

# From Parentheses To Perception



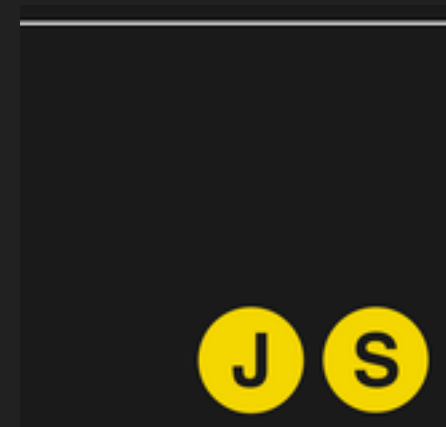
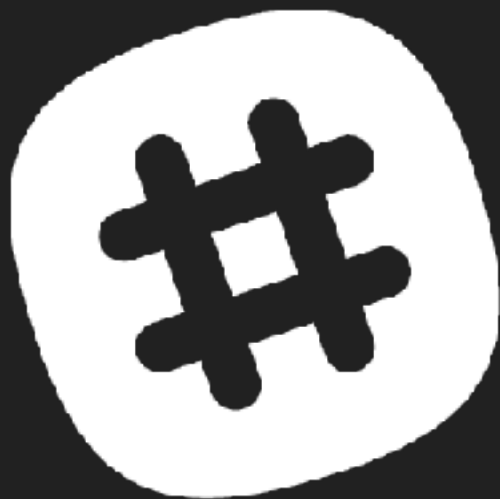
How Your Code Becomes  
Another's Reality

Jenna Zeigen  
Node+JS Interactive 2018  
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Senior Frontend Engineer  
at Slack

Organizer of EmpireJS

Organizer of BrooklynJS



jenna.is/at-node-js-interactive

@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);
```

Nom nom nom!





**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
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- 

1. Parsing
  2. Rendering
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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?

I begin to parse,  
To split the text apart  
Break it down into sections  
Tokens into selectors

♪ ♪ ♪



# Parsing

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

Stop! Grammar time!



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

[https://en.wikipedia.org/wiki/Context-free\\_grammar](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.

It's as if you know me better  
Than I ever knew myself  
I love how you can tell  
All the pieces, pieces, 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!

♪ ♪ ♪





# Parsing

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

Whatever, wherever  
I'm gonna make it render!



# Parsing

Instead, browsers write custom  
parsers for HTML

Yeah, my momma she told me  
Don't worry about your size  
She says I'm this big 'cause sometimes  
humans just aren't so bright!

♪ ♪ ♪



# Parsing

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

This parser's young and wild and  
context-free





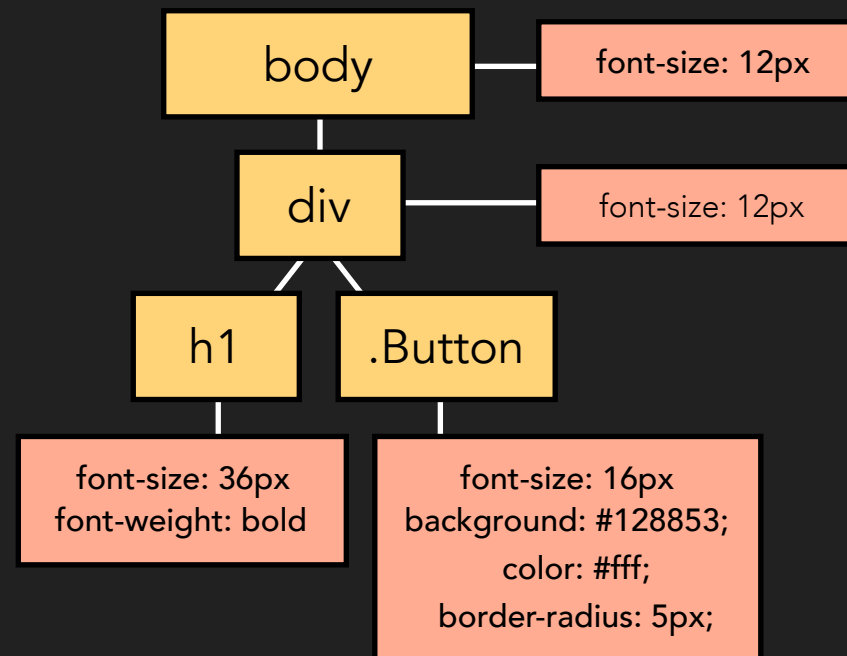
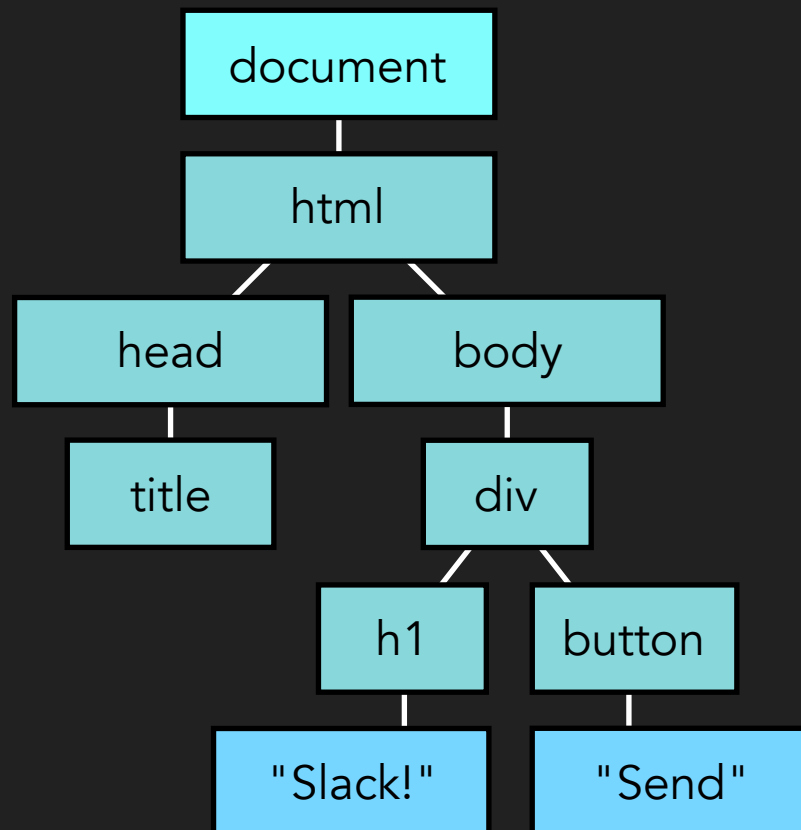
# Parsing

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

So build me up, buttercup  
Don't break my parse



# Parsing



# Parsing

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

Harder, better,  
faster parser!



<https://www.youtube.com/watch?v=Fg7niTmNNLg>

<http://www.ecma-international.org/ecma-262/#sec-notational-conventions>

Daft Punk - Harder, Better, Faster, Stronger

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# 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!)...



# 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  
♪ ♪ ♪





# Parsing

The low-level code then gets executed

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



# 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

♪ ♪ ♪



# Rendering

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

Well, I'm gonna paint my picture  
Paint myself in blue and red and  
green and... a

All of the beautiful pixels  
are very, very meaningful

♪ ♪ ♪





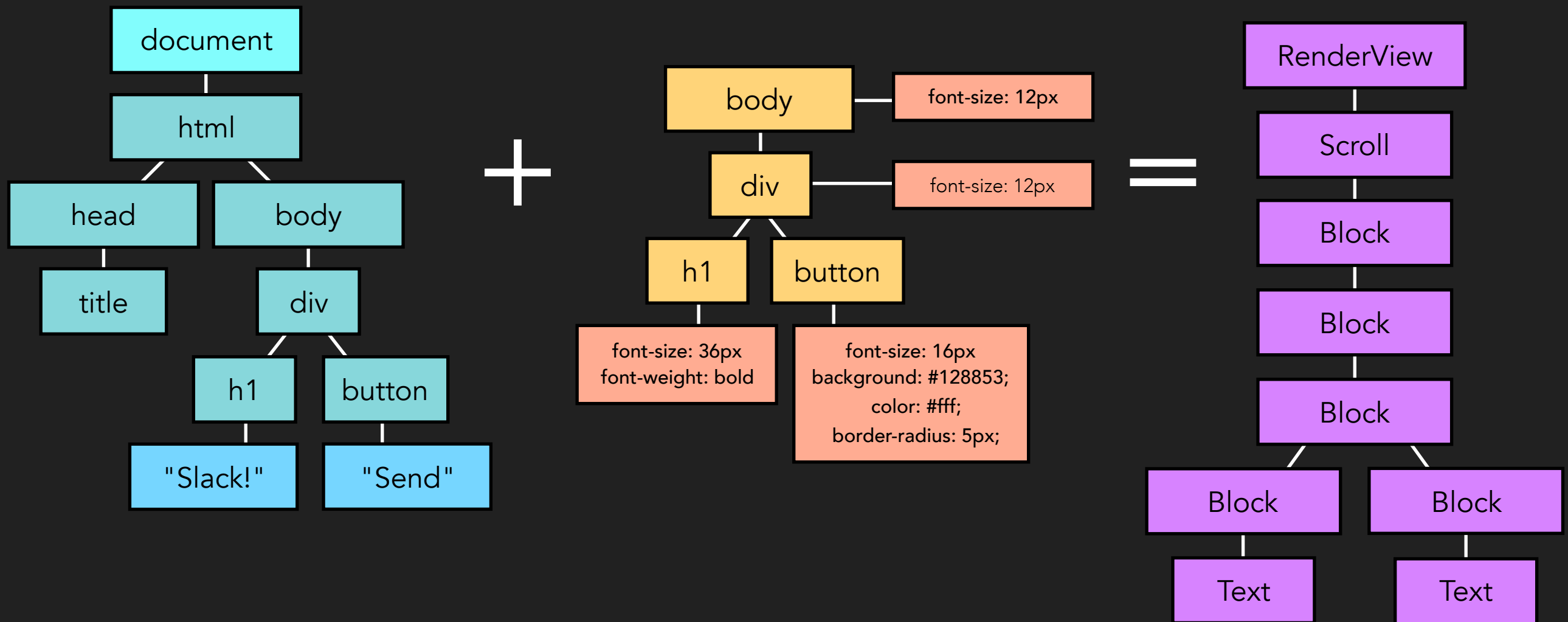
# Rendering

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

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



# Rendering



# Rendering

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

And the render's gonna  
rend, rend, rend?



# Rendering

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

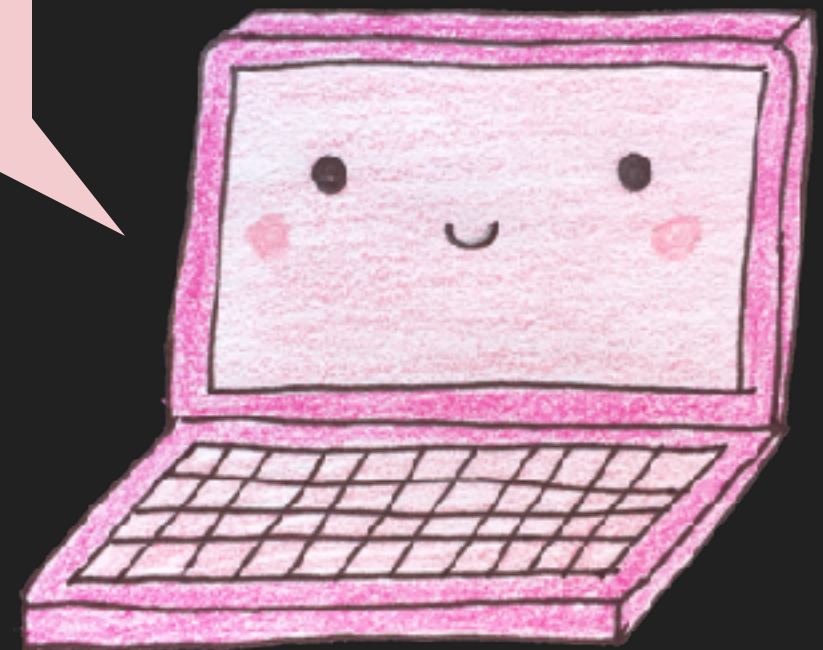
And the painter's gonna  
paint, paint, paint



# Rendering

Bitmaps are sent to the GPU for compositing

And the GPU's gonna  
composite, composite, composite...





# Rendering

The browser repeats the process,  
maybe 60 times a second

Do it alllll agaaaain...



# 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  
♪ ♪ ♪



# 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  
♪ ♪ ♪





# Perceiving

Light goes into the eye via the cornea and lens

I can see clearly now  
The light is on



# Perceiving

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

Turn up the lights in here, baby  
You know what I need  
Want you to see everything  
Want you to see all of the lights



# 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.



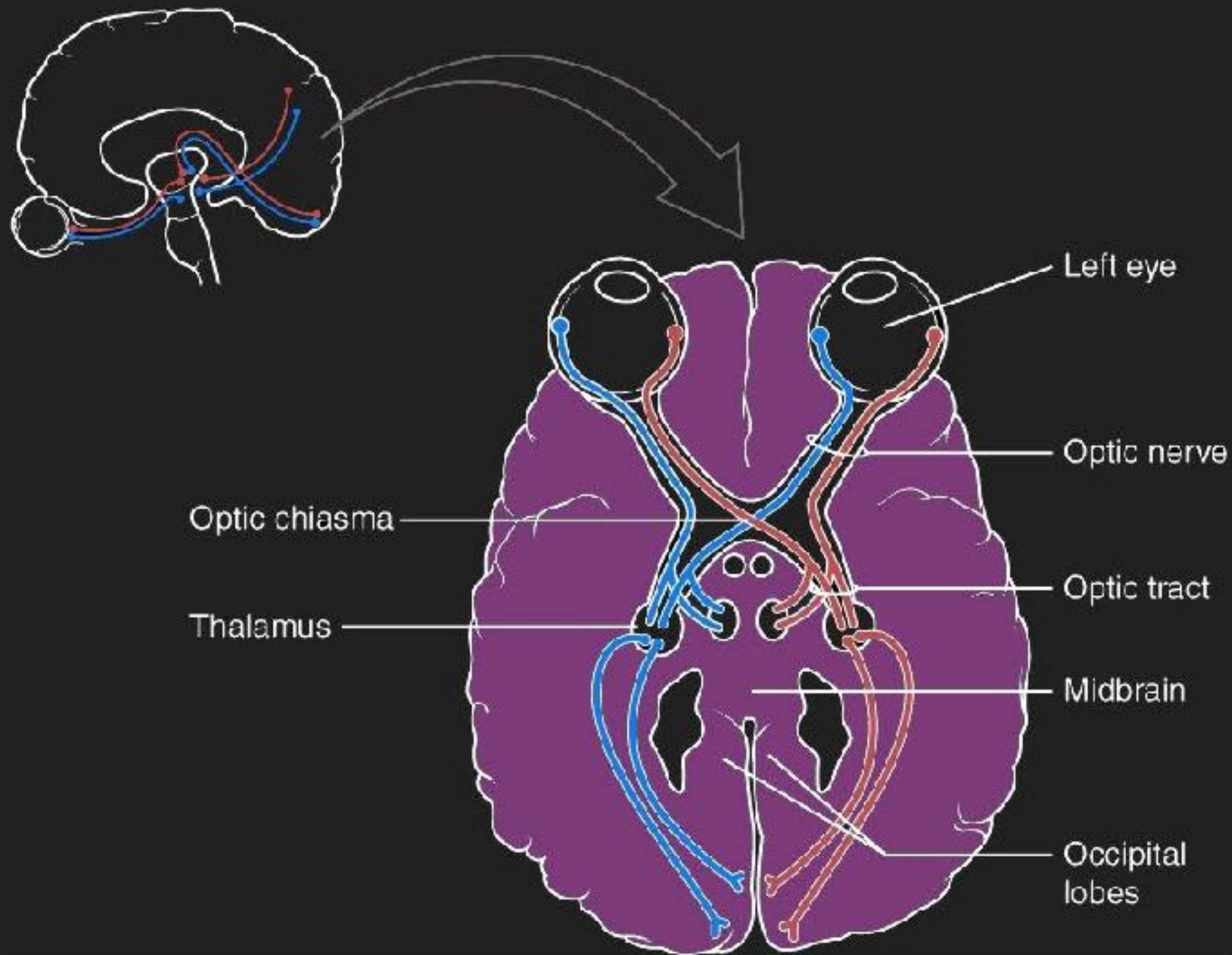
# Perceiving

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



# Perceiving



It me!





# 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

♪ ♪ ♪



# Perceiving

Signals then get sent to the  
primary visual cortex

I have an 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





# Perceiving

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

In the darkest night I'll  
I'll search through the crowd  
Your shape is all that I see  
I'll give you everything

♪ ♪ ♪



# 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)



# 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  
♪ ♪ ♪



# 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



# Comprehending

How do we understand  
written language?

Do you read me?



# Comprehending

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

word.





# 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



# Comprehending

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

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



# 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  
♪ ♪ ♪



# 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  
♪ ♪ ♪



# Comprehending

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

Role up!  
Role up for the magic mystery tour  
♪ ♪ ♪



# Comprehending

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

Yeah, it's just a phrase  
It will be over soon  
Yeah, it's just a phrase  
Yeah, it's just a...  
Phrase  
♪ ♪ ♪





# 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  
♪ ♪ ♪



# Comprehending

“The horse raced  
past the barn  
fell”



# Comprehending

“The horse (that)  
raced past the  
barn fell”



# 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



# 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'  
♪ ♪ ♪



# Comprehending

Humans are very forgiving of  
syntax errors

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





# Comprehending

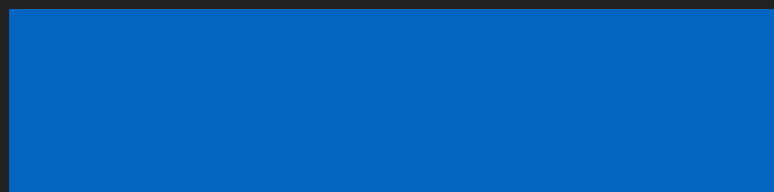
BLUE PURPLE RED

GREEN PURPLE

GREEN



# Comprehending



# Comprehending

BLUE PURPLE RED

GREEN PURPLE

GREEN




# Comprehending

BLUE PURPLE RED

GREEN PURPLE

GREEN



1. Parsing
  2. Rendering
  3. Perceiving
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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/](http://www.ecma-international.org/ecma-262/)
- [https://en.wikipedia.org/wiki/Visual\\_system](https://en.wikipedia.org/wiki/Visual_system)
- [https://en.wikipedia.org/wiki/Lateral\\_geniculate\\_nucleus](https://en.wikipedia.org/wiki/Lateral_geniculate_nucleus)
- [https://en.wikipedia.org/wiki/Language\\_processing\\_in\\_the\\_brain](https://en.wikipedia.org/wiki/Language_processing_in_the_brain)
- [https://en.wikipedia.org/wiki/Sentence\\_processing](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 - X0

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!

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