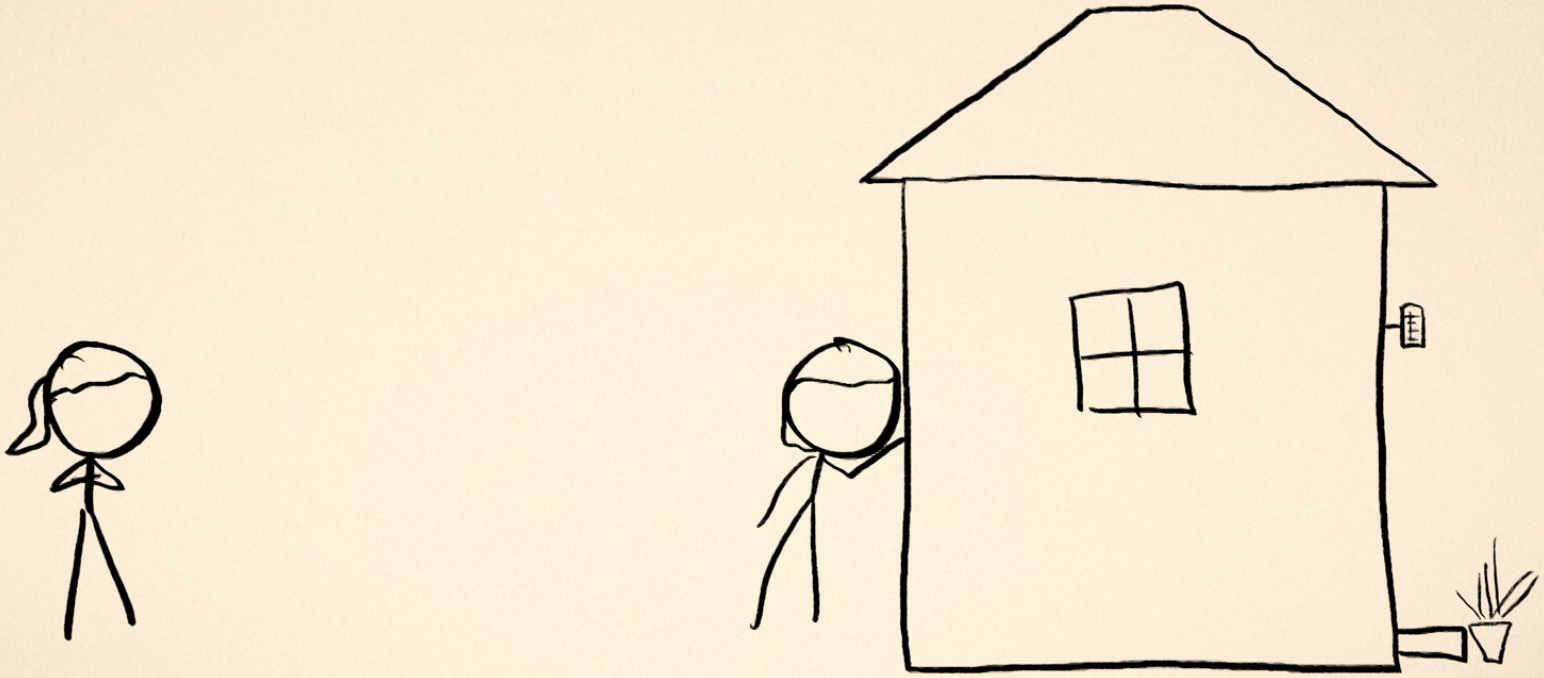


# Retroactive Syntactic Effect

**Gender is now part of the syntax of this presentation**

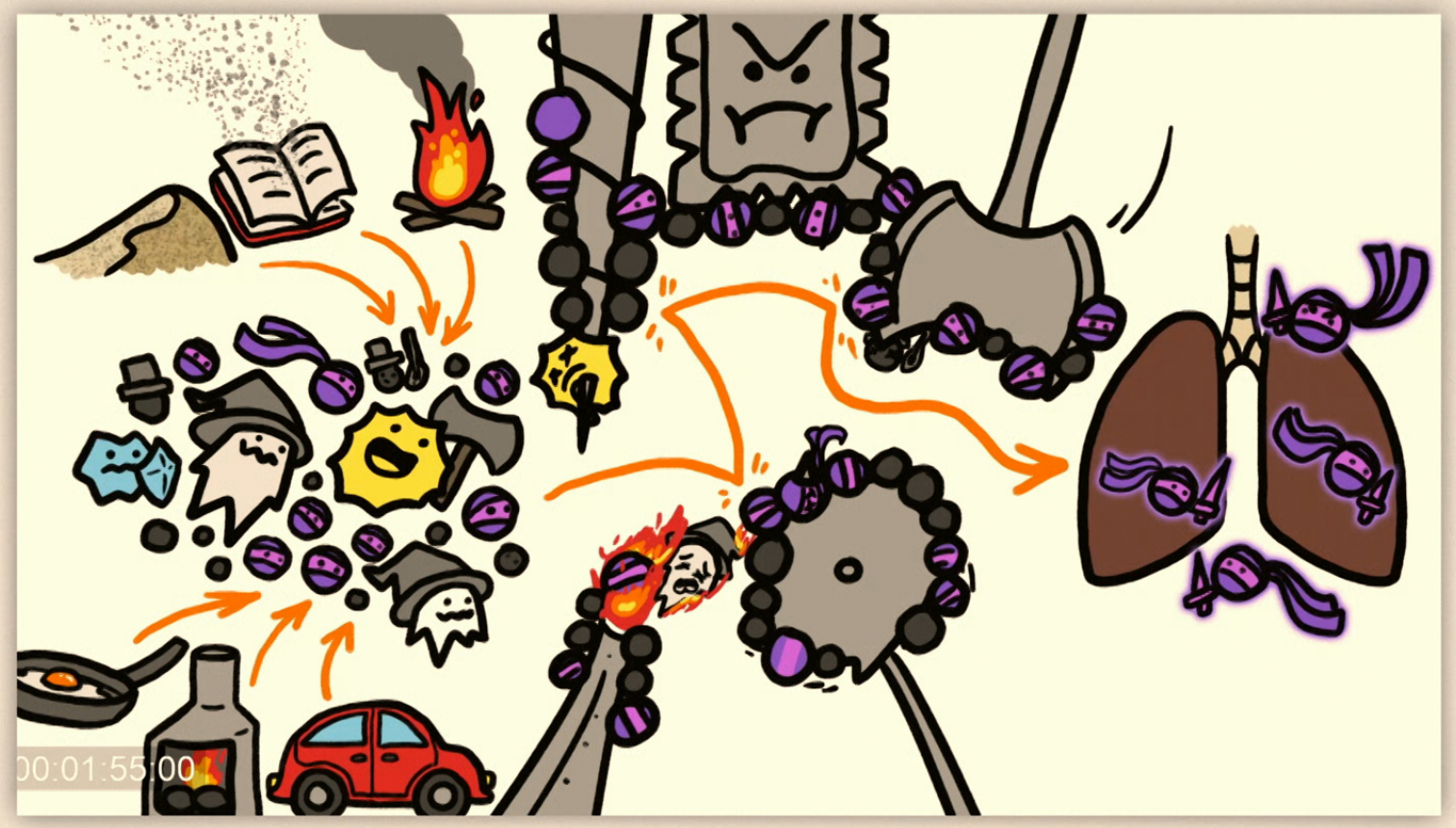


# "Reading off of your slides"

aka visuals that are too literal, too "on the nose"

"They built this city on rock and roll."

# When Decoration and Semantics collide



# Temporal Syntax (aka timing)

- Show people what they **want** to see, when they want to see it
  - *subverting this can create tension*
- Flesh out/represent ideas more fully (ie show people what they **need** to see, when they need to see it)
  - *subverting this can create confusion*
- Create semantic association between aural & visual elements

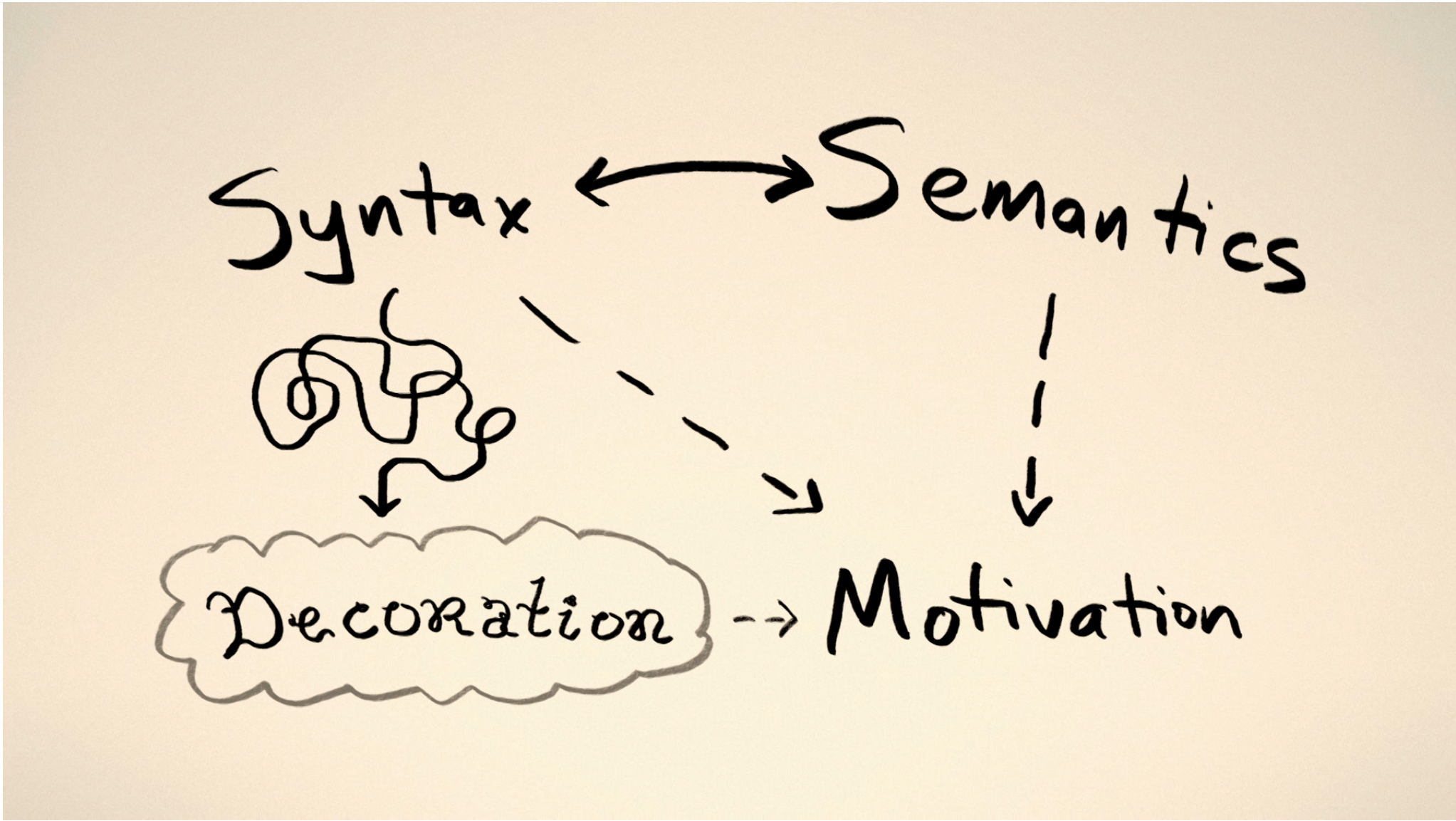
# Which came first: the sound or the picture?

- "Subservient anticipates dominant"
- In the real world (& world of narrative film): vision is typically dominant and sound is subservient; sound comes first.
- In the world of voiceovers and narration: sound is dominant and vision is subservient; visuals come first.

Visuals follow audio

# Assignment of meaning by correlation of timings

- Roughly speaking, tighter correlation = more direct semantic association
- Tight = visuals appear precisely with/before each word
- Loose = visuals appear loosely with/before phrases or sentences


Syntax
Semantics
Decoration
Motivation