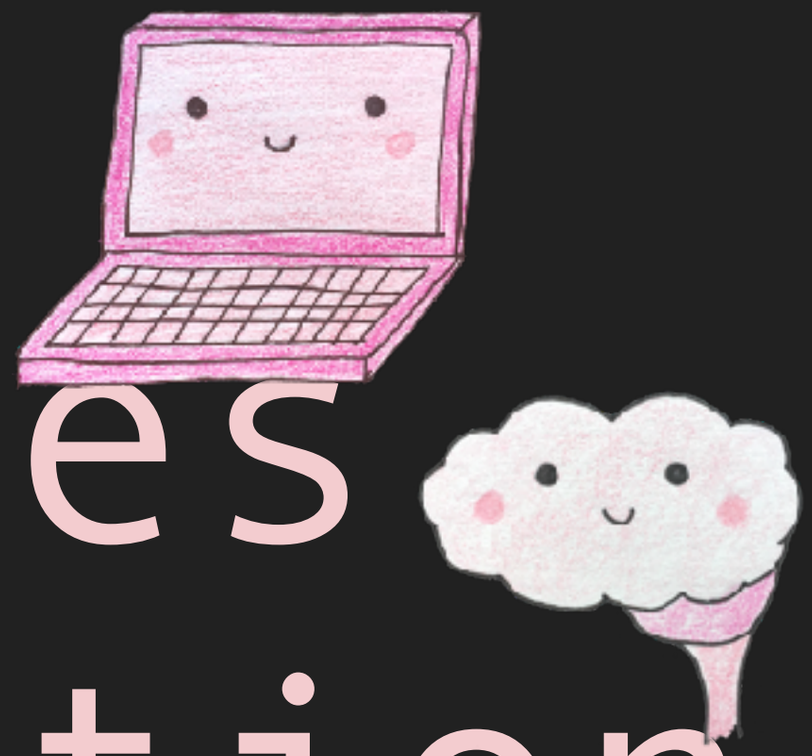
From Parentheses To Perception



How Your Code Becomes Another's Reality

Jenna Zeigen

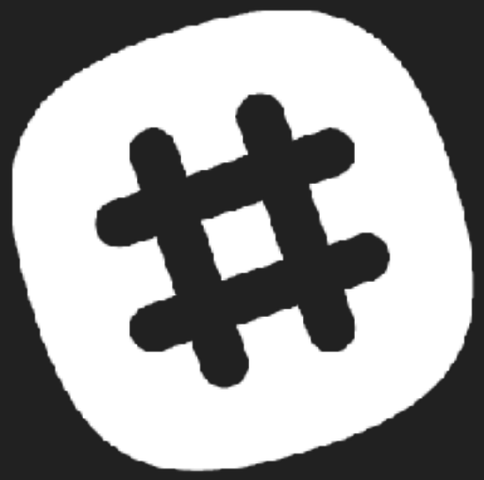
Node+JS Interactive 2018

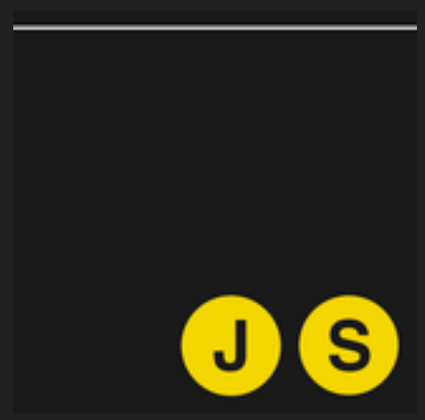
October 11, 2018

Senior Frontend Engineer
at Slack

Organizer of EmpireJS

Organizer of BrooklynJS





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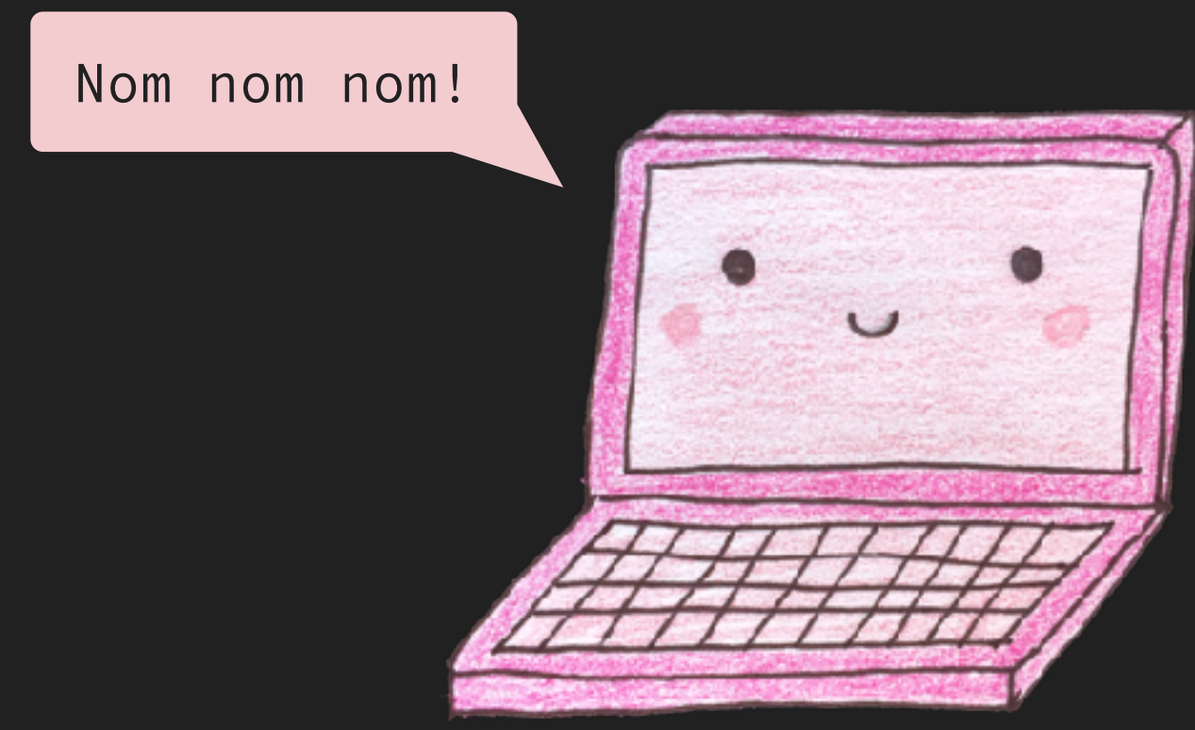
@zeigenvector

```
<button
  type="button"
  class="Button send-button"
>
  Send
</button>

.Button {
  font-size: 16px;
  background: #128853;
  color: #fff;
  border-radius: 5px;
}

const button =
  document.querySelector('.send-button');
button.addEventListener('click', onBtnClick);
```




Send
This is a button and I know I can click it and it'll do something!

1. Parsing
2. Rendering
3. Perceiving
4. Comprehending

1. Parsing
2. Rendering
3. Perceiving

4. Comprehending

1. Parsing
2. Rendering
3. Perceiving
4. Comprehending

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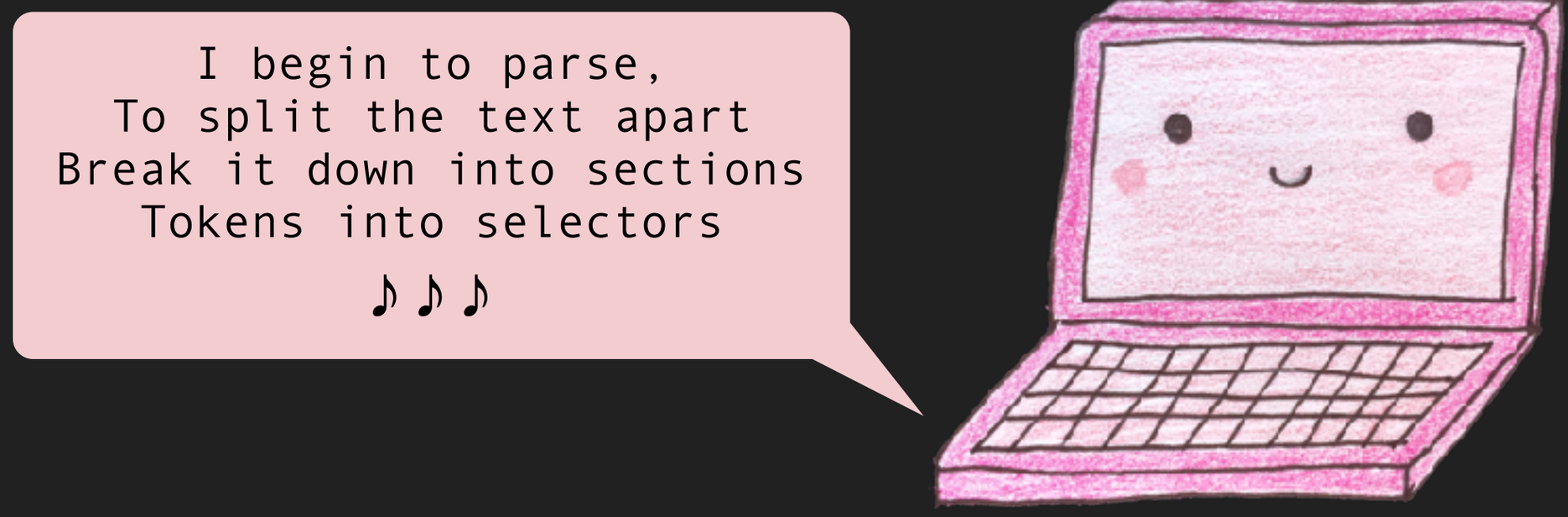
We made computers so we know all the answers.

We do science on humans to get closer to the answers.

Parsing

How does the browser process HTML, CSS, and JavaScript?



The Notorious B.I.G. – Sky's The Limit

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Parsing

Most programming languages have a vocabulary described using regular expressions and a syntax described by a context-free grammar.

https://www.html5rocks.com/en/tutorials/internals/howbrowserswork
https://en.wikipedia.org/wiki/Context-free_grammar
MC Hammer - U Can't Touch This

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Parsing

Parsers take a document and break it into a structure the browser can use.

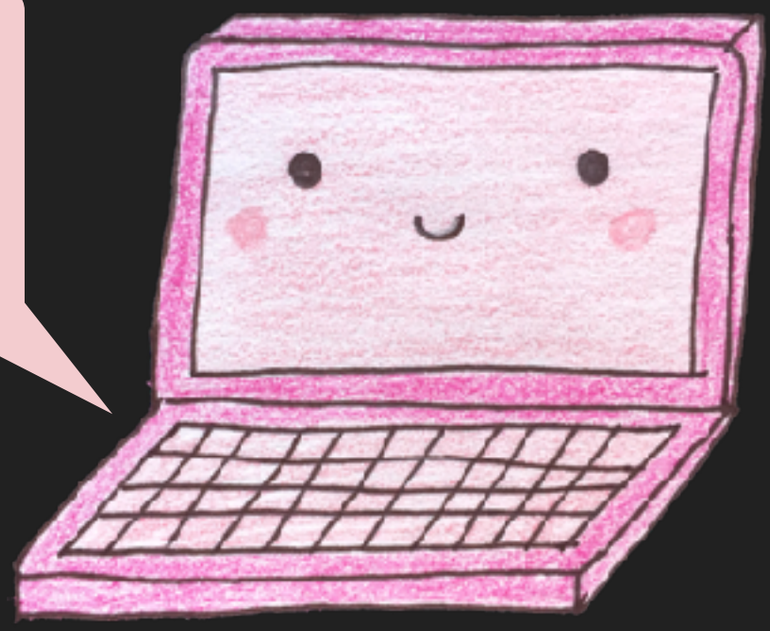
https://www.html5rocks.com/en/tutorials/internals/howbrowserswork
Ashlee Simpson - Pieces of Me

Parsing

Parsing can be separated into two parts— lexical and syntactic analysis— which are performed by a lexer and parser, respectively

This is the parse of me
That you're never gonna ever
Take away from me, no!

♪ ♪ ♪



https://www.html5rocks.com/en/tutorials/internals/howbrowserswork
Katy Perry - Part of Me

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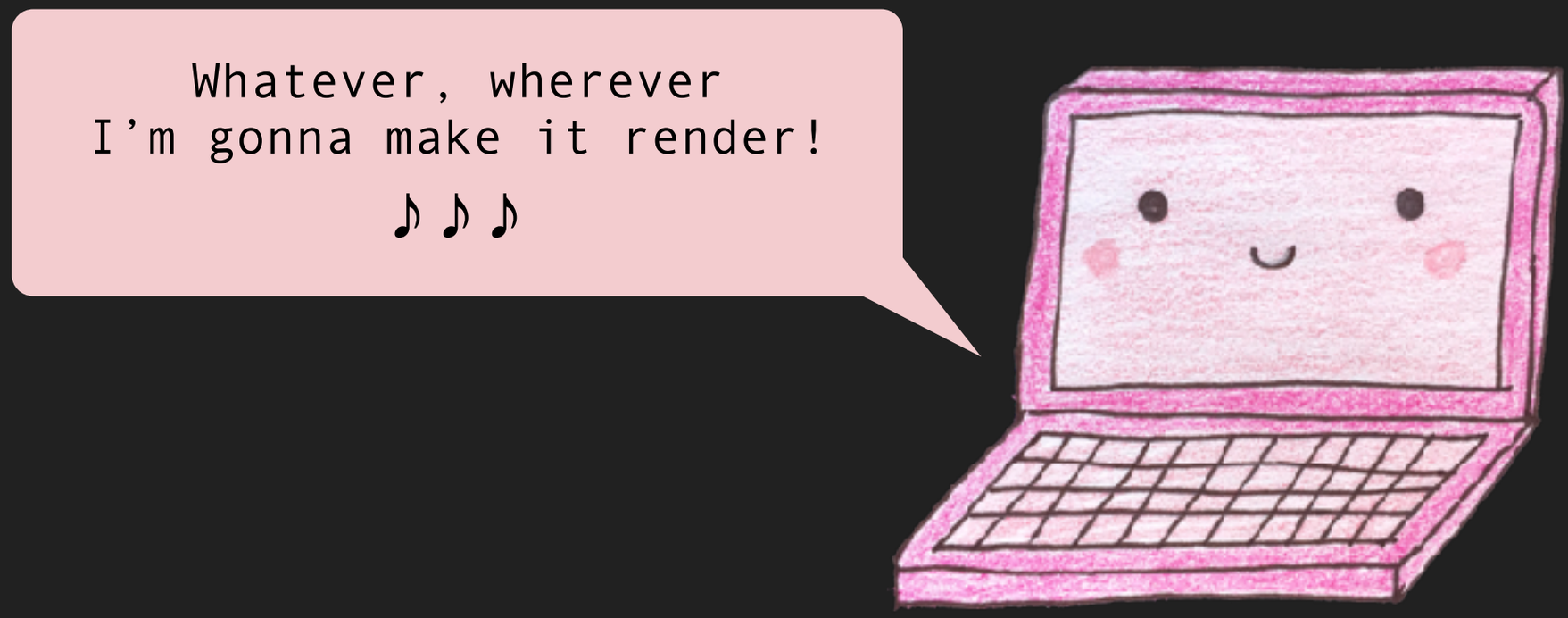
Parsing

HTML isn’t a context-free language and therefore can’t be parsed by a regular parser



https://www.html5rocks.com/en/tutorials/internals/howbrowserswork
Shakira - Whenever, Wherever

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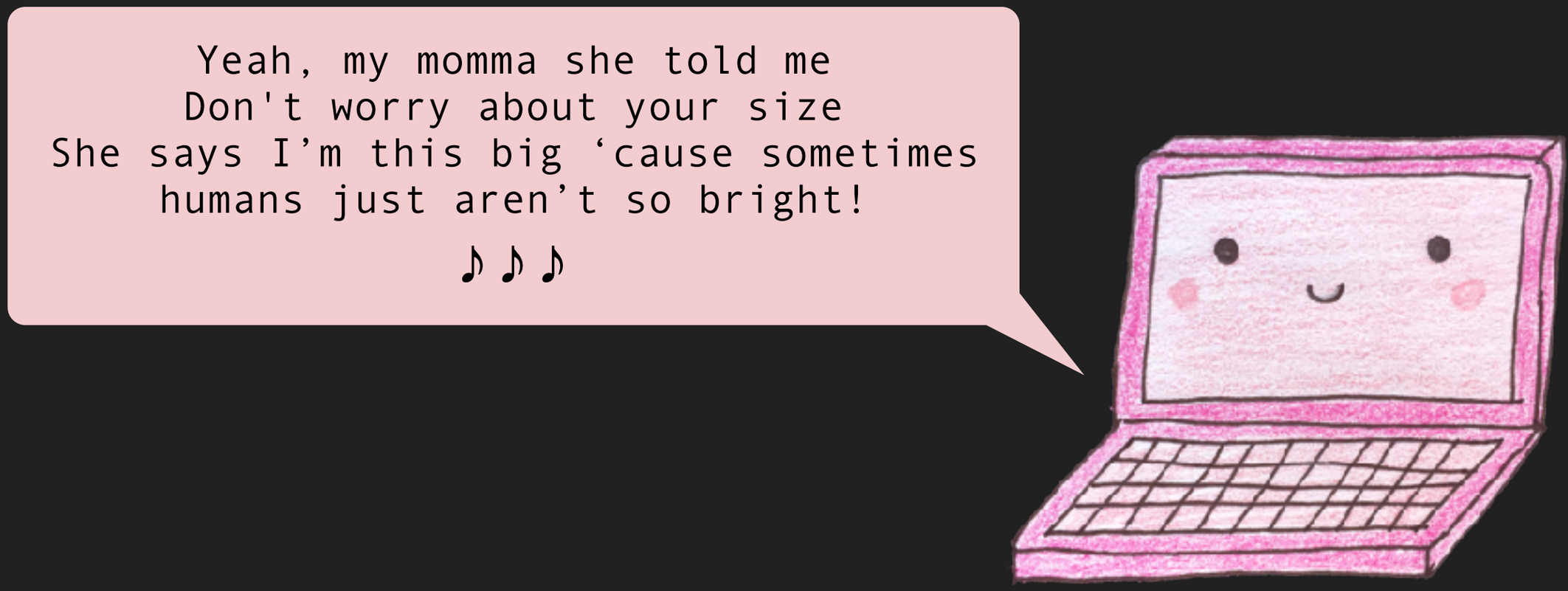
Parsing

Instead, browsers write custom parsers for HTML



https://www.html5rocks.com/en/tutorials/internals/howbrowserswork
Meghan Trainor - All About That Bass

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Parsing

CSS is a context-free language
and therefore easier to parse.

https://www.html5rocks.com/en/tutorials/internals/howbrowserswork
Snoop Dogg & Wiz Khalifa ft. Bruno Mars - Young, Wild, & Free

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Parsing

Both HTML and CSS parsers end up building a tree representing the language it parsed, the DOM and CSSOM trees

https://www.html5rocks.com/en/tutorials/internals/howbrowserswork
The Foundations - Build Me Up Buttercup

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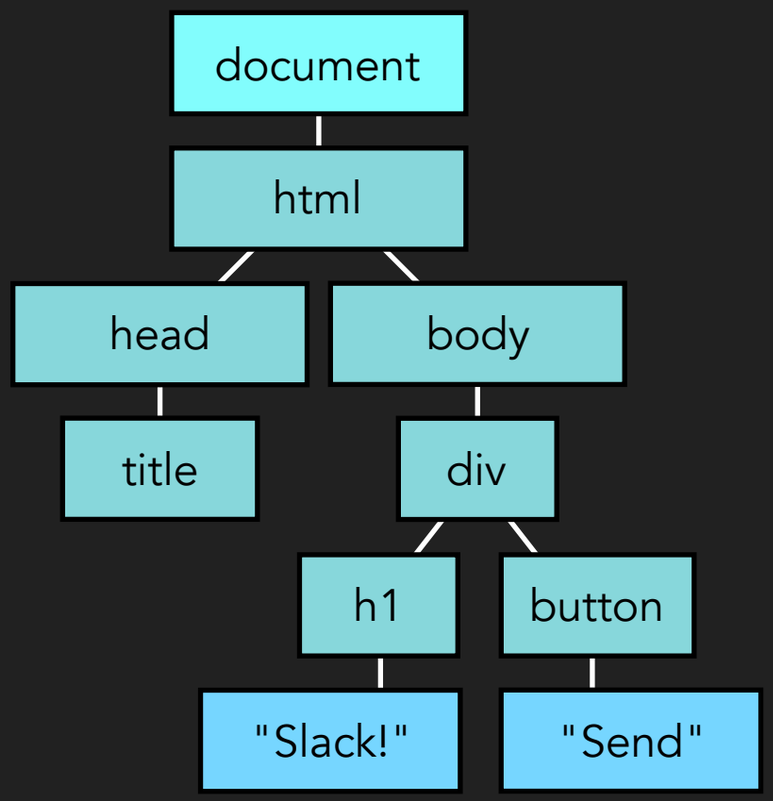
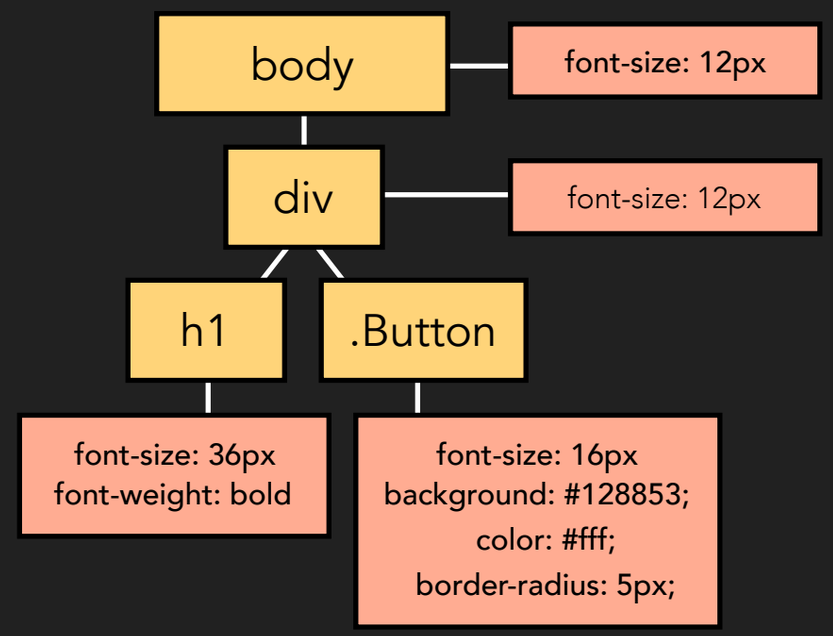
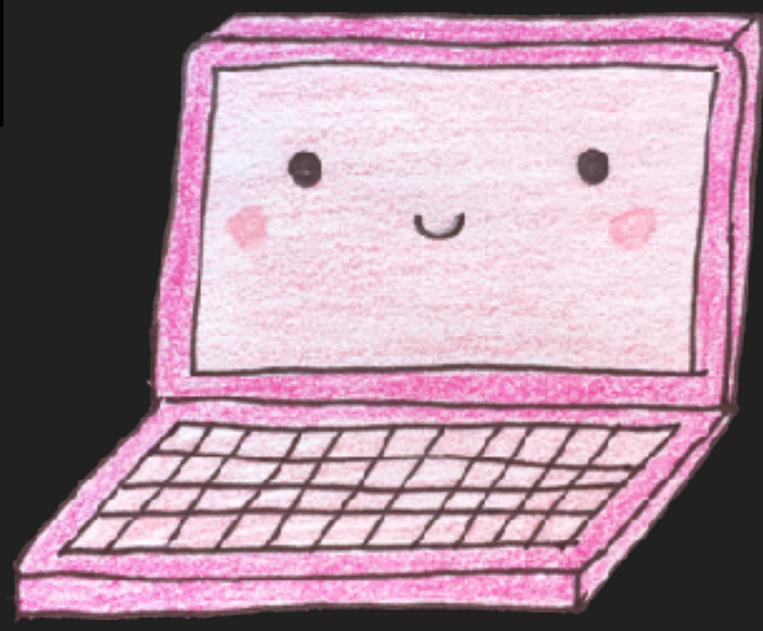
Parsing







https://www.html5rocks.com/en/tutorials/internals/howbrowserswork

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Parsing

JavaScript is also context-free and can use a regular parser, but browsers complicate things in order to optimize

http://www.ecma-international.org/ecma-262/#sec-notational-conventions
https://www.youtube.com/watch?v=Fg7niTmNNLg
Daft Punk - Harder, Better, Faster, Stronger

Parsing

V8 uses two parsers— eager and lazy— to eventually create an abstract syntax tree and scope structure

Scripty's now an abstract syntax tree
Thanks, smart parser (smart parser!)...

♪ ♪ ♪

https://www.youtube.com/watch?v=Fg7niTmNNLg
Flo Rida - Low

Parsing

The AST and scope structures get turned into low-level code

The next step is the baseline compiler
It made bytecode (it made bytecode!)
Next thing you know
Scripty got low-low-low
Low-low-low-low-low

♪ ♪ ♪

https://www.youtube.com/watch?v=Fg7niTmNNLg
Flo Rida - Low

Parsing

The low-level code then gets executed

Interpreted by Ignition
Your code's coming to fruition
♪ ♪ ♪

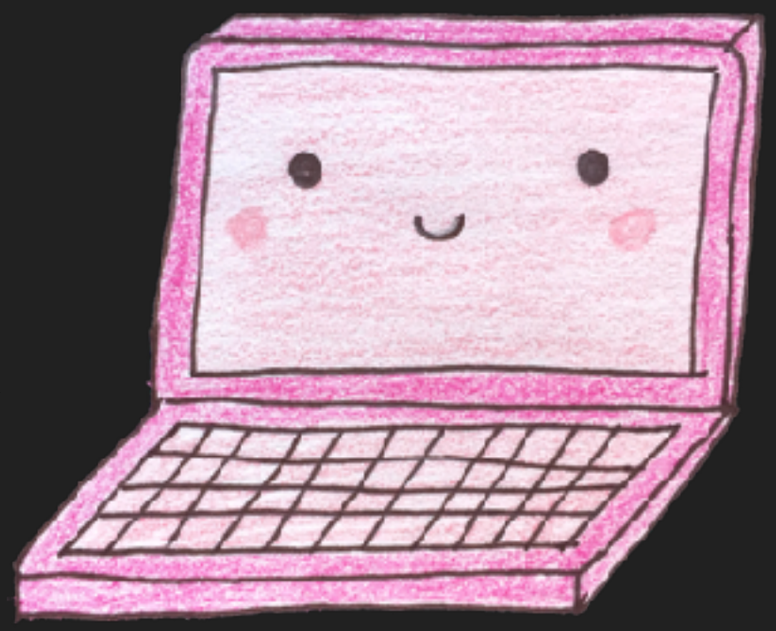
https://www.youtube.com/watch?v=Fg7niTmNNLg
R Kelly - Ignition

Parsing

The bytecode also gets fed to the optimizing compiler which spits out machine code

Who can say where that byte goes
Turbofan does, at runtime
And who can say if your code flows
Turbofan knows, just-in-time

♪ ♪ ♪



https://www.youtube.com/watch?v=p-iiEDtpy6I
Enya - Only Time

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Rendering

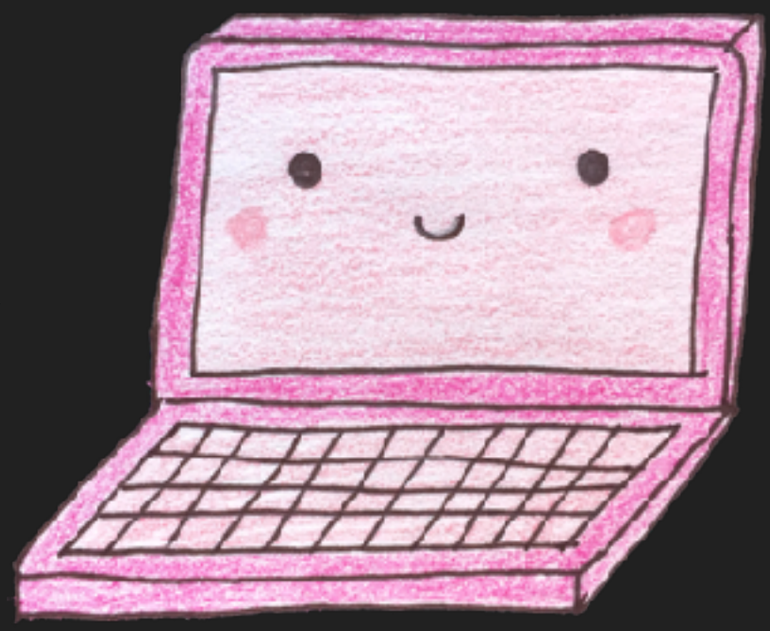
How does the browser put pixels on the screen and move ‘em around?

Counting Crows - Mr. Jones

Rendering

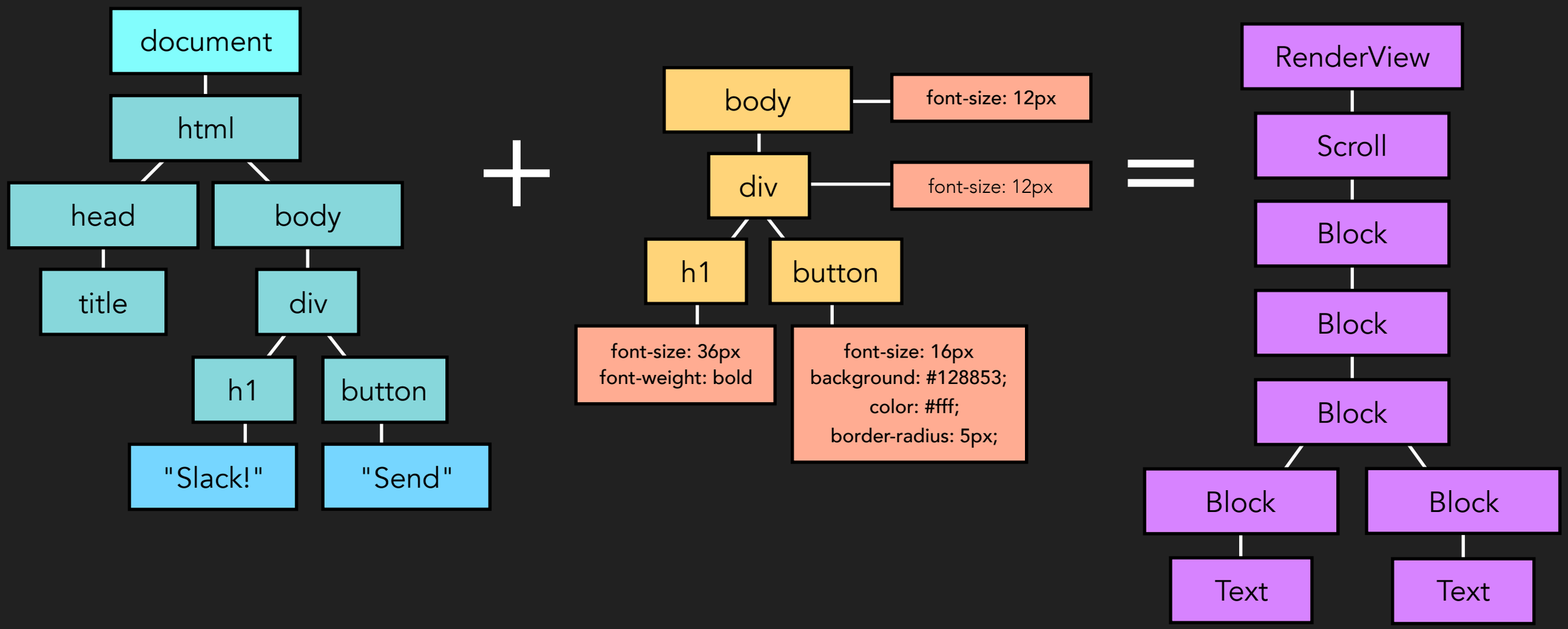
The DOM and CSSOM trees are combined to form the render tree

O render tree,
O render tree
How lovely are thy branches
♪ ♪ ♪



https://developers.google.com/web/fundamentals/performance/critical-rendering-path/render-tree-construction
https://en.wikipedia.org/wiki/O_Tannenbaum

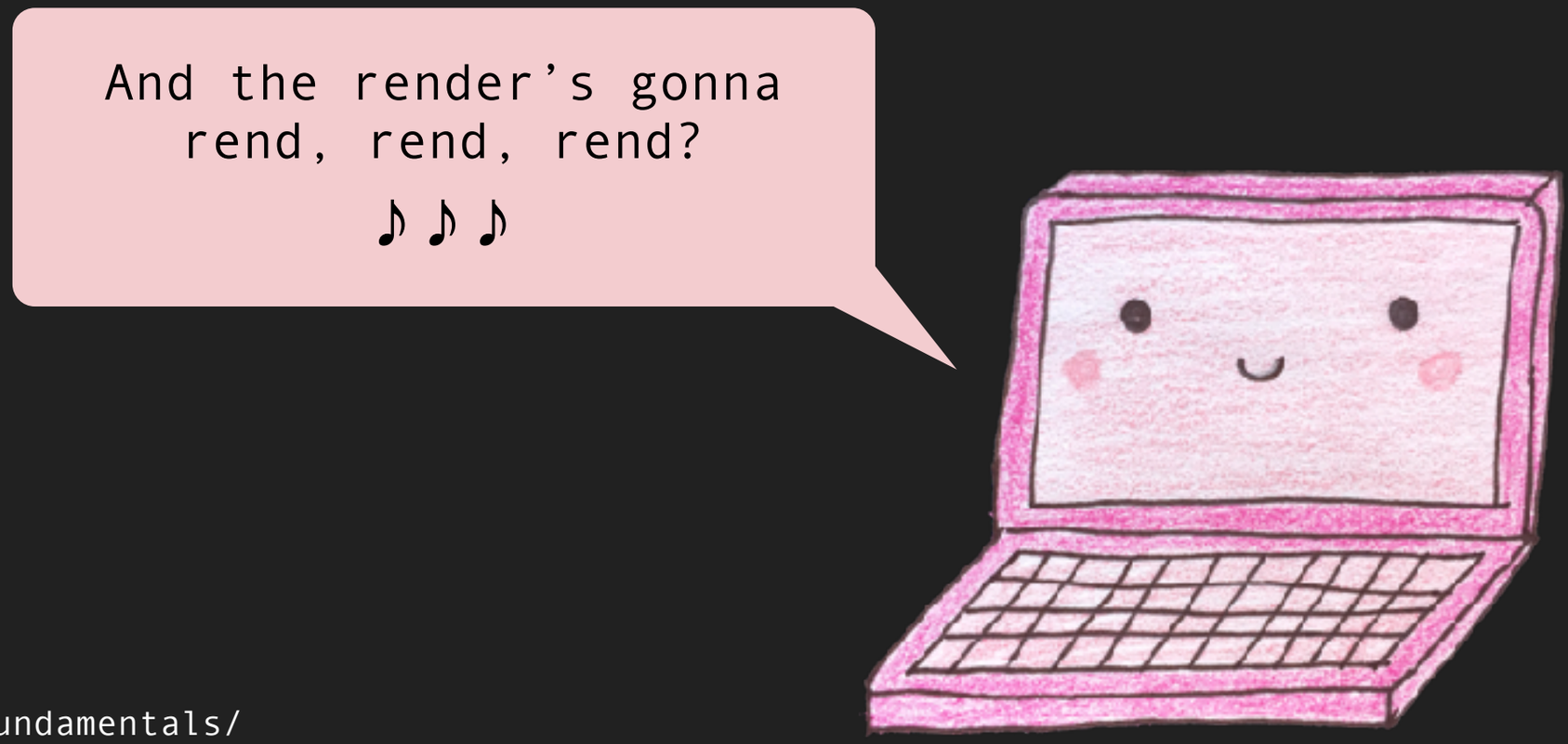
Rendering



https://developers.google.com/web/fundamentals/performance/critical-rendering-path/render-tree-construction

Rendering

The browser traverses the render tree, calculating the location and size of all elements

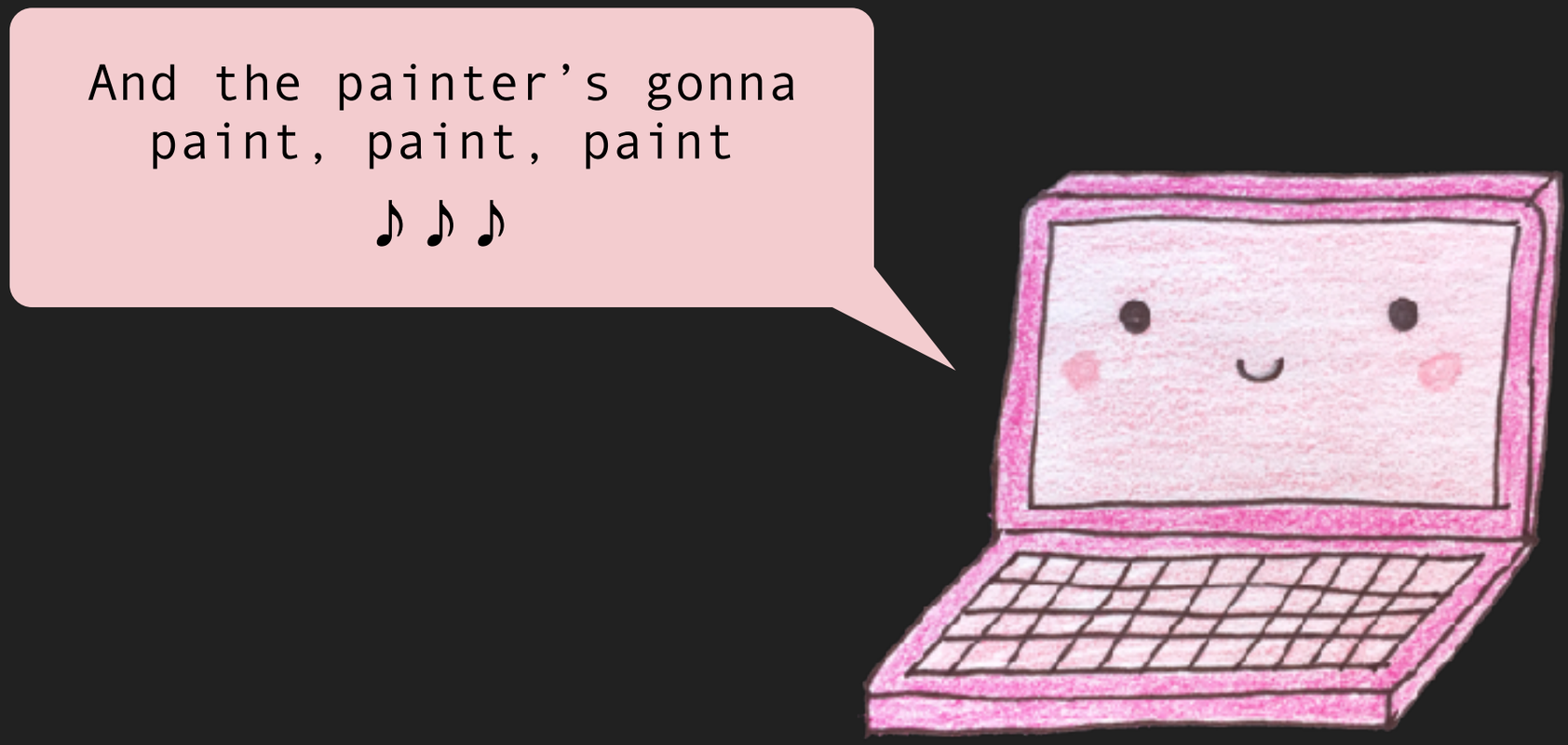


https://developers.google.com/web/fundamentals/performance/critical-rendering-path/render-tree-construction

Taylor Swift - Shake it Off

Rendering

The browser again traverses the render tree, creating bitmaps for each layer



https://www.youtube.com/watch?v=gqc88qWuiI4
Taylor Swift - Shake it Off

Rendering

Bitmaps are sent to the GPU for compositing

https://www.youtube.com/watch?v=gqc88qWuiI4
https://www.html5rocks.com/en/tutorials/speed/layers/
Taylor Swift - Shake it Off

Rendering

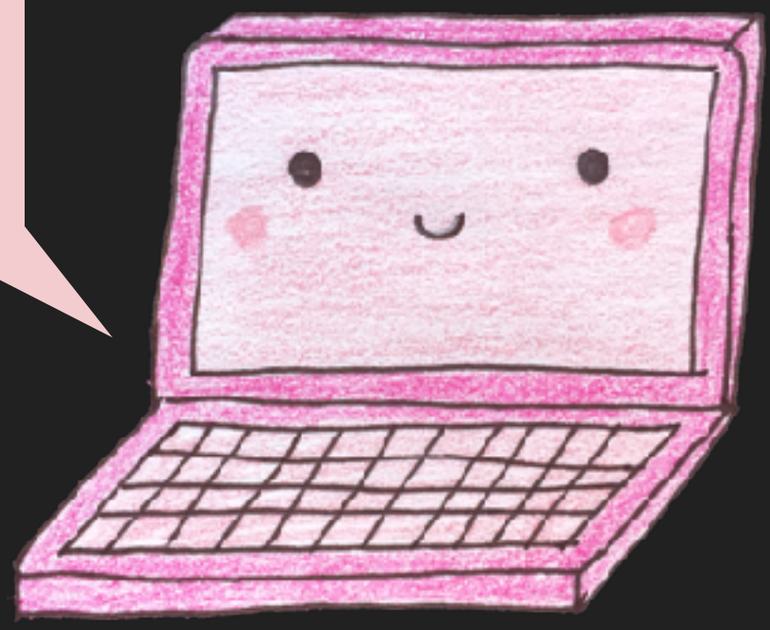
The browser repeats the process, maybe 60 times a second

https://www.html5rocks.com/en/tutorials/speed/layers/
Katy Perry - Last Friday Night (T.G.I.F.)

Rendering

JavaScript runs on the browser's main thread with everything else

Loop loop ba-doop loop ba-doop
Loop ba-doop ba-doop
Ba-doop loop ba-doop loop
Ba-doop loop ba-doop, ba-doop, ba-doop
♪ ♪ ♪



https://www.youtube.com/watch?v=p-iiEDtpy6I
Salt-N-Pepa - Shoop

Perceiving

How does the brain paint pictures of the world and recognize what we see?

It’s beautiful
It’s beautiful
It’s beautiful, it's true
This interface, it’s a crowded place
But I know just what to do
♪ ♪ ♪

https://en.wikipedia.org/wiki/Visual_system
James Blunt - You’re Beautiful

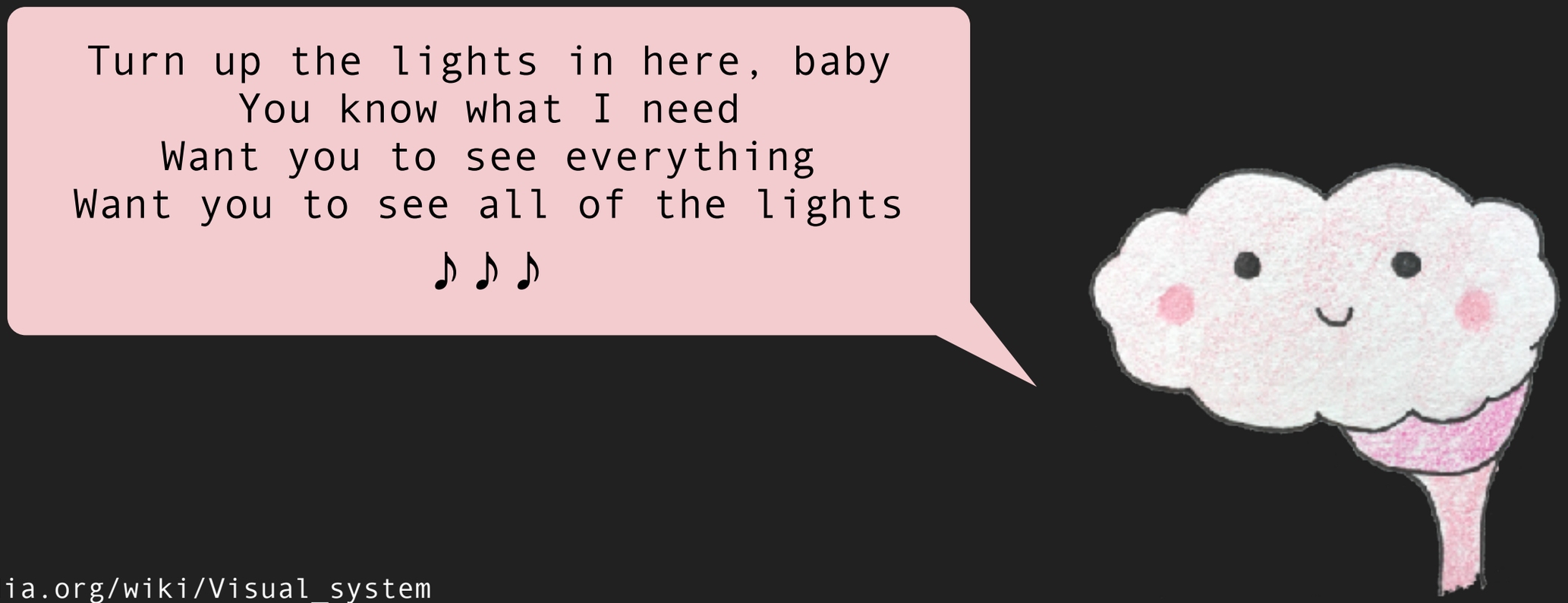
Perceiving

Light goes into the eye via the cornea and lens

https://en.wikipedia.org/wiki/Visual_system
Johnny Nash - I Can See Clearly Now

Perceiving

The retina turns the light into neural signals using rods and cones



https://en.wikipedia.org/wiki/Visual_system
https://en.wikipedia.org/wiki/Flicker_fusion_threshold
Kanye West - All of the Lights

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Perceiving

The neural signals get sent via the optic nerve to the brain

The signals that we send
Over the nerves
Over the nerves
Over the nerves
Over the nerves.

♪ ♪ ♪

https://en.wikipedia.org/wiki/Visual_system
Thursday - Signals Over the Air

Perceiving

Signals from both eyes reach the optic chiasm, are combined, split by visual field, and sent to the opposite side of the brain

Why don’t you just meet me in the middle,
In the middle

♪ ♪ ♪

https://en.wikipedia.org/wiki/Visual_system
Zedd, Maren Morris, Grey - The Middle

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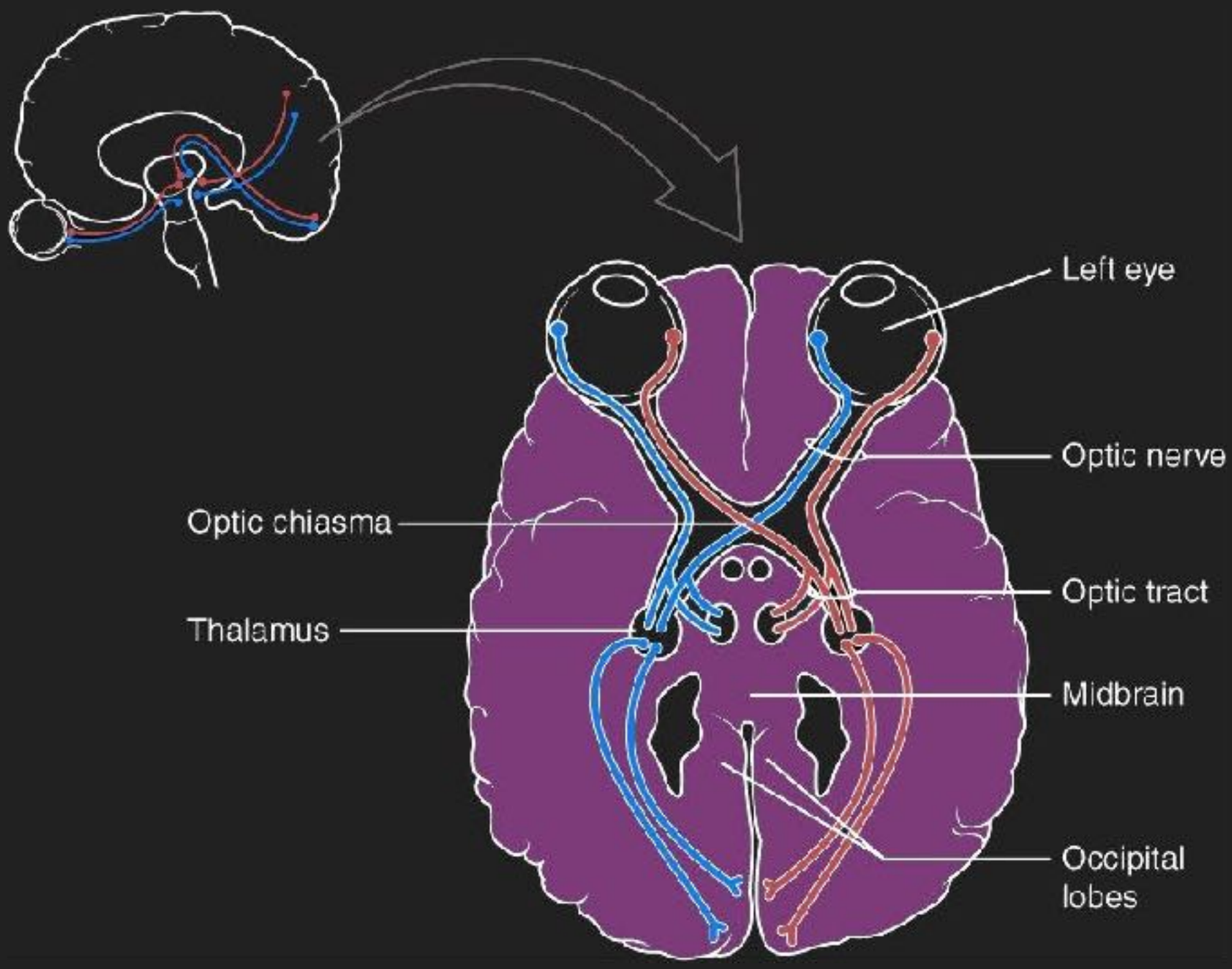
Perceiving



https://commons.wikimedia.org/wiki/File:1204_Optic_Nerve_vs_Optic_Tract.jpg

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Perceiving

Most signals get sent to the lateral geniculate nuclei, which collates information from different eyes

I've looked at life from both sides now
From left and right and still somehow
♪ ♪ ♪

Blake, R., & Sekuler, R. (2006)
Joni Mitchell - Both Sides Now

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Perceiving

Signals then get sent to the primary visual cortex

Blake, R., & Sekuler, R. (2006)
Lady Gaga - Edge of Glory

Perceiving

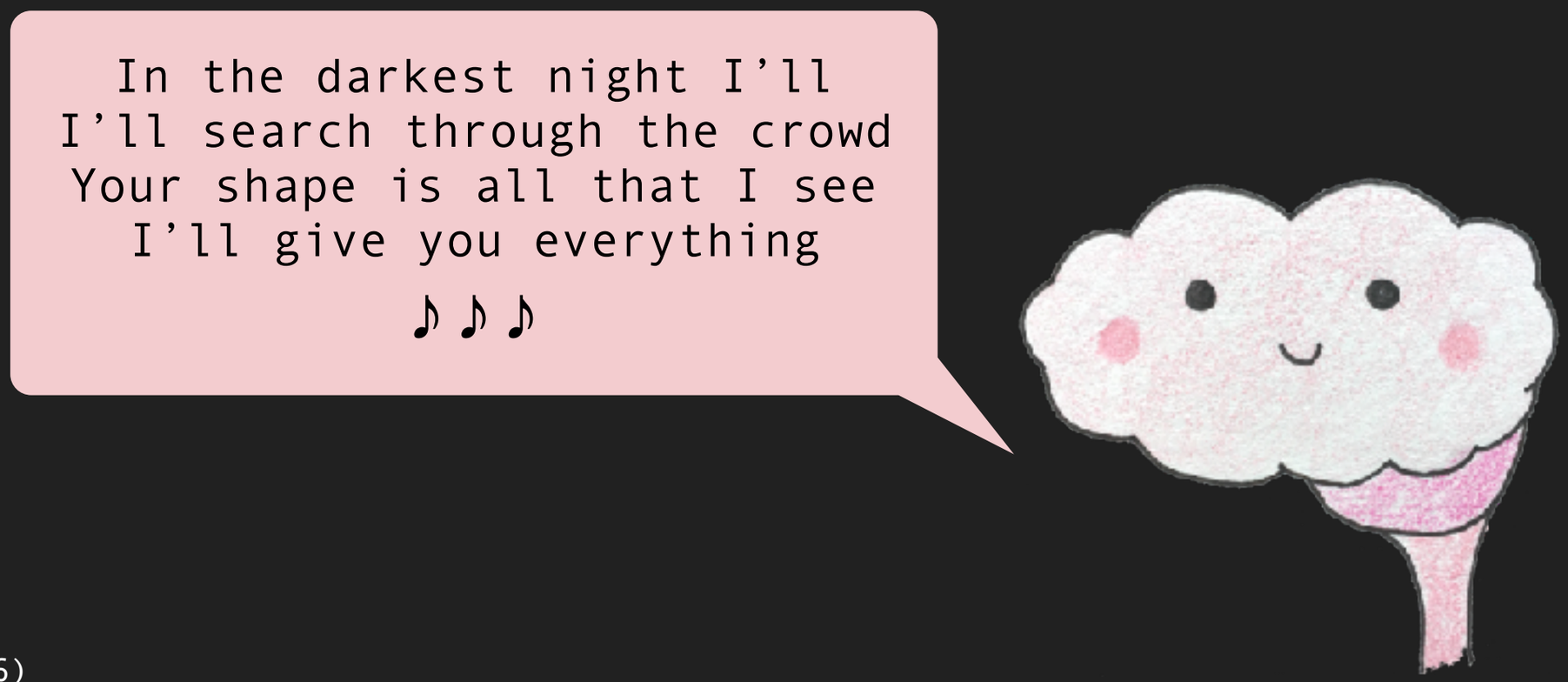
Signals gets sent to higher visual processing centers that help us actually perceive what we are seeing

It's the way I see
Everything I need
…
Higher and higher and higher
Higher and higher and higher
♪ ♪ ♪

Blake, R., & Sekuler, R. (2006)
Passion Pit - Little Secrets

Perceiving

We start to figure out what is background and what are different objects



Blake, R., & Sekuler, R. (2006)
Kellogg (2007)
Beyoncé - XO

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Perceiving

We translate data about different regions into data about different forms, such as size and shape

Every day discovering something brand new
I can discern the shape of you

♪ ♪ ♪

(no, not <form>s, silly)

Blake, R., & Sekuler, R. (2006)
Ed Sheehan - Shape of You

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Perceiving

Then, we start to recognize and identify objects.

Send

Suddenly I see (suddenly I see)
What that's supposed to be
Suddenly I see (suddenly I see)
Why the hell it means so much to me
♪ ♪ ♪

Blake, R., & Sekuler, R. (2006)
KT Tunstall - Suddenly I See

Perceiving

Our minds take choppy, discrete inputs and create a seamless experience that we perceive as continuous

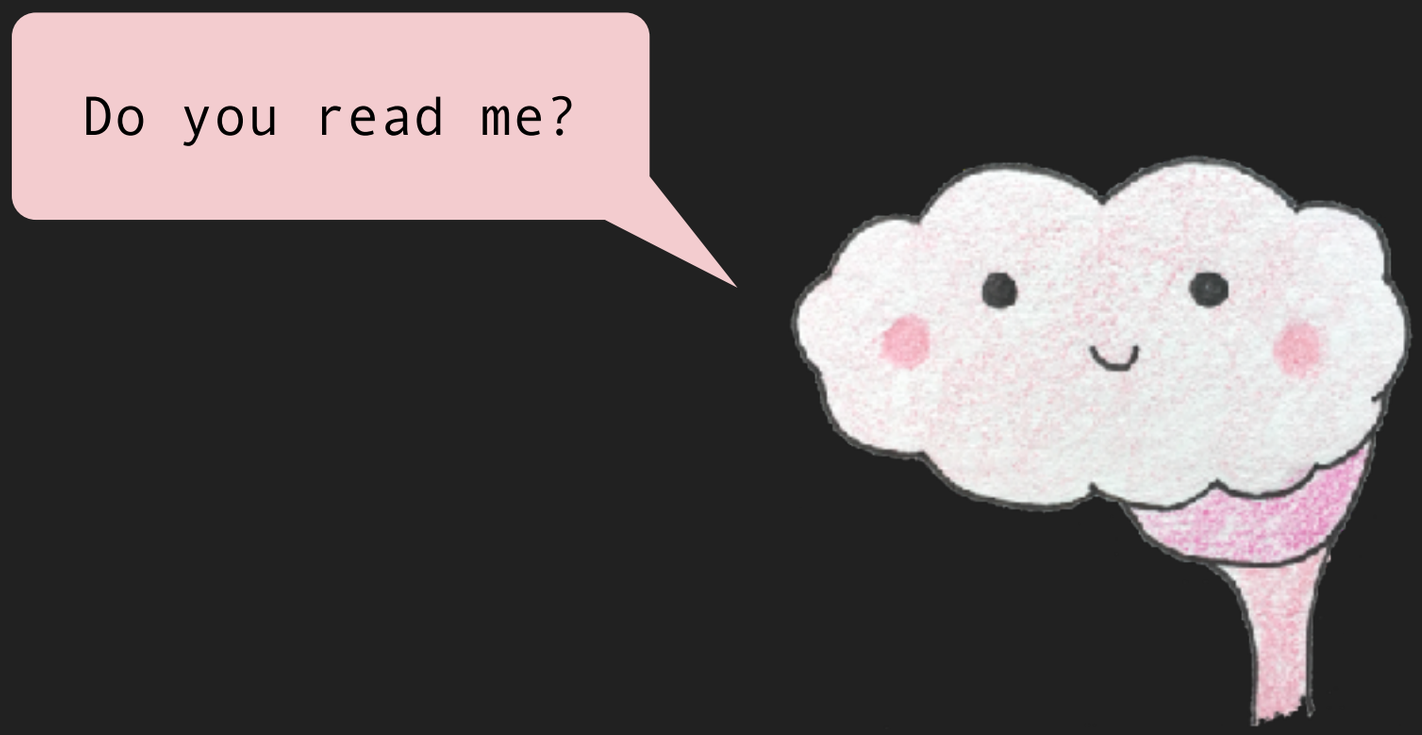
You got the kind of vision
That can be so ~smooth~, yeah
Might be choppy, make it real
Or else forget about it

♪ ♪ ♪

Blake, R., & Sekuler, R. (2006)
Smooth - Santana ft. Rob Thomas

Comprehending

How do we understand written language?



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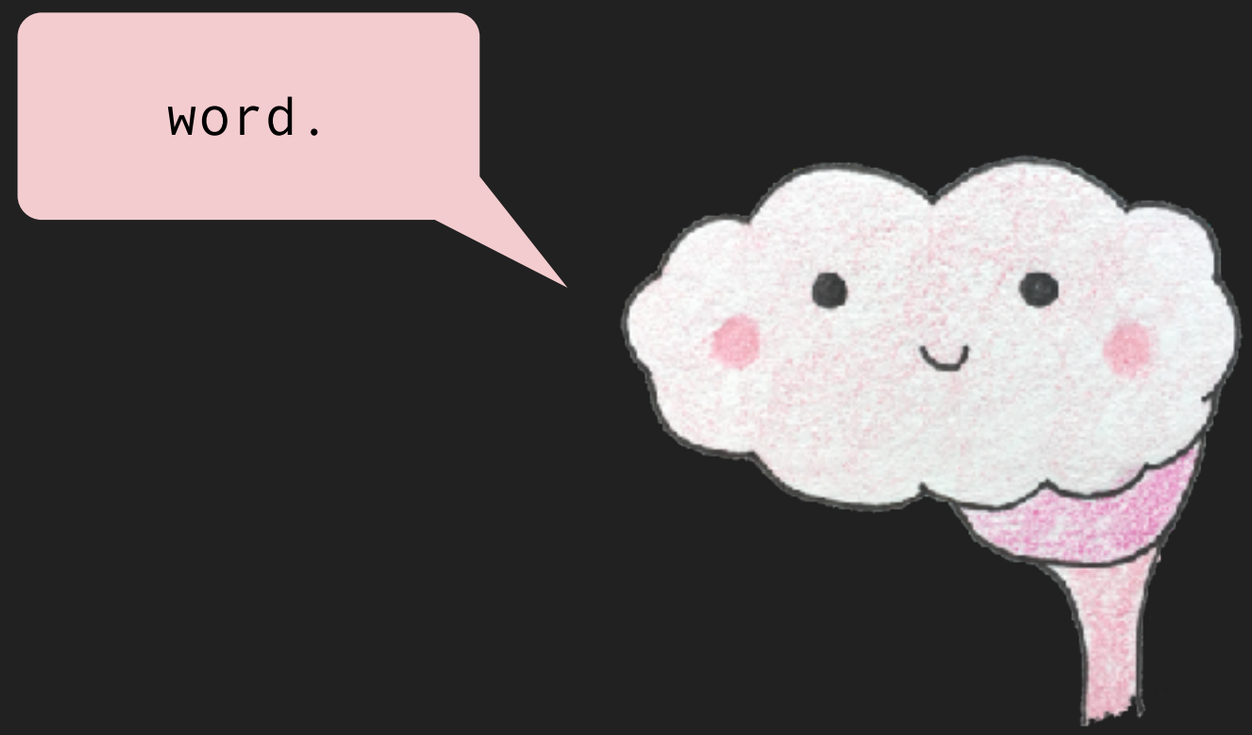
Comprehending

To understand written language, we first have to recognize pixels on the screen as words



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Comprehending

We process words as holistic units, not as separate letters, and we recognize words faster than non-words.

It's not always easy and
Sometimes words can be deceiving
I'll tell you one thing,
Letters are better when they're together

♪ ♪ ♪

Blake, R., & Sekuler, R. (2006)
Jack Johnson - Better Together

Comprehending

We are also able to understand wordswhentheyaresmushedtogether better than if theyh aves paces inarb itraryp la ces

I wanna know
Does this meaning flow both ways
♪ ♪ ♪

Blake, R., & Sekuler, R. (2006)
Arctic Monkeys - Do I Wanna Know?

Comprehending

We are also able to understand words when they are smushed together better than if they have spaces in arbitrary places

I wanna know
Does this meaning flow both ways
♪ ♪ ♪

Blake, R., & Sekuler, R. (2006)
Arctic Monkeys - Do I Wanna Know?

Comprehending

Our minds match the word we see to the representations of words we have stored in our minds

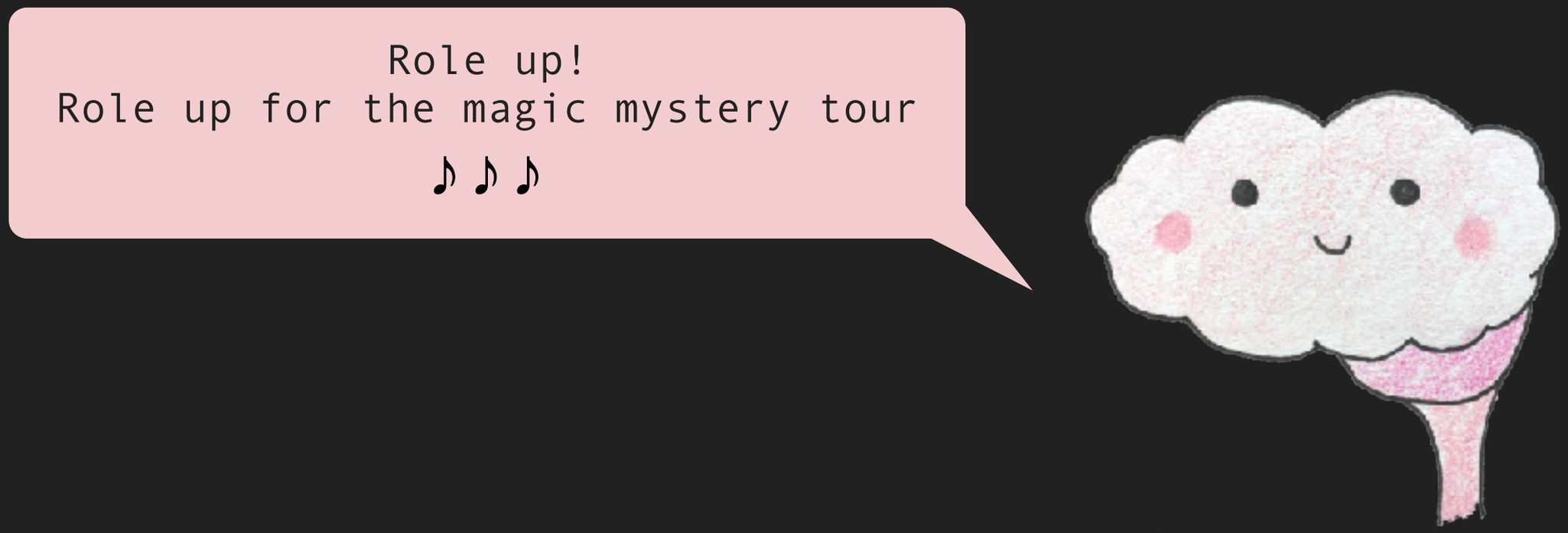
First you're up and you’re down
And then between
Oh I really want to know
What do you mean? Ooh

♪ ♪ ♪

Lupker (2005)
Justin Bieber - What Do You Mean?

Comprehending

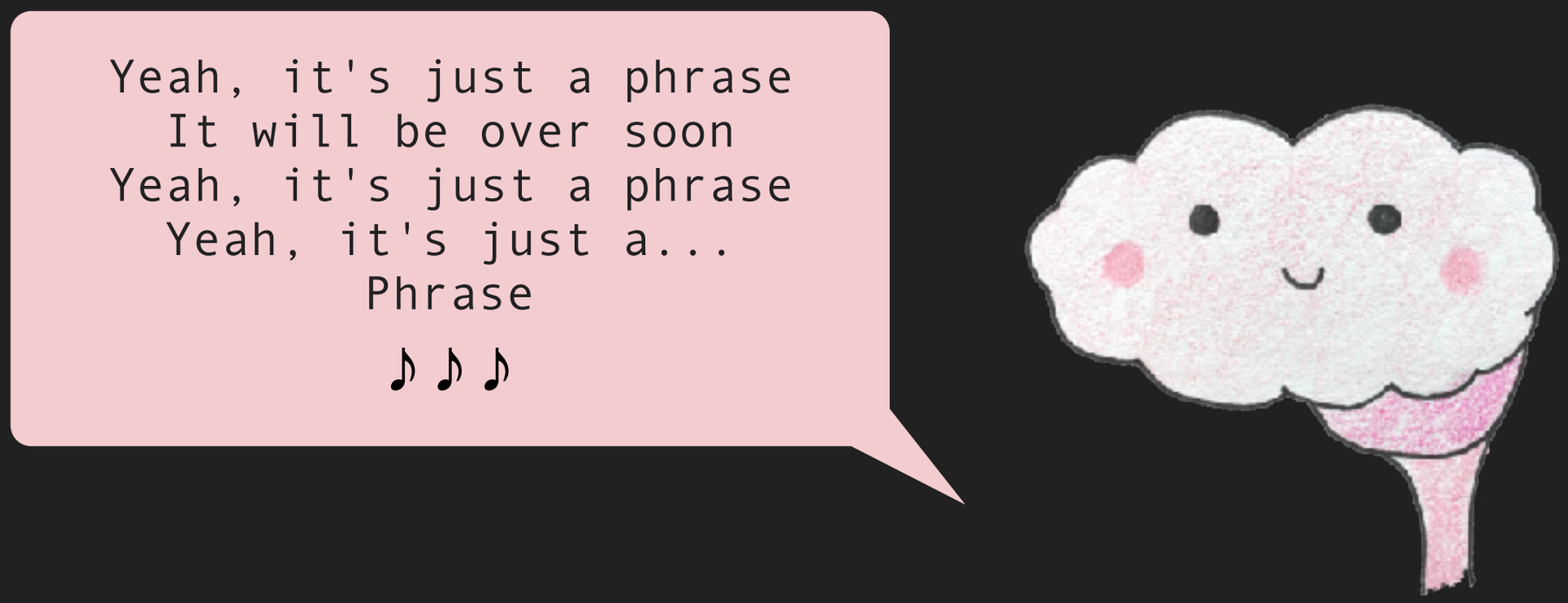
Once we access a word, we have access to its meaning and its syntactic and thematic roles



The Beatles - Magical Mystery Tour

Comprehending

We then parse the sentence, construct a representation of its meaning



Incubus - Just a Phase

Comprehending

Garden Path Theory: We construct the simplest parse first, and then see if it makes sense semantically based on context

If at first you don't succeed
(First you don't succeed),
Dust yourself off, and try again
You can dust it off and try again
Try again

♪ ♪ ♪

https://en.wikipedia.org/wiki/Sentence_processing
Aaliyah - Try Again

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Comprehending

"The horse raced past the barn fell"

https://en.wikipedia.org/wiki/Sentence_processing

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Comprehending

"The horse (that) raced past the barn fell"

https://en.wikipedia.org/wiki/Sentence_processing

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Comprehending

Constraint-based Theories: we interpret sentences based on probabilistic constraints

We feel the same
With these constraints
We feel the same
Within our brains

♪ ♪ ♪

https://en.wikipedia.org/wiki/Sentence_processing
Chvrches - Keep You on My Side

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Comprehending

Human language contains a ton of ambiguity, both semantic and syntactic

One way or another, I'm gonna find ya'
I'm gonna get ya', get ya',
Get ya', get ya'

♪ ♪ ♪

Blondie - One Way or Another

Comprehending

Humans are very forgiving of syntax errors

And here's to you
‘Cause forgiveness is a nice thing to do
♪ ♪ ♪

Taylor Swift - This is Why We Can’t Have Nice Things

Comprehending

BLUE PURPLE RED
GREEN PURPLE
GREEN

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Comprehending

@zeigenvector
jenna.is/at-node-js-interactive

Comprehending

BLUE PURPLE RED
GREEN PURPLE
GREEN

@zeigenvector
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Comprehending

BLUE PURPLE RED
GREEN PURPLE
GREEN

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1. Parsing
2. Rendering
3. Perceiving
4. Comprehending

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Resources

Books

- Blake, R., & Sekuler, R. & (2006). Perception (5th ed.). Boston: McGraw-Hill.
- Harley, T. A. (2008). Psychology of Language: From Data to Theory (3rd ed.). New York: Psychology Press.
- Kellogg, R. T. (2007). Fundamentals of cognitive psychology. Thousand Oaks, CA: SAGE.

Websites

- https://www.html5rocks.com/en/tutorials/internals/howbrowserswork
- https://www.html5rocks.com/en/tutorials/speed/layers/
- https://developers.google.com/web/fundamentals/performance/critical-rendering-path/render-tree-construction
- Marja Hölttä: Parsing JavaScript - better lazy than eager? (Video)
- Franziska Hinkelmann: JavaScript engines - how do they even? (Video)
- Chelsea Derrick: True Grit: Debugging CSS & Render Performance (Video)
- www.ecma-international.org/ecma-262/
- https://en.wikipedia.org/wiki/Visual_system
- https://en.wikipedia.org/wiki/Lateral_geniculate_nucleus
- https://en.wikipedia.org/wiki/Language_processing_in_the_brain
- https://en.wikipedia.org/wiki/Sentence_processing
- Visual Word Recognition: Theories and Findings

Tracklist

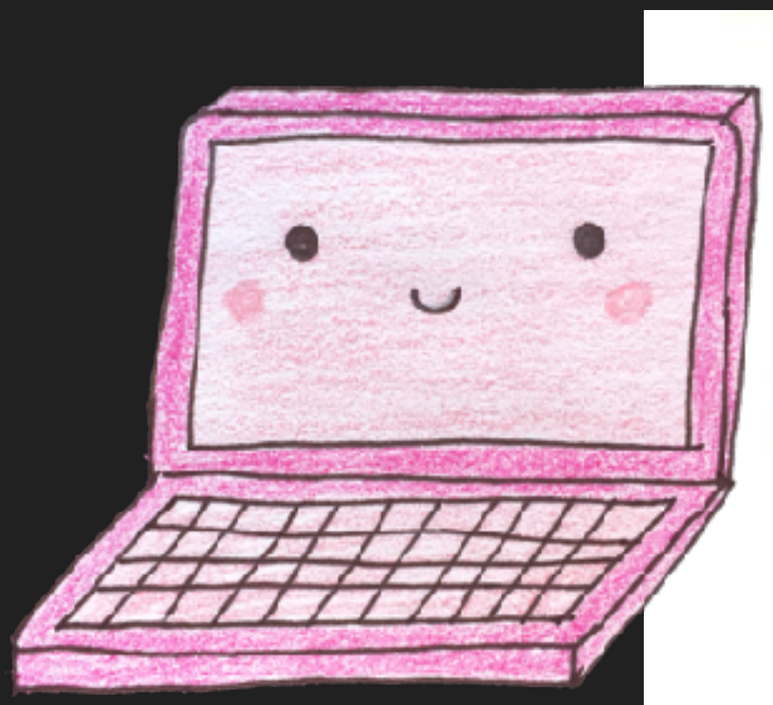
The Notorious B.I.G. – Sky's The Limit
MC Hammer - U Can't Touch This
Ashlee Simpson - Pieces of Me
Katy Perry - Part of Me
Shakira - Whenever, Wherever
Meghan Trainor - All About That Bass
Snoop Dogg & Wiz Khalifa ft. Bruno Mars - Young, Wild, & Free
The Foundations - Build Me Up Buttercup
Daft Punk - Harder, Better, Faster, Stronger
Flo Rida - Low
R Kelly - Ignition
Enya - Only Time
Counting Crows - Mr. Jones
Traditional - O Tannenbaum
Taylor Swift - Shake it Off
Katy Perry - Last Friday Night (T.G.I.F.)
Salt-N-Pepa - Shoot
James Blunt - You’re Beautiful
Johnny Nash - I Can See Clearly Now

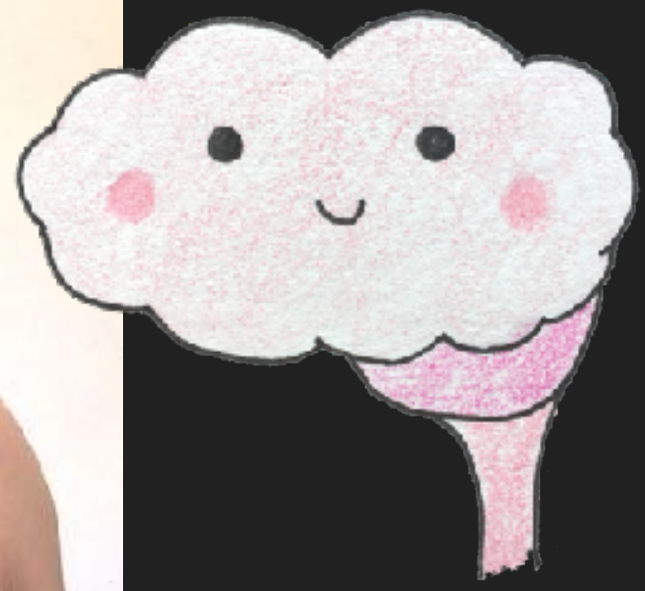
Tracklist

Kanye West - All of the Lights
Thursday - Signals Over the Air
Zedd, Maren Morris, Grey - The Middle
Joni Mitchell - Both Sides Now
Lady Gaga - Edge of Glory
Passion Pit - Little Secrets
Beyoncé - XO
Ed Sheehan - Shape of You
KT Tunstall - Suddenly I See
Smooth - Santana ft. Rob Thomas
Jack Johnson - Better Together
Arctic Monkeys - Do I Wanna Know?
Justin Bieber - What Do You Mean?
The Beatles - Magical Mystery Tour
Incubus - Just a Phase
Aaliyah - Try Again
Chvrches - Keep You on My Side
Blondie - One Way or Another
Taylor Swift - This is Why We Can’t Have Nice Things

Thanks!

jenna.is/at-node-js-interactive





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