What if your brain were

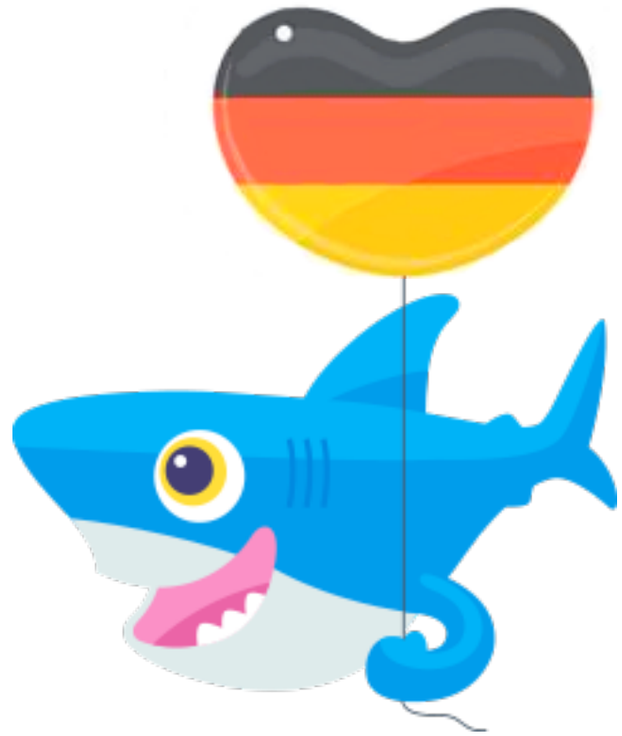
~*literally*~

JavaScript?

Jenna Zeigen

RejectJS 2015

Engineering Manager
@ DigitalOcean



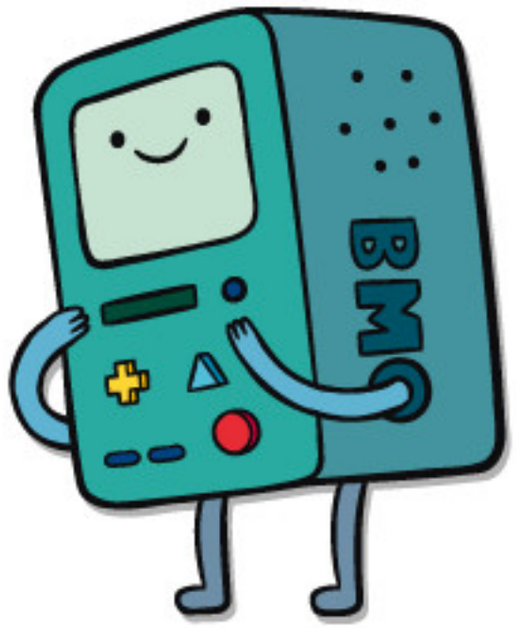
zeigenvector

jennazee

jenna.is/rejectjs

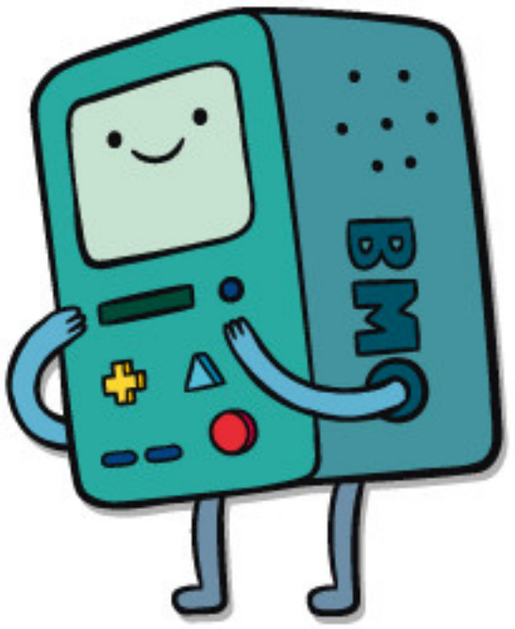
Human

JavaScript



¯_(ツ)_/¯

ヽ(*‿*)ノ



Language&
Imagery&
Perception&
Thinking&
Concepts&
Categories&
Memory&
Attention&
Judgement&
Reasoning&
Decision Making&
Consciousness…

Language&
Imagery&
Perception&
Thinking&
Concepts&
Categories&
Memory&
Attention&
Judgement&
Reasoning&
Decision Making&
Consciousness…

1. Human Language vs. Programming Languages

2. Human Concepts + Categories vs. JavaScript Prototypes + Primitives

3. Human Attention vs. the JavaScript event loop

Language

Language

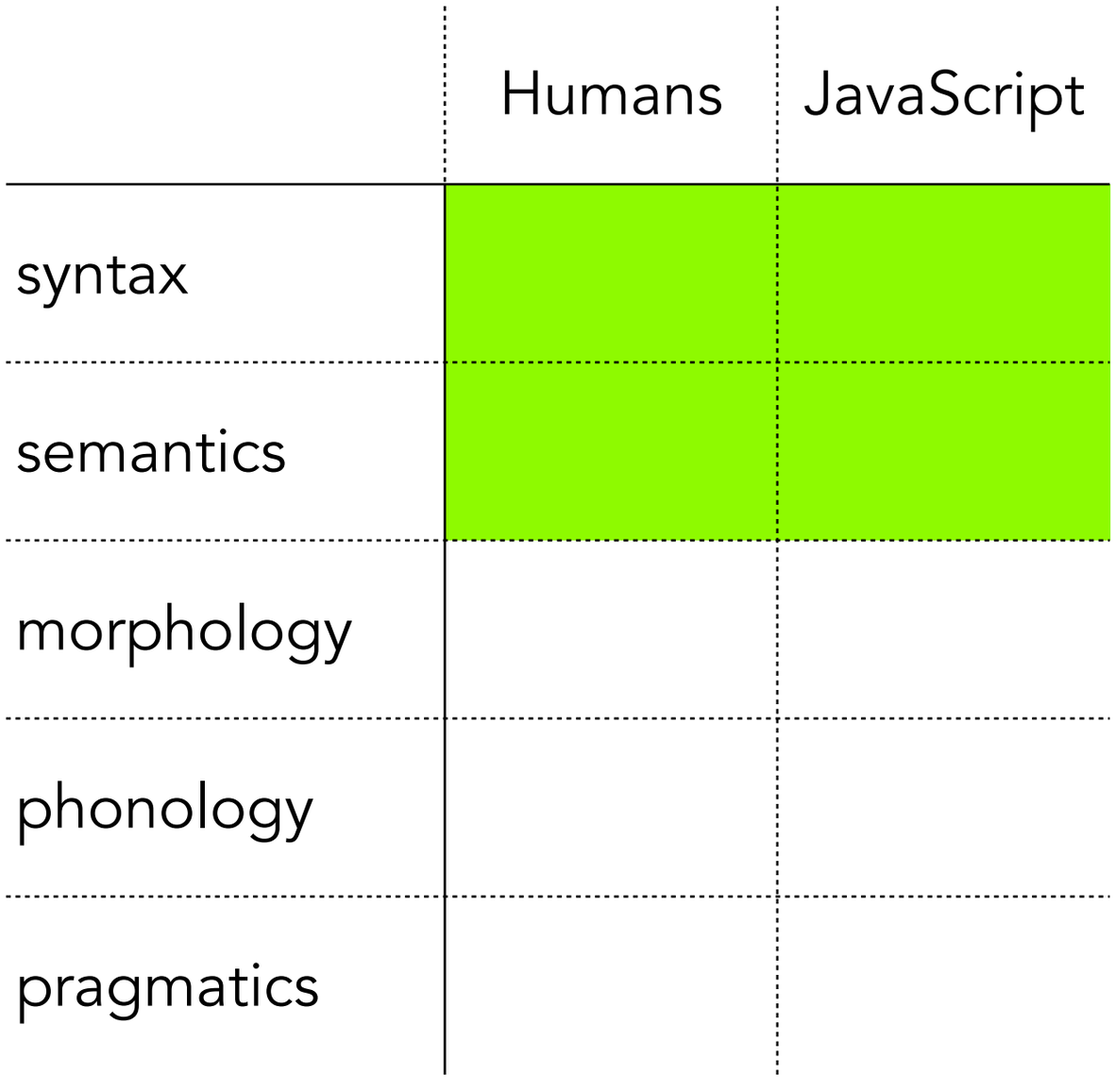
natural language vs. programming language

- regulation
- evolution
- learning

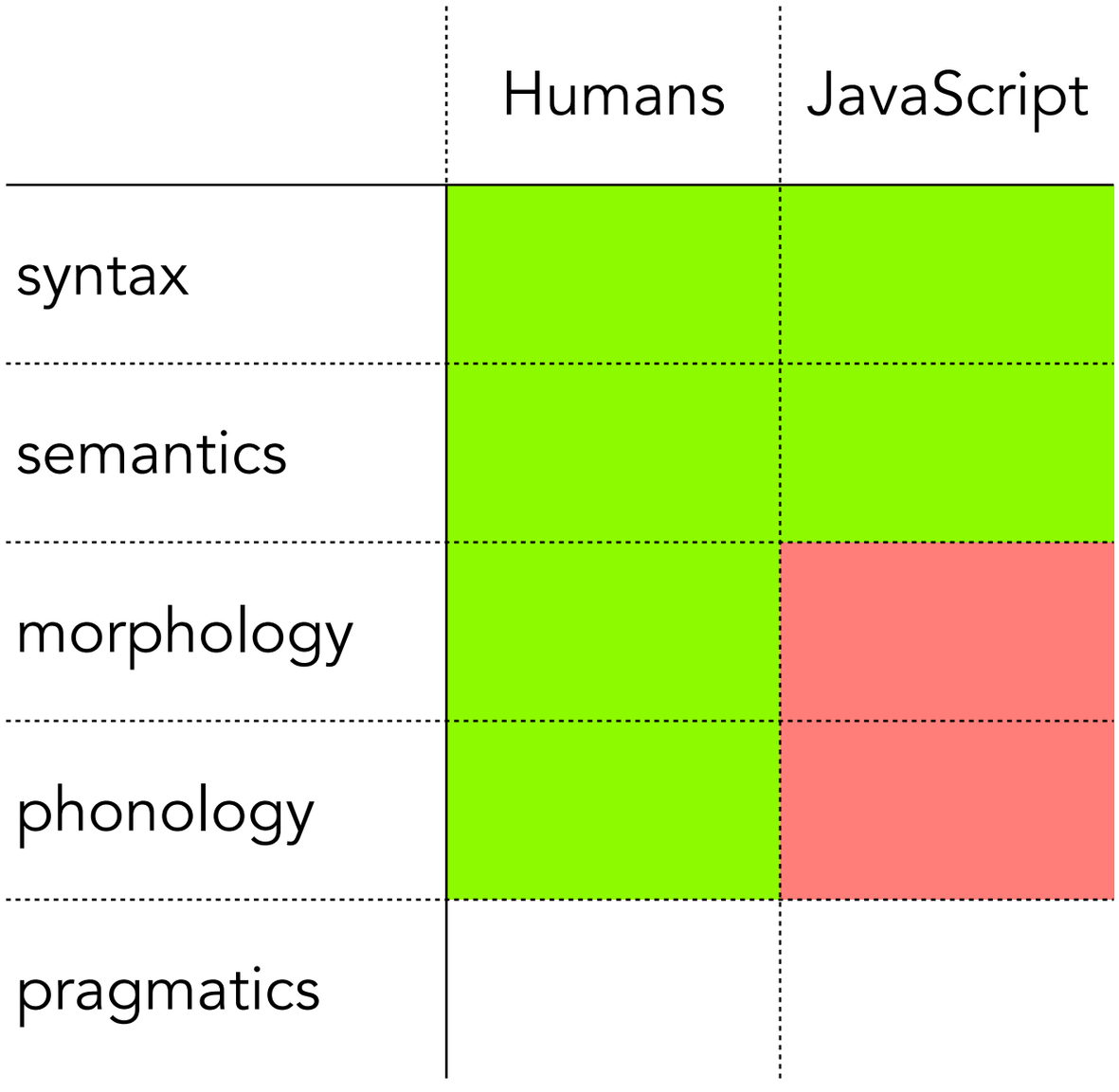
Language

Programming languages **create** and **manipulate** the environment, rather than just describe it.

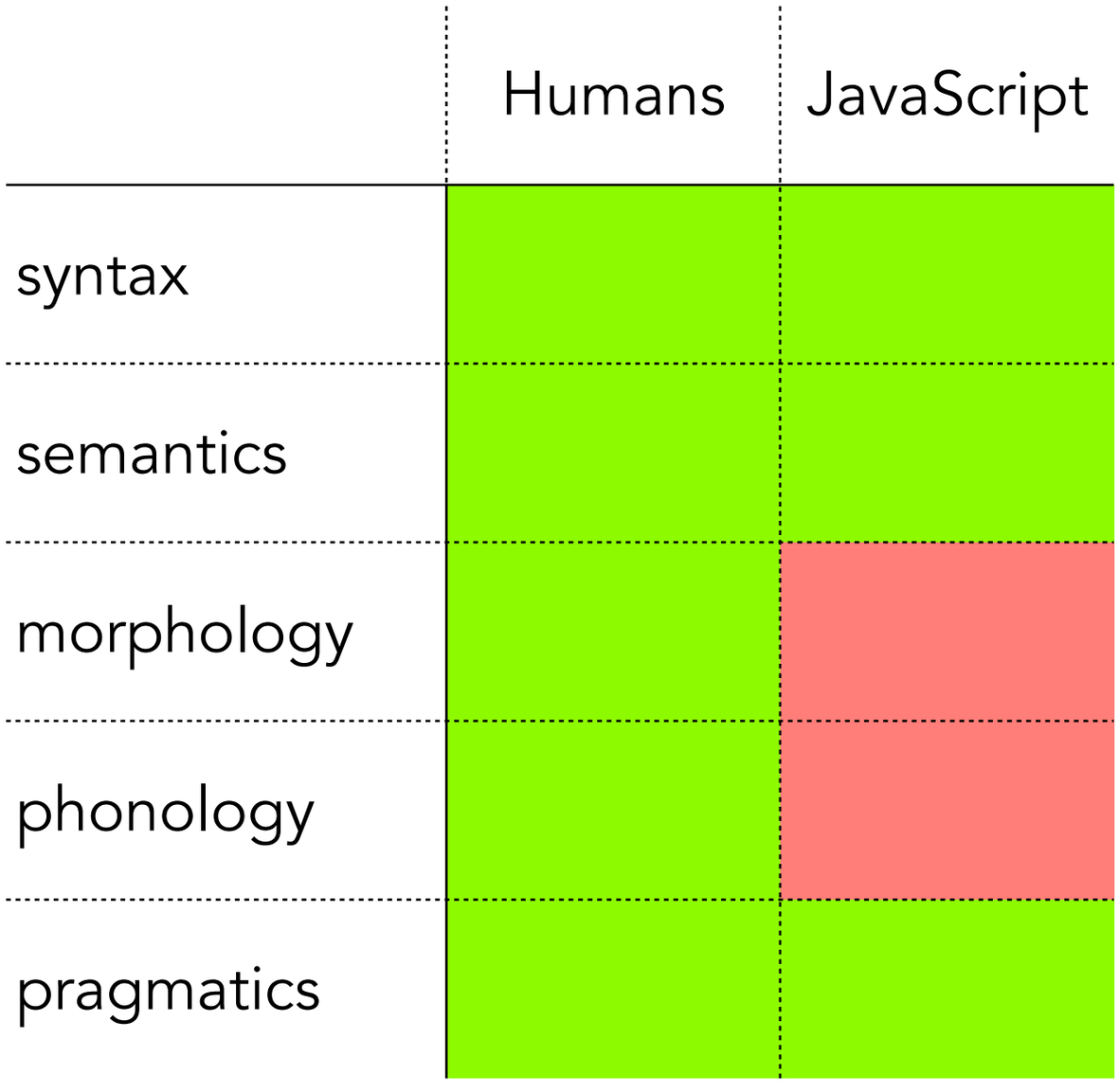
Language


Humans
JavaScript
syntax
semantics
morphology
phonology
pragmatics

Language


Humans
JavaScript
syntax
semantics
morphology
phonology
pragmatics

Language


Humans
JavaScript
syntax
semantics
morphology
phonology
pragmatics

Language

context.

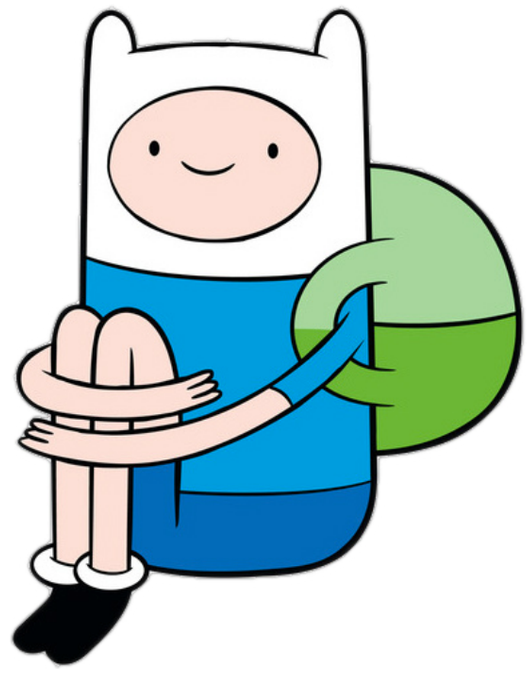
http://www.ecma-international.org/ecma-262/6.0/index.html#sec-syntactic-and-lexical-grammars

Language

"I saw the unicorn with the binoculars."

Language

"I saw the unicorn with the binoculars."



Language

context.

Language

Reference:

pronouns + variables

https://en.wikipedia.org/wiki/Anaphora_(linguistics)

Language

Anaphora:

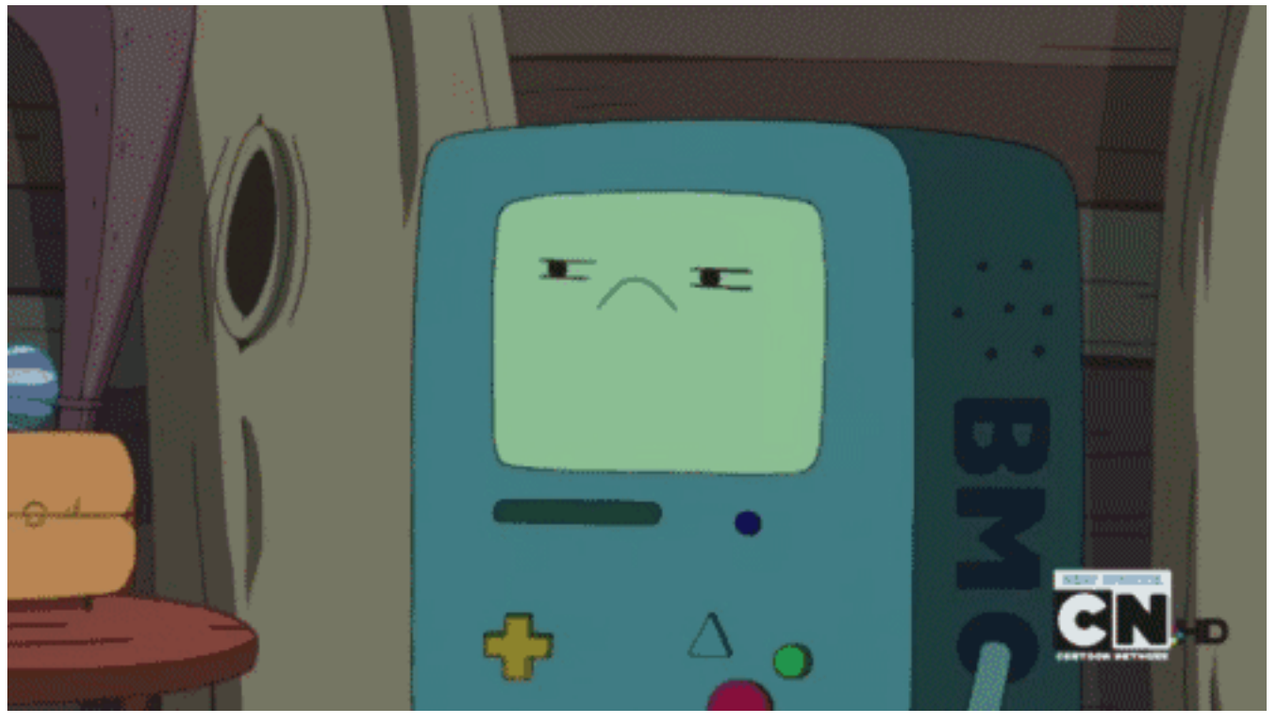
"Jenna gave a talk on the cognitive science of JavaScript, and she totally rocked it."

Language

Cataphora:

"Since she was there last year, Jenna was excited to visit Berlin."

Language

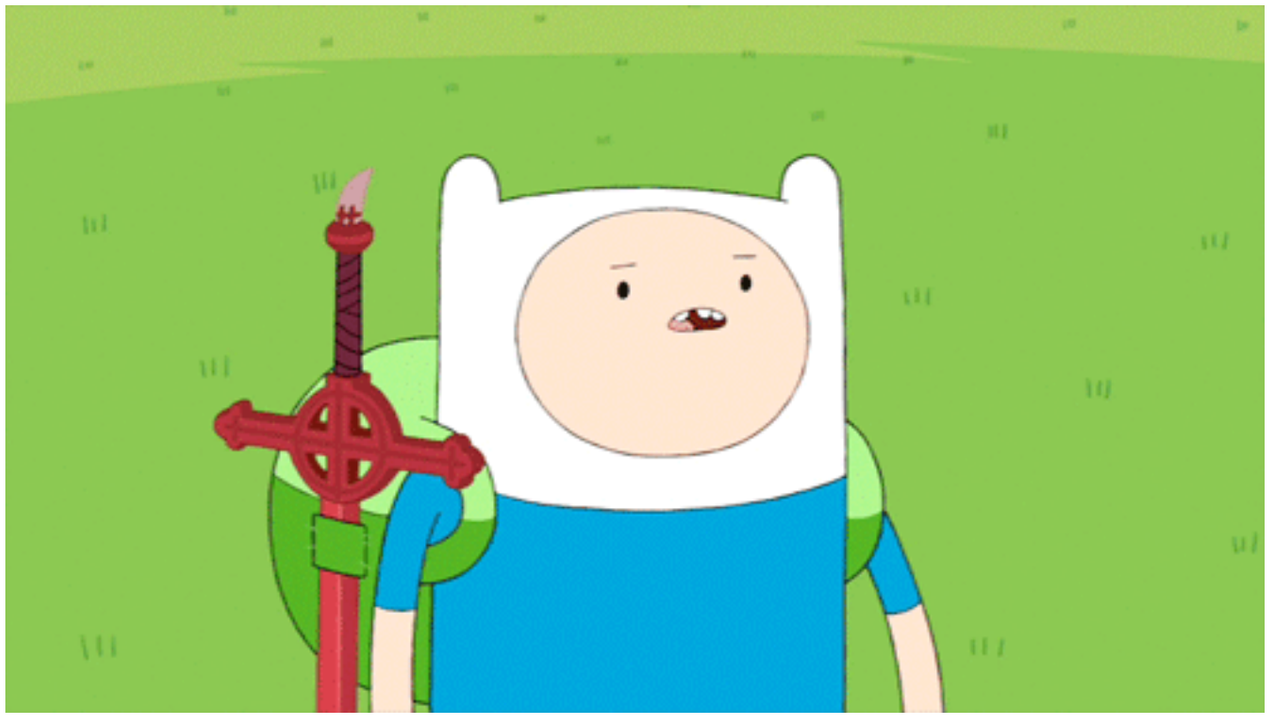


Language

Reference:

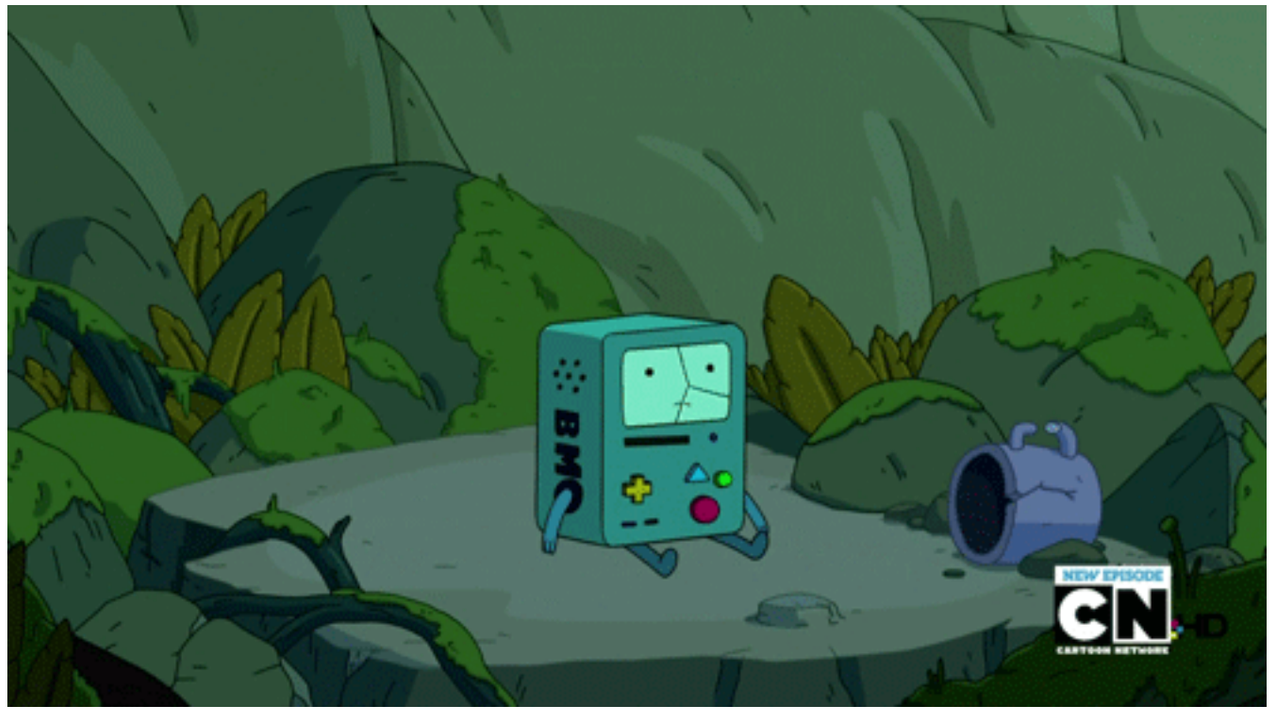
pronouns + JavaScript's `this`

Language



http://www.ecma-international.org/ecma-262/6.0/index.html#sec-error-handling-and-language-extensions

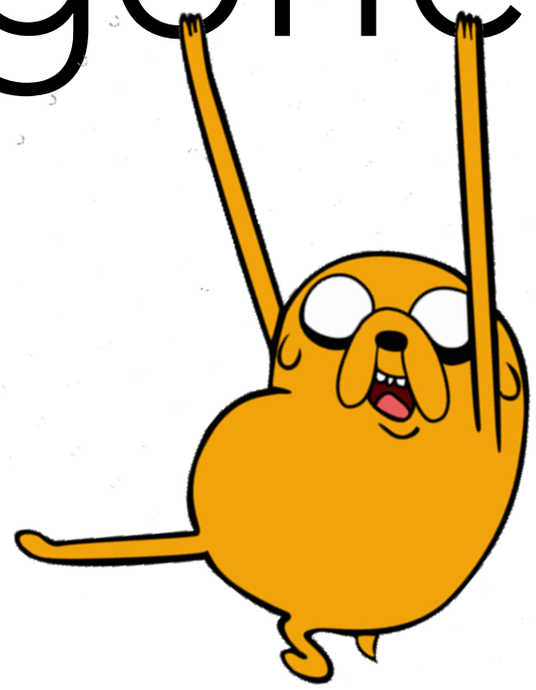
Language



http://www.ecma-international.org/ecma-262/6.0/index.html#sec-error-handling-and-language-extensions

Concepts +

Categories



Concepts + Categories

“knowledge representation”

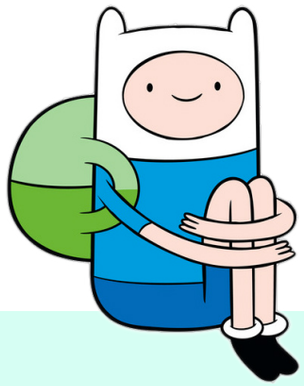
Concepts + Categories

http://www.photogalaxy.com/pic/eventhorizon-20/yorkie_puppy.jpg

Concepts + Categories

http://www.photogalaxy.com/pic/eventhorizon-20/yorkie_puppy.jpg

Concepts + Categories

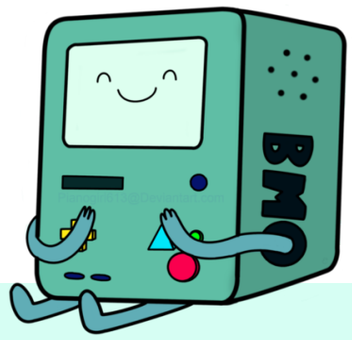


classical

vs.

prototype

(categorization theories)



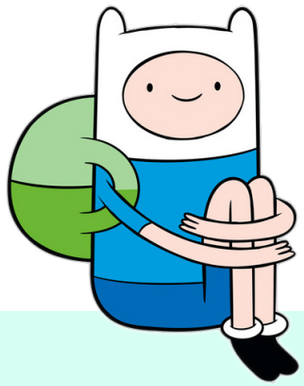
classical

vs.

prototypal

(inheritance)

Concepts + Categories

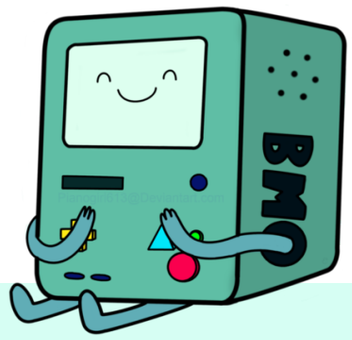


classical

vs.

prototype

(categorization theories)



classical

vs.

prototypal

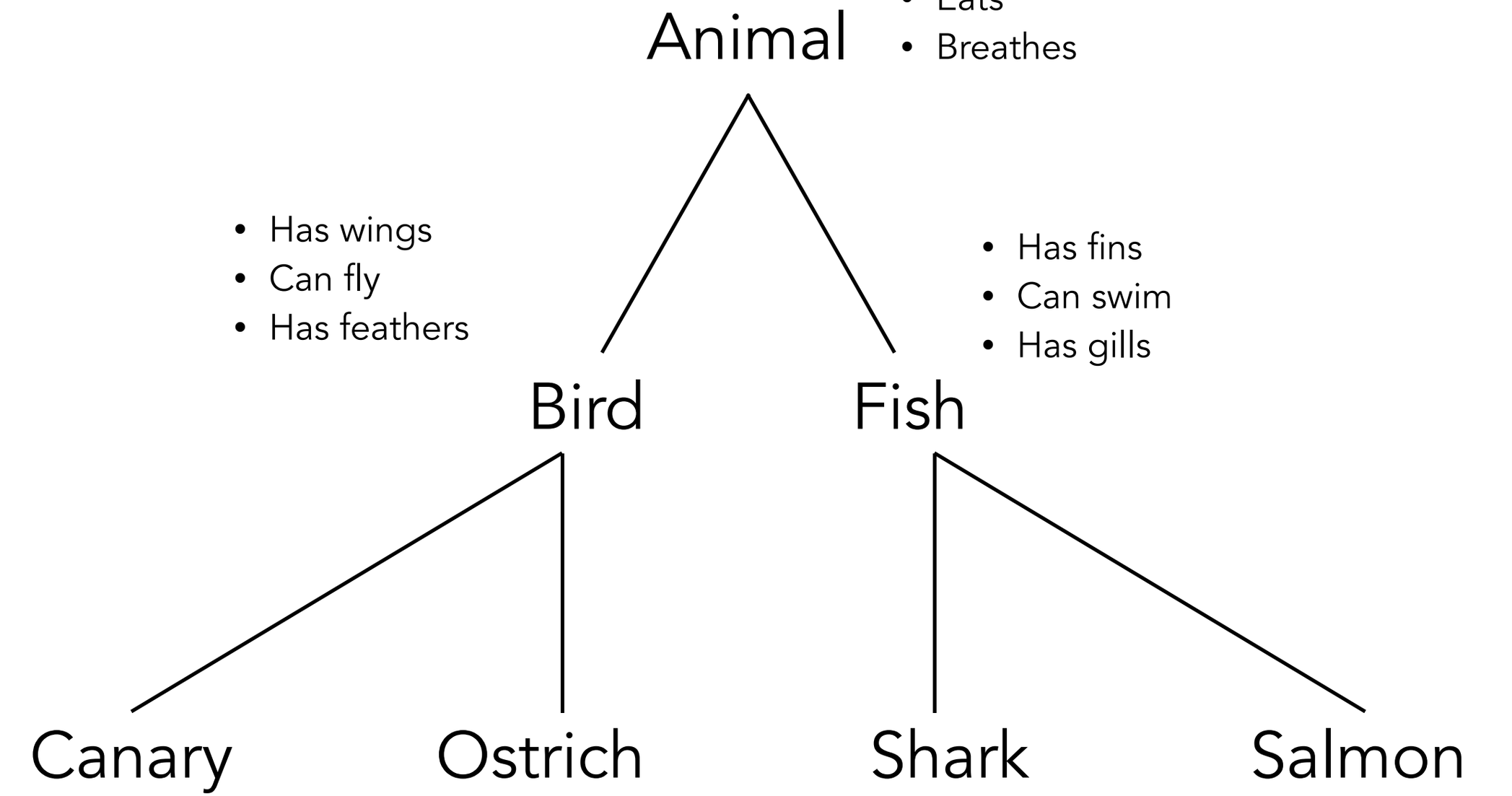
(inheritance)

coincidence? ¯_(ツ)_/¯

Concepts + Categories

"In a computer system designed for the storage of semantic information, it is **more economical to store generalized information with superset nodes**, rather than with all the individual nodes to which such a generalization might apply. But such a storage system incurs the cost of additional processing time in retrieving the information. When the implications of such a model were tested for human [subjects] using **well-ordered hierarchies** that are part of the common culture, there was a substantial agreement between the predictions and the data."

(Collins & Quillian, 1969)



Collins & Quillian, 1969

Is a canary a bird?

- Has skin
- Can move around
- Eats
- Breathes

Animal

- Has wings
- Can fly
- Has feathers

Bird

- Has fins
- Can swim
- Has gills

Fish

Canary

- Can sing
- Is yellow

Ostrich

- Has long, thin legs
- Is tall
- Can’t fly

Shark

- Can bite
- Is dangerous

Salmon

- Is pink
- Is edible
- Swims upstream to lay eggs

Collins & Quillian, 1969

Is a canary an animal?

- Has skin
- Can move around
- Eats
- Breathes

Animal

- Has wings
- Can fly
- Has feathers

Bird

- Has fins
- Can swim
- Has gills

Fish

Canary

- Can sing
- Is yellow

Ostrich

- Has long, thin legs
- Is tall
- Can’t fly

Shark

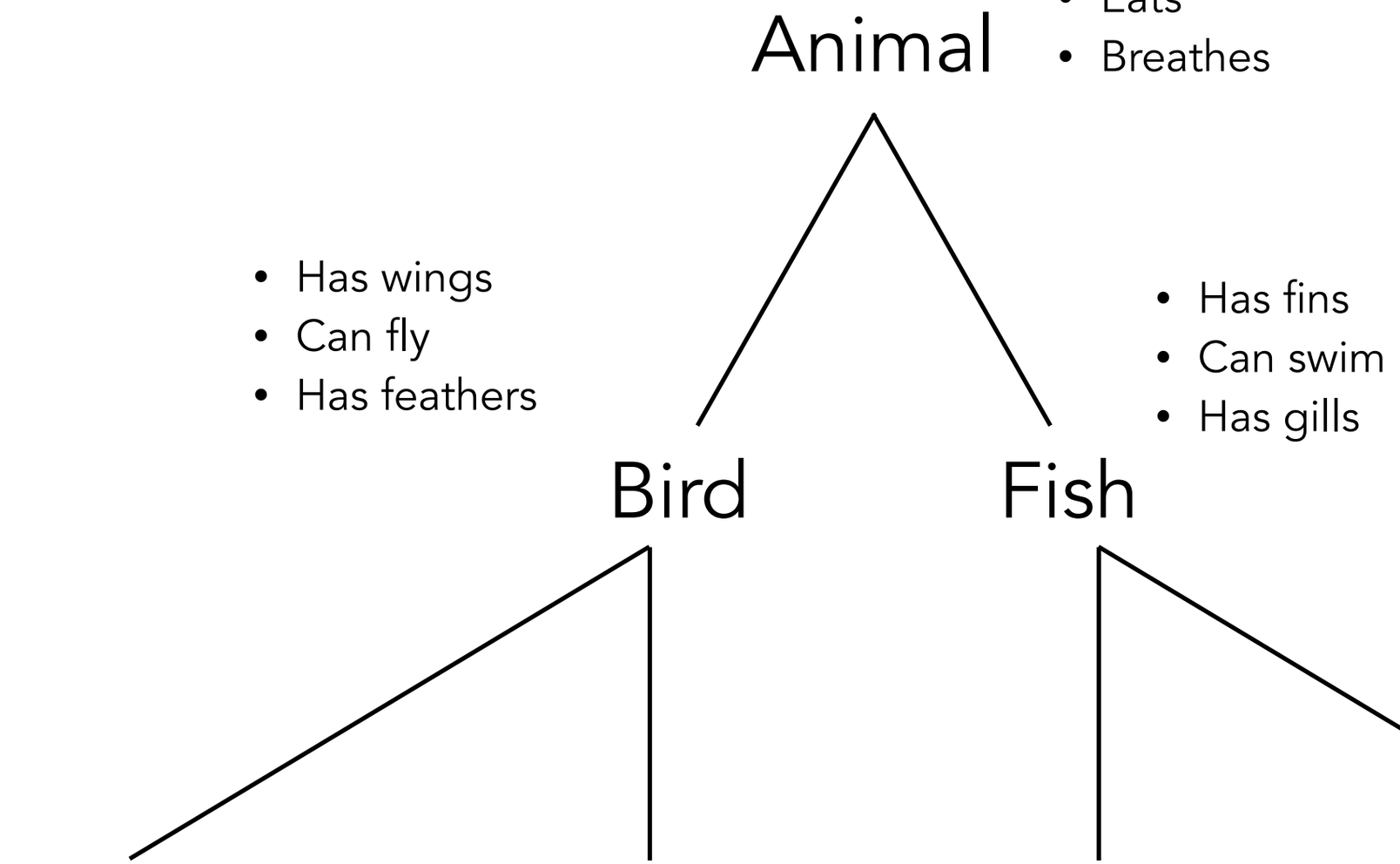
- Can bite
- Is dangerous

Salmon

- Is pink
- Is edible
- Swims upstream to lay eggs

Collins & Quillian, 1969

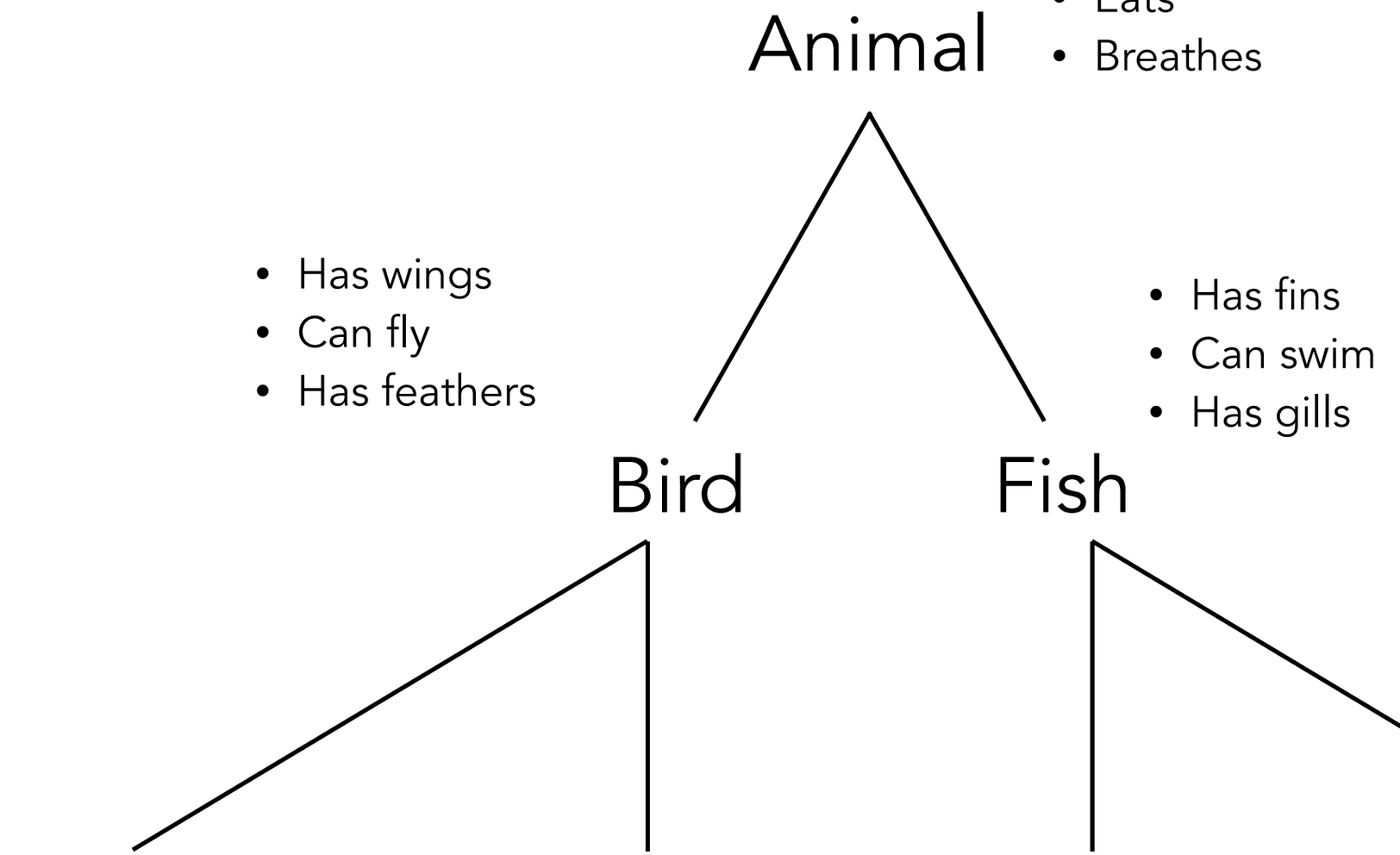
Is a canary yellow?



Collins & Quillian, 1969

Does a canary breathe?

- Has skin
- Can move around
- Eats
- Breathes



- Has wings
- Can fly
- Has feathers

- Has fins
- Can swim
- Has gills

- Can sing
- Is yellow

- Has long, thin legs
- Is tall
- Can’t fly

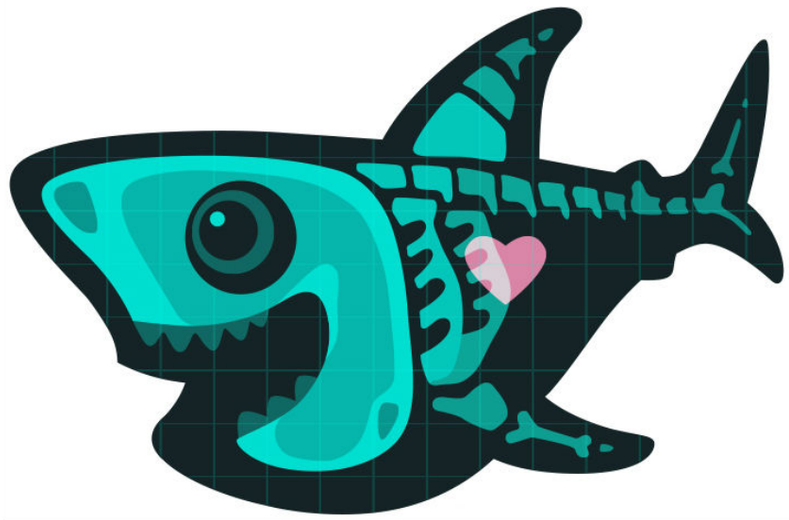
- Can bite
- Is dangerous

- Is pink
- Is edible
- Swims upstream to lay eggs

Collins & Quillian, 1969

Concepts + Categories

Is a shark a fish?



Concepts + Categories

Prototype theory (Rosch, 1973):

- we store an average ideal representation of a category

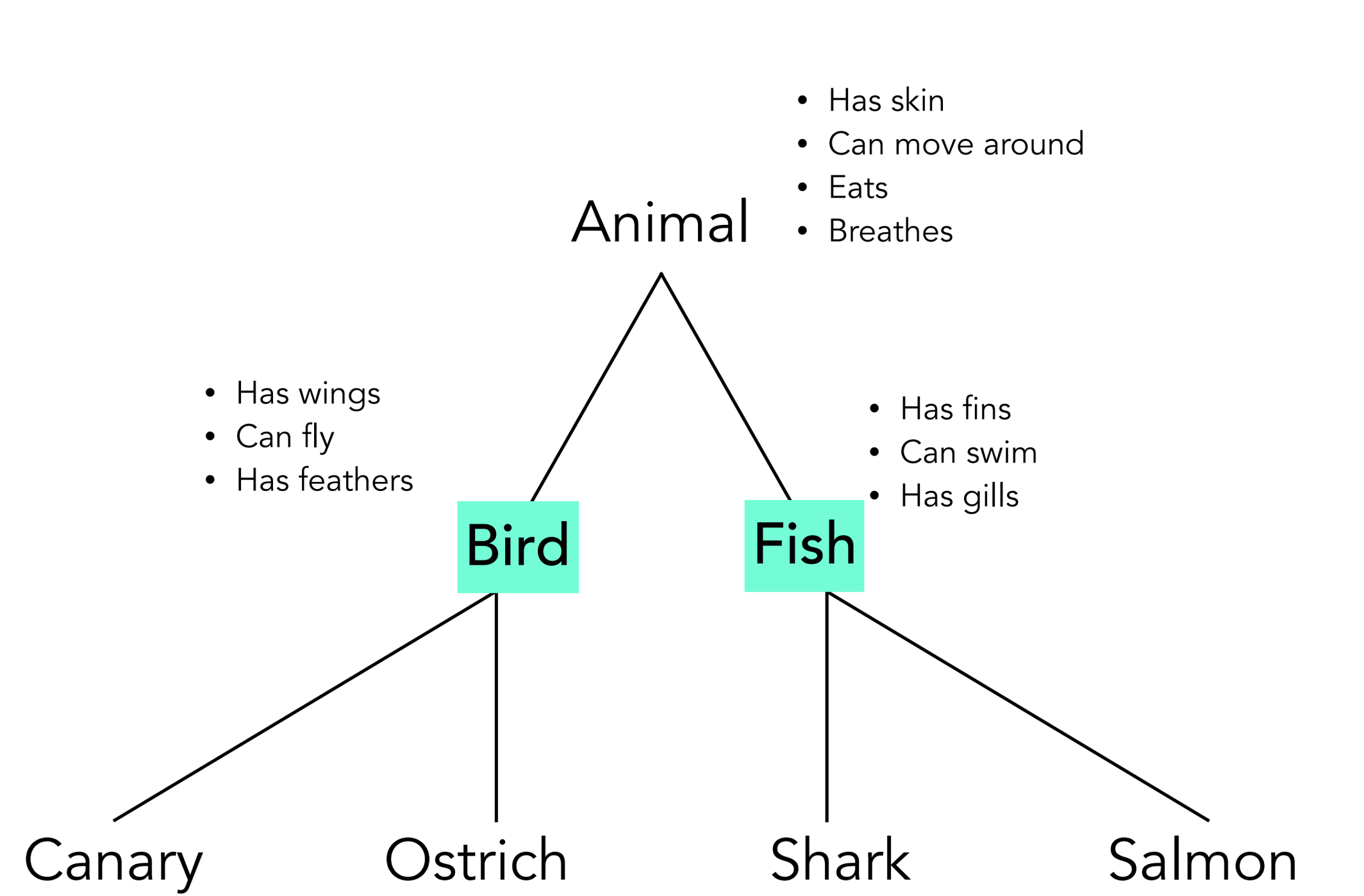
Exemplar theory

- we store an **instance** of a category that is a combination of all experienced exemplars

Concepts + Categories

Basic Level Categories:

A “natural” level of categorization



Collins & Quillian, 1969

Concepts + Categories

Basic Level Categories:

ECMAScript language types?
(Boolean, Null, Undefined, Number, String, Symbol)

http://www.ecma-international.org/ecma-262/6.0/index.html#sec-ecmascript-data-types-and-values

Concepts + Categories

Basic Level Categories:

ECMAScript language types?
(Boolean, Null, Undefined, Number, String, Symbol)

```
> String.prototype.__proto__
◂ ▶ Object {}
> Boolean.prototype.__proto__
◂ ▶ Object {}
> Number.prototype.__proto__
◂ ▶ Object {}
> Symbol.prototype.__proto__
◂ ▶ Object {}
```

http://www.ecma-international.org/ecma-262/6.0/index.html#sec-ecmascript-data-types-and-values

Concepts + Categories

Basic Level Categories:

ECMAScript types?
(Boolean, Null, Undefined, Number, String, Symbol)

```
> undefined.prototype
▶ Uncaught TypeError: Cannot read property 'prototype' of undefined
    at <anonymous>:2:10
    at Object.InjectedScript._evaluateOn (<anonymous>:905:140)
    at Object.InjectedScript._evaluateAndWrap (<anonymous>:838:34)
    at Object.InjectedScript.evaluate (<anonymous>:694:21)
> null.prototype
▶ Uncaught TypeError: Cannot read property 'prototype' of null
    at <anonymous>:2:5
    at Object.InjectedScript._evaluateOn (<anonymous>:905:140)
    at Object.InjectedScript._evaluateAndWrap (<anonymous>:838:34)
    at Object.InjectedScript.evaluate (<anonymous>:694:21)
```

http://www.ecma-international.org/ecma-262/6.0/index.html#sec-ecmascript-data-types-and-values

Concepts + Categories

Basic Level Categories:

But what about Arrays? Functions? Dates? Promises?

http://www.ecma-international.org/ecma-262/6.0/index.html#sec-ecmascript-data-types-and-values

Concepts + Categories

Basic Level Categories:

But what about Arrays? Functions? Dates? Promises?

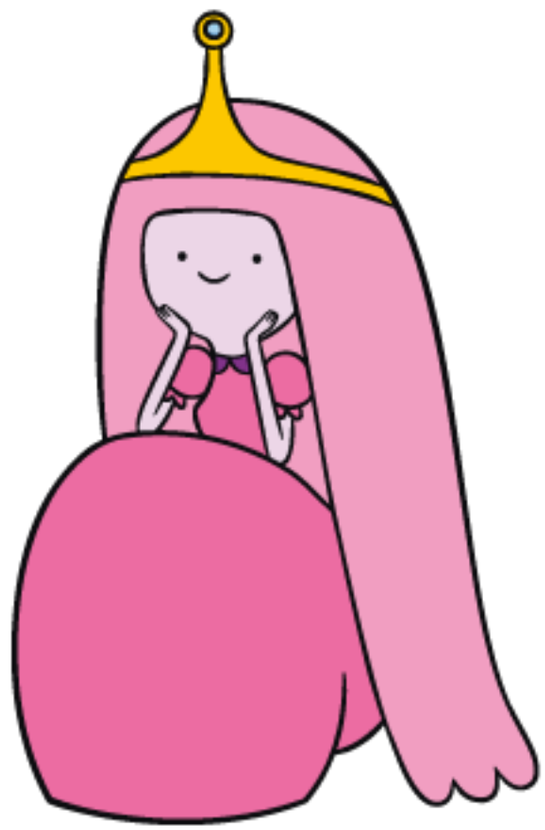
“Well-Known Intrinsic Objects”

http://www.ecma-international.org/ecma-262/6.0/index.html#sec-ecmascript-data-types-and-values

```
> Array.prototype.__proto__
◂ ▶ Object {}
> ArrayBuffer.prototype.__proto__
◂ ▶ Object {}
> Boolean.prototype.__proto__
◂ ▶ Object {}
> DataView.prototype.__proto__
◂ ▶ Object {}
> Date.prototype.__proto__
◂ ▶ Object {}
> Error.prototype.__proto__
◂ ▶ Object {}
> EvalError.prototype.__proto__
◂ ▶ d {name: "Error", message: ""}
> Float32Array.prototype.__proto__
◂ ▶ Object {}
> Float64Array.prototype.__proto__
◂ ▶ Object {}
> Function.prototype.__proto__
◂ ▶ Object {}
> Int8Array.prototype.__proto__
◂ ▶ Object {}
> Map.prototype.__proto__
◂ ▶ Object {}
> Number.prototype.__proto__
◂ ▶ Object {}
> Object.prototype.__proto__
◂ null
> Proxy.prototype.__proto__
✕ ▶ Uncaught ReferenceError: Proxy is not defined
      at <anonymous>:2:1
      at Object.InjectedScript._evaluateOn (<anonymous>:895:140)
      at Object.InjectedScript._evaluateAndWrap (<anonymous>:828:34)
      at Object.InjectedScript.evaluate (<anonymous>:694:21)
> Promise.prototype.__proto__
◂ ▶ Object {}
> RangeError.prototype.__proto__
◂ ▶ d {name: "Error", message: ""}
> ReferenceError.prototype.__proto__
◂ ▶ d {name: "Error", message: ""}
> RegExp.prototype.__proto__
◂ ▶ Object {}
> Set.prototype.__proto__
◂ ▶ Object {}
> String.prototype.__proto__
◂ ▶ Object {}
> WeakMap.prototype.__proto__
◂ ▶ Object {}
```

```
EvalError.prototype.__proto__
▶ d {name: "Error", message: ""}
```

Attention



Attention

- attention as a filter
- attention as a spotlight
- attention as glue
- attention as control

Attention

blue

green

red

orange

Attention

- attention as a filter
- attention as a spotlight
- attention as glue
- attention as control

Attention

- attention as a filter
- attention as a spotlight
- attention as glue
- attention as control

Attention as threads!

Attention

Humans are pretty bad at multitasking:

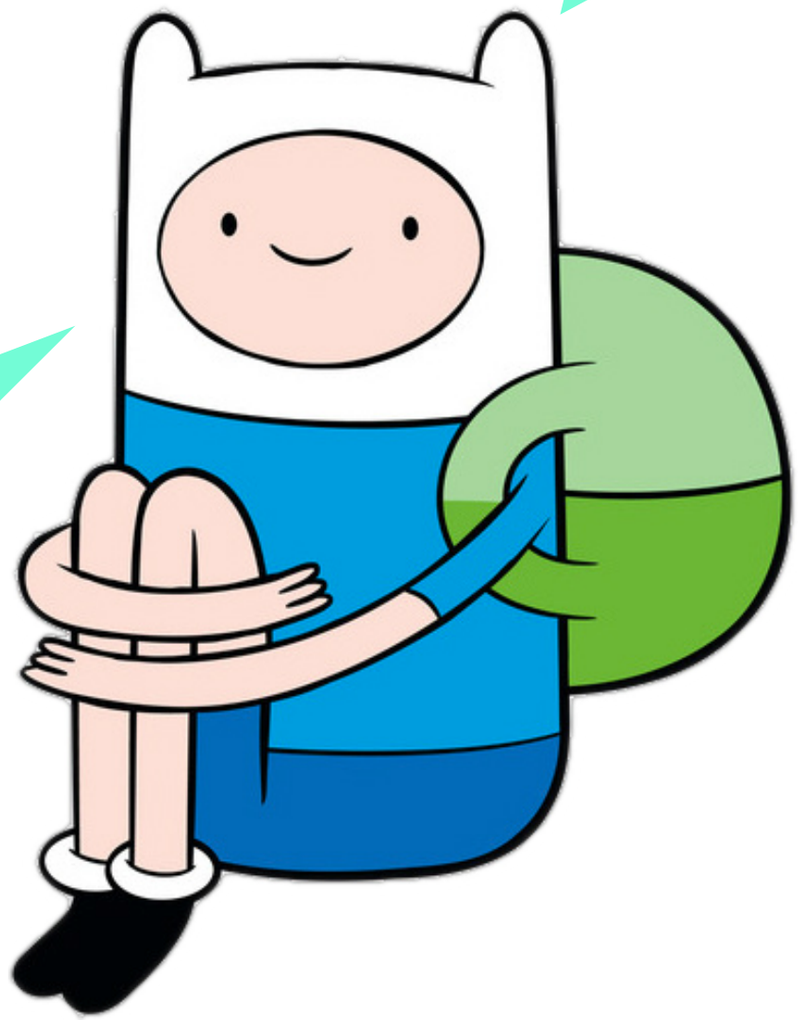
- inattentional blindness
- dichotic listening task
- shadowing

(Simons, 1999; Cherry, 1953; Triesman, 1964; Allport et al., 1972)

Attention

"These are the words you need to repeat back."

"These are the words you aren't supposed to be listening to."



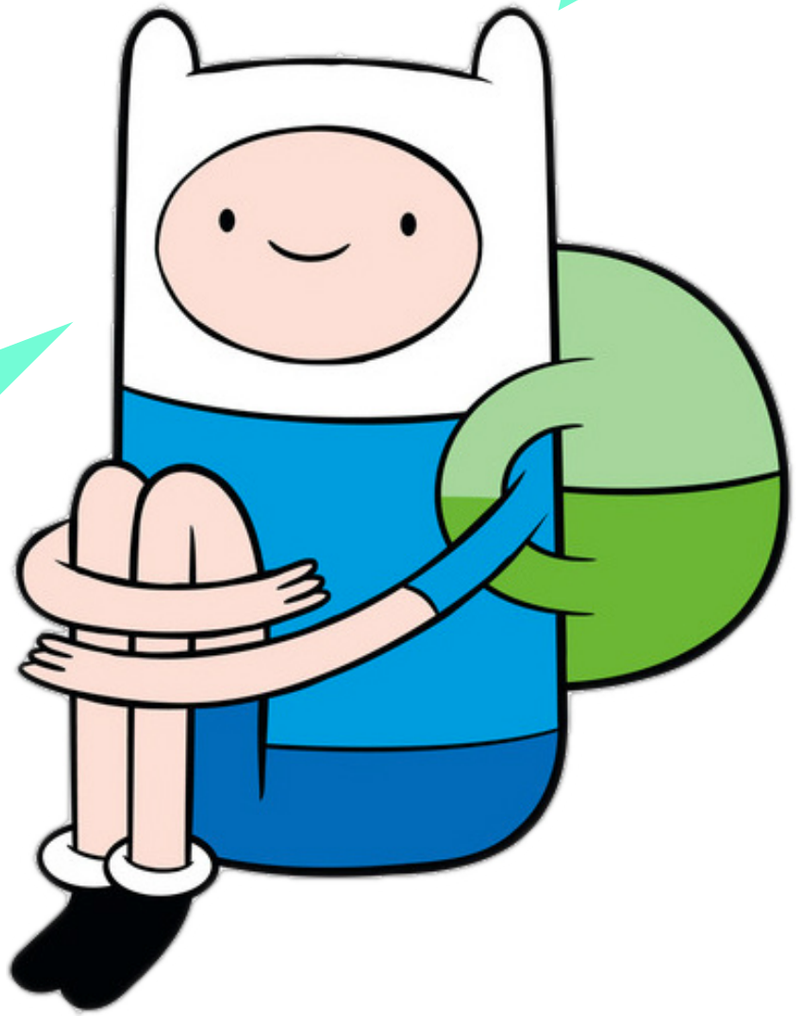
"These are the words you need to repeat back."

(Simons, 1999; Cherry, 1953; Triesman, 1964; Allport et al., 1972)

Attention

"These are the words you need to repeat back."

"Words these are the aren't supposed to you be to listening."

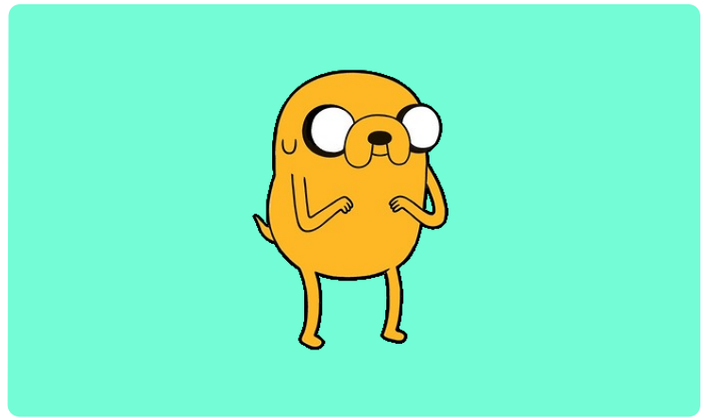


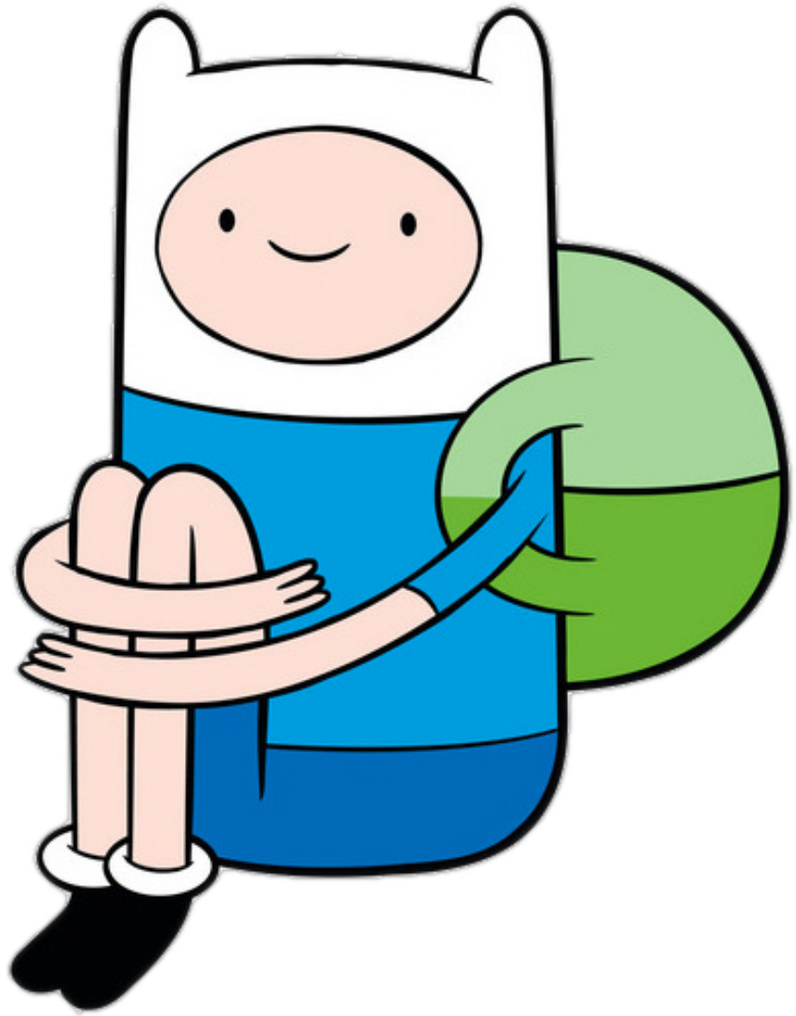
"These are the words you need to repeat back."

(Simons, 1999; Cherry, 1953; Triesman, 1964; Allport et al., 1972)

Attention

"These are the words you need to repeat back."



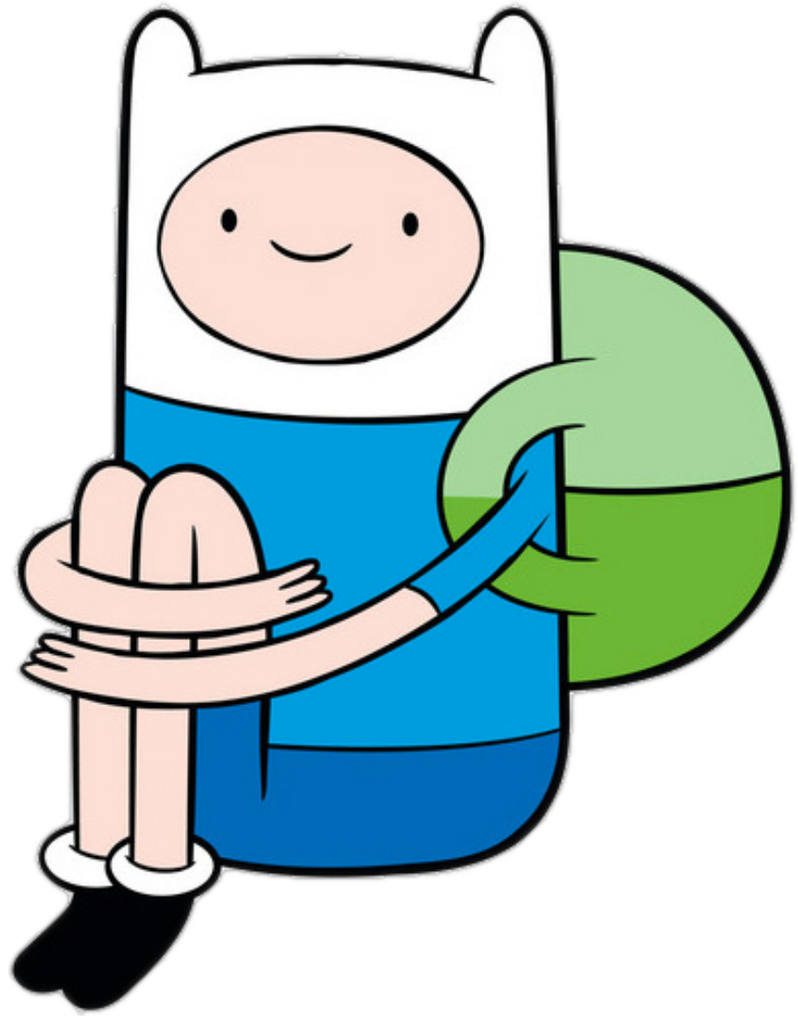


(Simons, 1999; Cherry, 1953; Triesman, 1964; Allport et al., 1972)

Attention

"These are the words you need to repeat back."

DOG

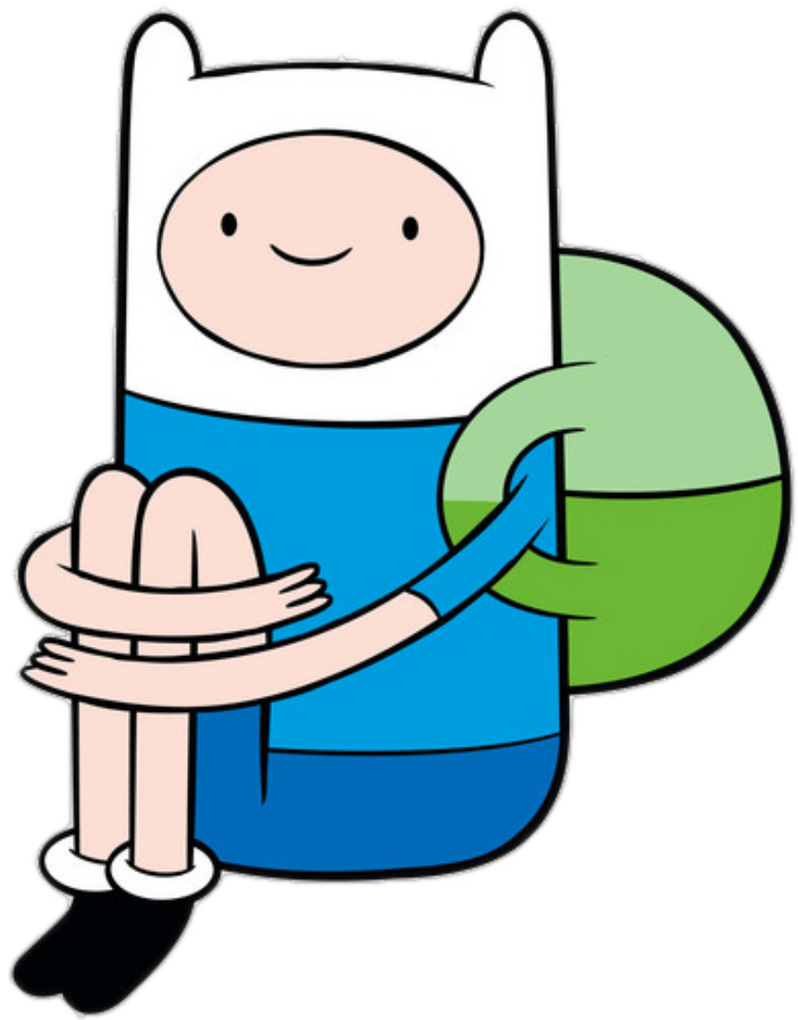


(Simons, 1999; Cherry, 1953; Triesman, 1964; Allport et al., 1972)

Attention

"These are the words you need to repeat back."

"dog"



(Simons, 1999; Cherry, 1953; Triesman, 1964; Allport et al., 1972)

Attention

Humans are pretty bad at multitasking:

- inattentional blindness
- dichotic listening task
- shadowing

task-specific resources

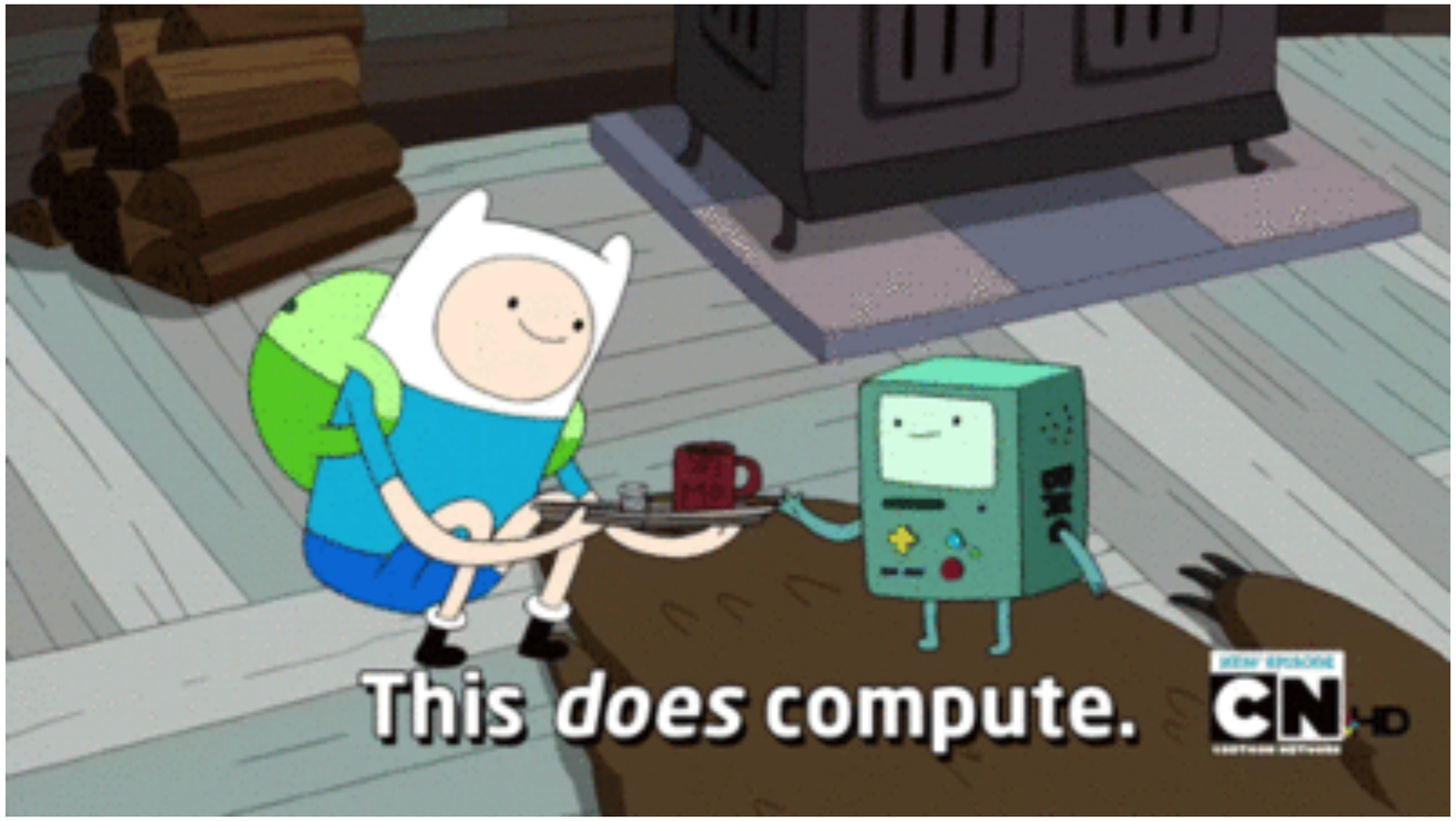
(Simons, 1999; Cherry, 1953; Triesman, 1964; Allport et al., 1972)

Attention

JavaScript does not multitask.

- single-threaded
- non-blocking
- asynchronous


BMO
NEW EPISODE
CN HD



http://itsadventuretimepeasants.tumblr.com/

Thanks!

↑

Me, @zeigenvector