

# LESSON 6

## EXECUTION CONTEXT & CLOSURES

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Actions Supported by All the Laws of Nature

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### Other References:

- <https://betterprogramming.pub/execution-context-lexical-environment-and-closures-in-javascript-b57c979341a5>
- <https://medium.com/@happymishra66/execution-context-in-javascript-319dd72e8e2c>
- <https://ui.dev/javascript-visualizer/>

**Wholeness:** A fundamental aspect of function-oriented programming in JavaScript is the use of closures to store state information associated with a function when the function is passed to other objects.

**Science of Consciousness:** Closures provide a protective wrapper for state information associated with a function. An analogy in consciousness is the supportive wrapper that transcendental consciousness provides to our own consciousness. At this level of consciousness, we are connected to the home of all the laws of nature.

# Main Points

1. Global Environment
2. Execution Context
3. Lexical Environment
4. Closure

# The six global objects

- The global object provides variables and functions that are available anywhere. By default, those that are built into the language or the environment.
- In a browser it is named **window**, for Node.js it is **global**, for other environments it may have another name.

| Name      | Description  |
|-----------|--|
| document  | Current HTML page and its content                  |
| history   | List of pages the user has visited                 |
| location  | URL of the current HTML page                       |
| navigator | Info about the web browser you are using           |
| screen    | Info about the screen area occupied by the browser |
| window    | The browser window                                 |

# The window object



- *the entire browser window; the top-level object in DOM hierarchy*
- technically, all global code and variables become part of the window object
- properties:
  - [document](#), [history](#), [location](#), [name](#)
- methods:
  - [alert](#), [confirm](#), [prompt](#) (popup boxes)
  - [setInterval](#), [setTimeout](#), [clearInterval](#), [clearTimeout](#) (timers)
  - [open](#), [close](#) (popping up new browser windows)
  - [blur](#), [focus](#), [moveBy](#), [moveTo](#), [print](#), [resizeBy](#), [resizeTo](#), [scrollBy](#), [scrollTo](#)

# Popup windows with window.open

```
window.open("http://foo.com/bar.html", "My Foo Window",  
"width=900,height=600,scrollbars=1");
```

- [window.open](#) pops up a new browser window
- This method is the cause of all the terrible popups on the web!
- some popup blocker software will prevent this method from running



# The document object

- JavaScript representation of *the current web page and the elements inside it*
- properties:
  - [anchors](#), `body`, [cookie](#), [domain](#), [forms](#), [images](#), [links](#), [referrer](#), [title](#), [URL](#)
- methods:
  - [getElementById](#)
  - [getElementsByClassName](#)
  - [getElementsByName](#)
  - [getElementsByTagName](#)
  - [close](#), [open](#), [write](#), [writeln](#)
- [complete list](#)



# The location object

- *the URL of the current web page*
- properties:
  - [host](#), [hostname](#), [href](#), [pathname](#), [port](#), [protocol](#), [search](#)
- methods:
  - [assign](#), [reload](#), [replace](#)
- [complete list](#)

# The navigator object

- *information about the web browser application*
- properties:
  - [appName](#), [appVersion](#), [language](#), [cookieEnabled](#), [platform](#)
  - [complete list](#)
- Some web programmers examine the navigator object to see what browser is being used, and write browser-specific scripts and hacks:
  - `if (navigator.appName === "Microsoft Internet Explorer") { ...`
  - (this is poor style; you should not need to do this)

# The screen object

- *information about the client's display screen*
- properties:
  - [availHeight](#), [availWidth](#), [colorDepth](#), [height](#), [pixelDepth](#), [width](#)
  - [complete list](#)

# The history object

- *the list of sites the browser has visited in this window*
- properties:
  - [length](#)
- methods:
  - Moving backward and forward through the user's history is done using the [back](#), [forward](#), [go](#) methods.
  - `window.history.back();`
  - HTML5 history API allows JavaScript to [manipulate for SPA](#)
- [complete list](#)
- sometimes the browser won't let scripts view history properties, for security

# Main Point

JavaScript has a set of global DOM objects accessible to every web page. Every Javascript object runs inside the global window object. The window object has many global functions such as alert and timer methods.

*At the level of the unified field, an impulse anywhere is an impulse everywhere.*

# JavaScript Engine

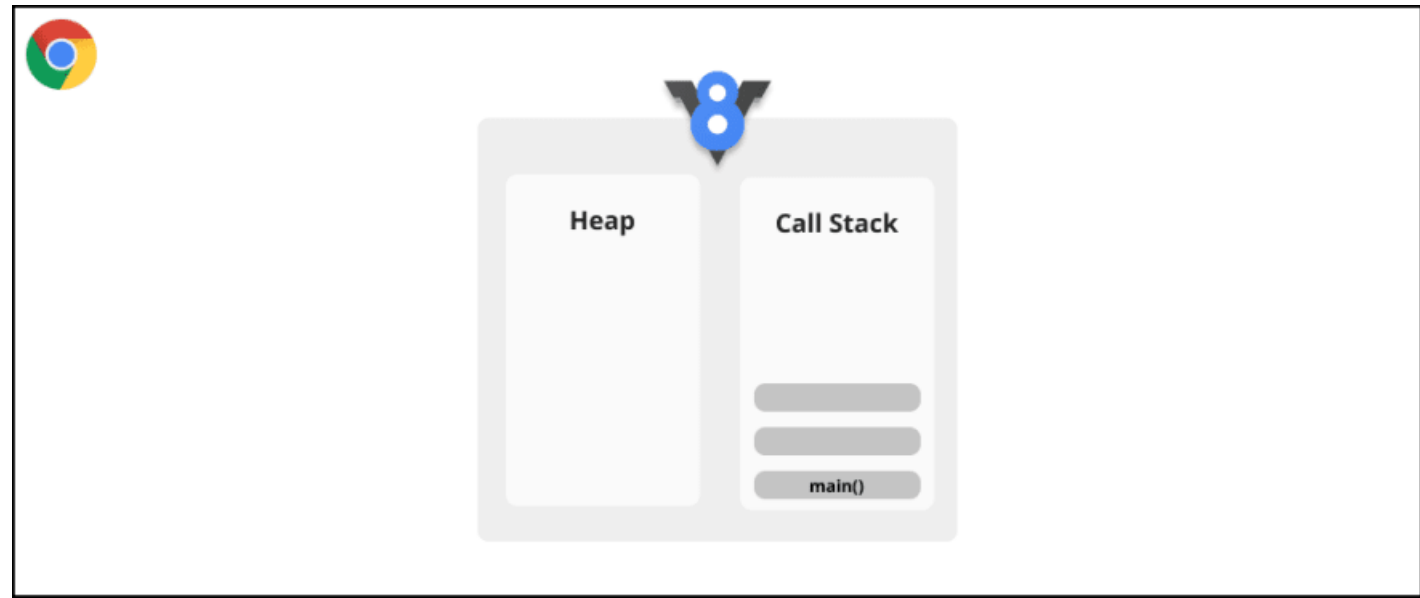
The JavaScript engine is a program that executes the JavaScript code.

A popular example of a JavaScript engine is Google's V8 engine.

The V8 engine is an open-source and written in C++.

Two main components:

- **Heap** is an unstructured memory that is used for memory allocation of the objects.
- **Call Stack** is a LIFO data structure that is used for function calls that record where we are in the program.



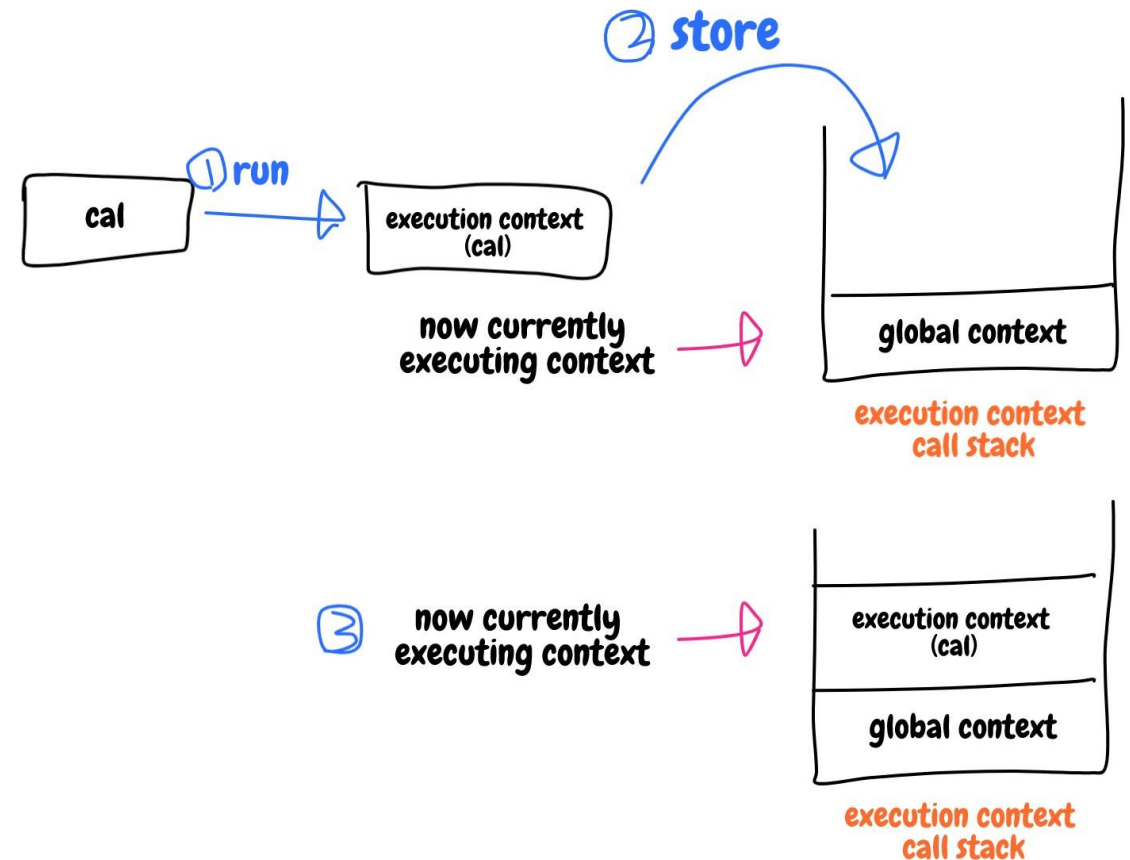
# What is Execution Context?

- **Execution context (EC)** is created when the JavaScript code is executed.
- All ECs are pushed to Execution Context Stack (**call stack**)
- Two types of EC:
  - **Global execution context (GEC):**
    - Default, loads first when run JS in browser
    - Only 1 GEC, JS is single threaded
    - Stores global objects: `window`, `document`, `history`, etc.
  - **Functional execution context (FEC):**
    - Created whenever any function is called
    - Each function has its own execution context
    - No `window` or other global objects
    - `arguments` object

# Draw Execution Context Stack

```
function cal(type, a, b) {
  if (type === 'add') {
    return a + b;
  } else if (type === 'subtract') {
    return a - b;
  } else if (type === 'multiply') {
    return a * b;
  } else {
    return a / b;
  }
}
```

```
let four = 4;
let seven = 7;
cal('add', four, seven);
```





# Two Stages Creating EC by JS Engine

## 1. Creation Phase

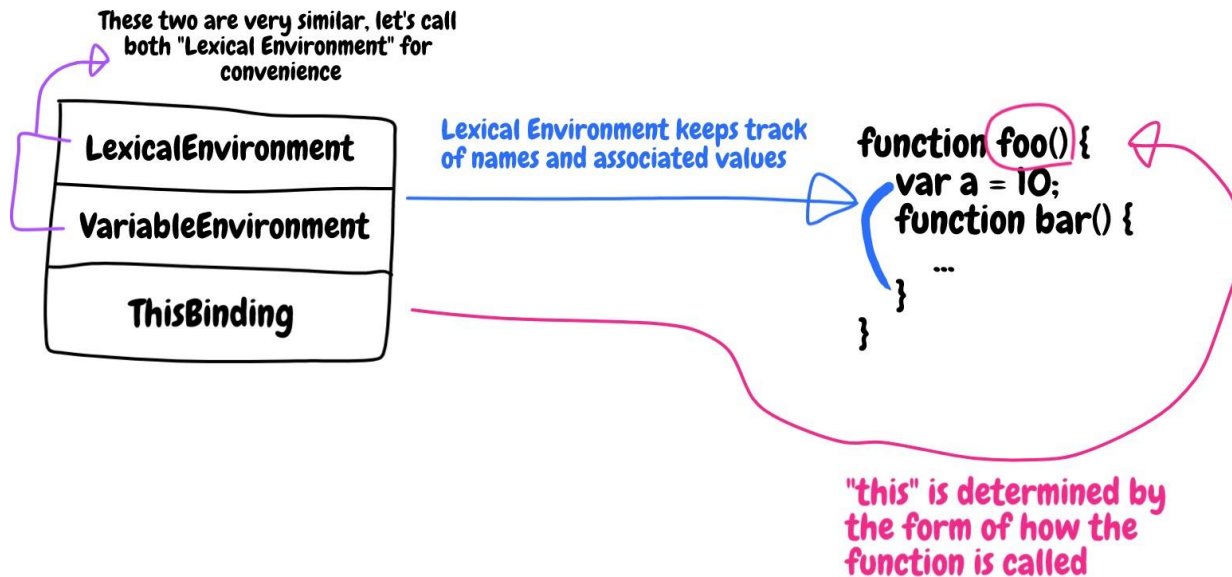
- A function is called but its execution has not started
- JS engine compile the code, doesn't execute any code
  - Records variable declarations, functions – only variable declared with `var`, not `let` and `const`

## 2. Execution Phase

- Scans through the function
- Update the variable object with the values of the variables
- Execute variables declared with `let` and `const`

# Creation Phase: Lexical Environment (LE)

- A execution context is divided into three different areas
- **LE** is to keep track of variables, function names and associated values
  - `ThisBinding` determines how the function is called, will explain in later lecture.



```
function foo() {
  var a = 10;
  function bar() {}
}
foo();
```

// When foo is called, a new execution environment  
// might look like this below

```
execution_environment: {
  LexicalEnvironment: {
    a: undefined,
    bar: function() {}
  },
  ThisBinding: ...
}
```

# Creation Phase:

## What's inside Lexical Environment?

- EnvironmentRecord
  - records declaration of variables, functions.
- Outer Lexical Environment – Scope
  - Links to parent LexicalEnvironment
  - Used when can't find a property in the current LexicalEnvironment
  - Global LexicalEnvironment doesn't have outer, `null`

# Creation Phase:

## Example: The Global Lexical Environment

```
let x = 1;
```

```
function foo() {  
  let y = 2;
```

```
  function bar() {  
    let z = 3;
```

```
    function baz() {  
      console.log(z);  
      console.log(y);  
      console.log(x);  
      console.log(w);
```

```
    }
```

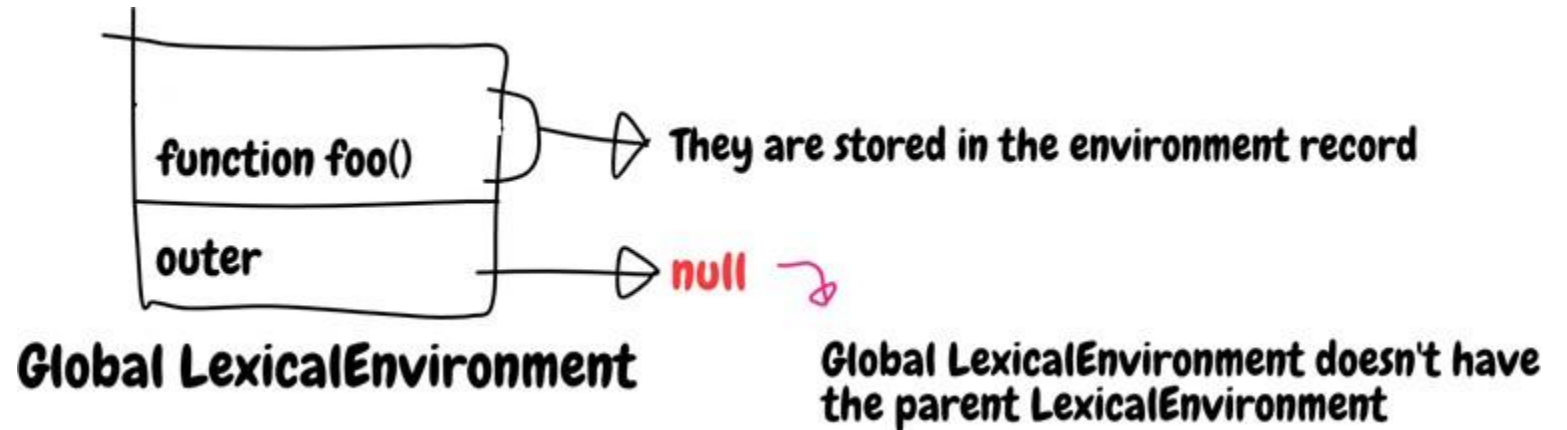
```
    baz();
```

```
  }
```

```
  bar();
```

```
}
```

```
foo();
```



# Execution Phase: Scope Chain

- A list of all the variable objects of functions inside which the current function exists
- The entire relationship amongst LexicalEnvironments

```
let x = 1;
```

```
function foo() {
```

```
  let y = 2;
```

```
  function bar() {
```

```
    let z = 3;
```

```
    function baz() {
```

```
      console.log(z);
```

```
      console.log(y);
```

```
      console.log(x);
```

```
      console.log(w);
```

```
    }
```

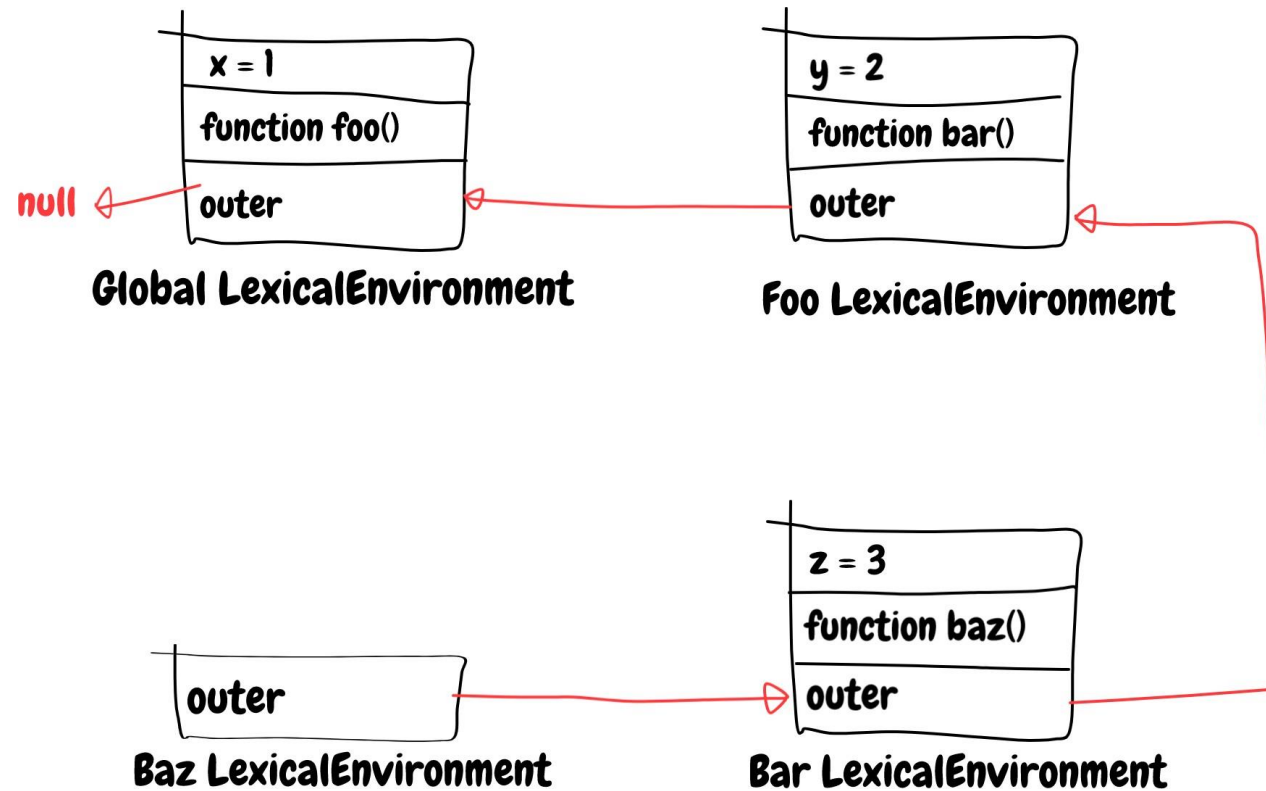
```
    baz();
```

```
  }
```

```
  bar();
```

```
}
```

```
foo();
```



# Execution Phase:

## The workflow when `z` and `w` are looked for

- When `baz()` is called, it looks for `z`, `y`, `x`, and `w`.

```
let x = 1;
```

```
function foo() {
```

```
  let y = 2;
```

```
  function bar() {
```

```
    let z = 3;
```

```
    function baz() {
```

```
      console.log(z);
```

```
      console.log(y);
```

```
      console.log(x);
```

```
      console.log(w);
```

```
    }
```

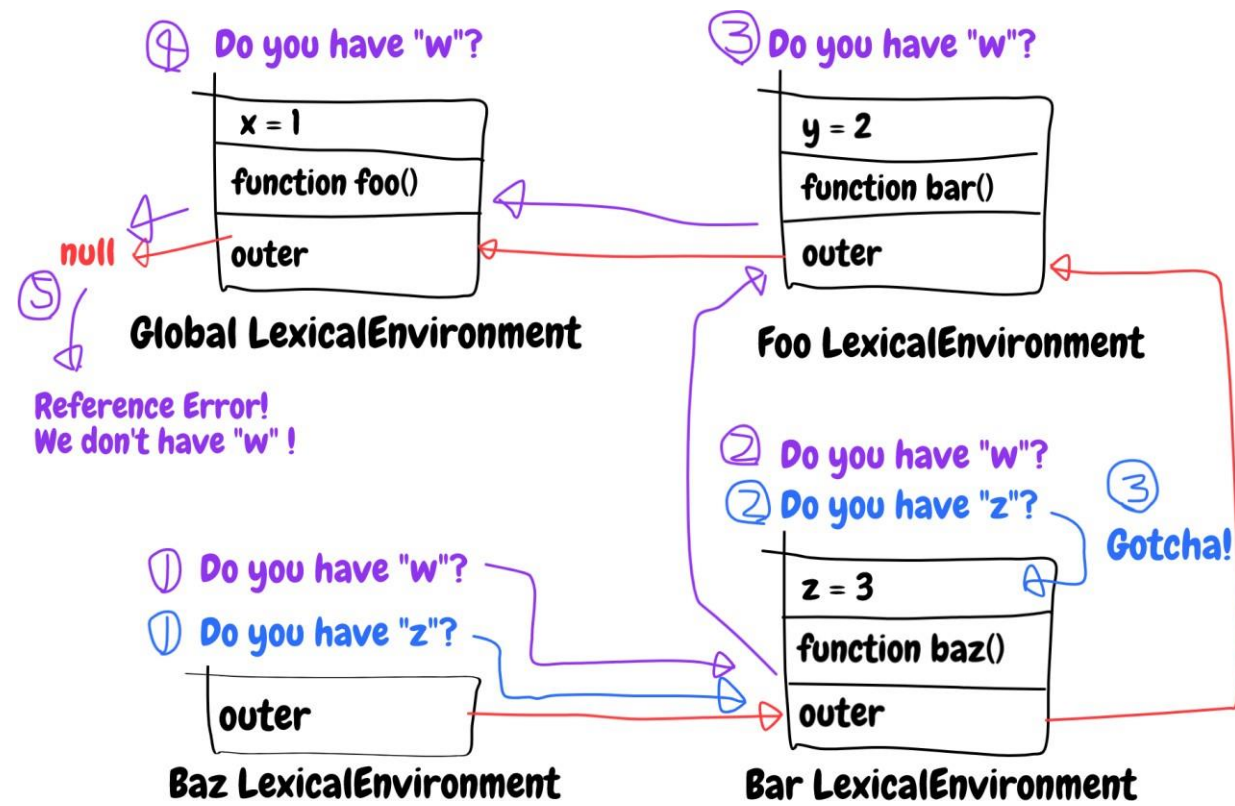
```
    baz();
```

```
  }
```

```
  bar();
```

```
}
```

```
foo();
```



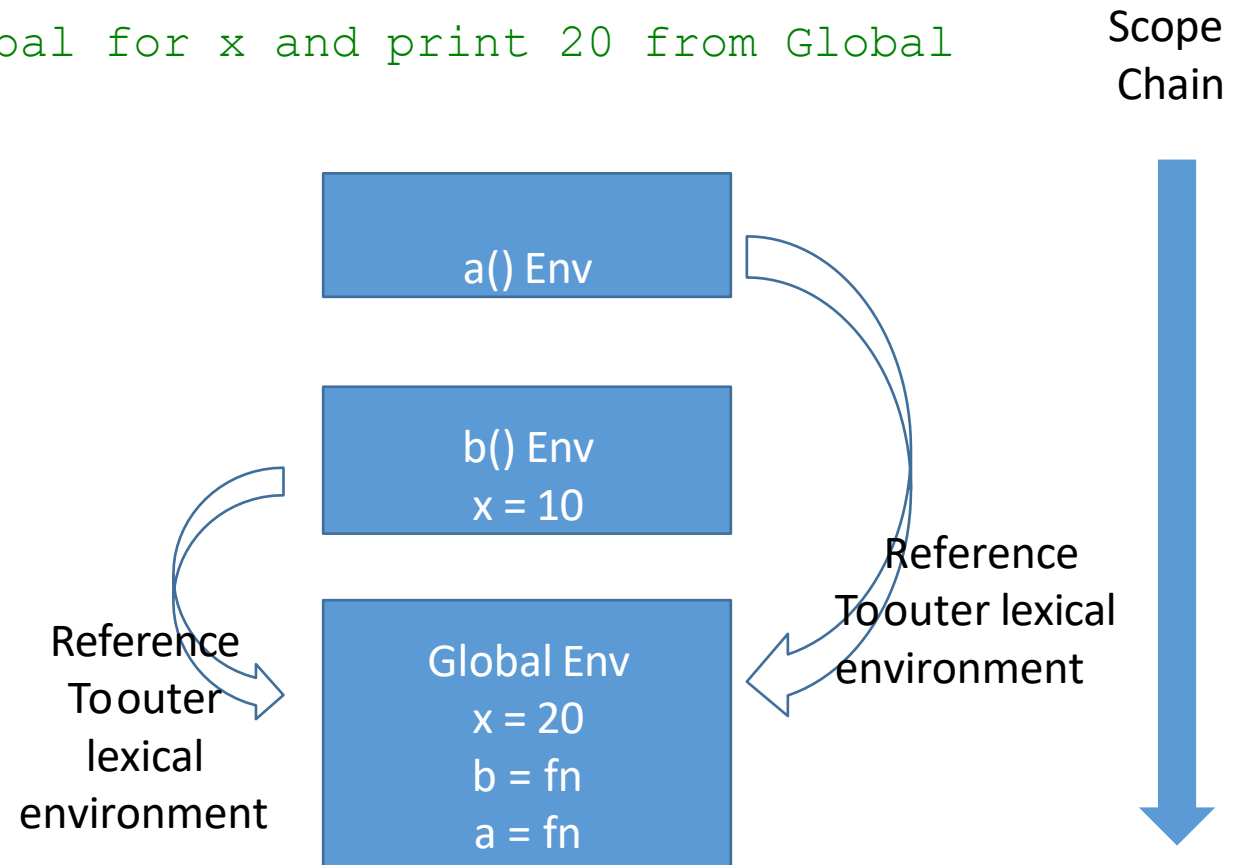
# Nested functions

- A function is called “nested” (inner) when it is created inside another function
- Nested functions are quite common in JavaScript.
- What’s much more interesting, a nested function can be returned:
  - as a property of a new object
    - if the outer function creates an object with methods
  - as a result by itself.
    - can then be used somewhere else.
    - No matter where, it still has access to the same outer variables



# Environment exercise: Scope Example1

```
function a() {  
  console.log(x); // consult Global for x and print 20 from Global  
}  
function b() {  
  const x = 10;  
  a(); // consult Global for a  
}  
const x = 20;  
b();
```



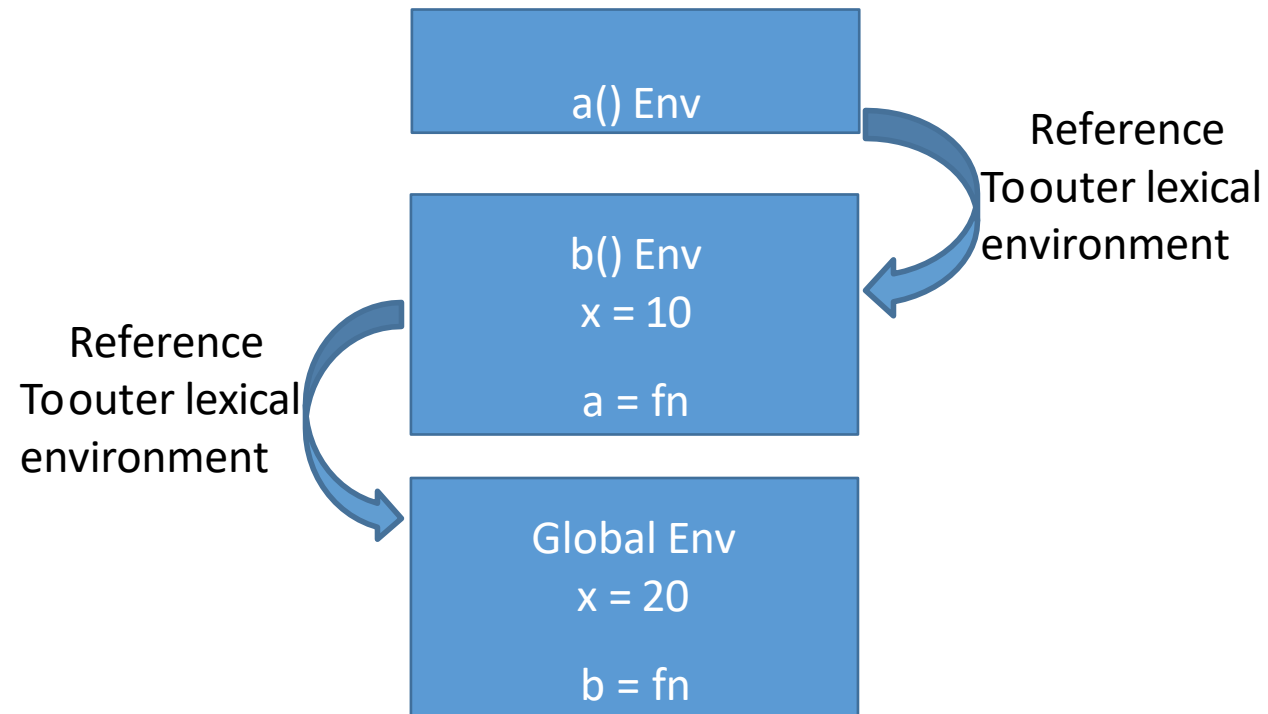




# Environment exercise:

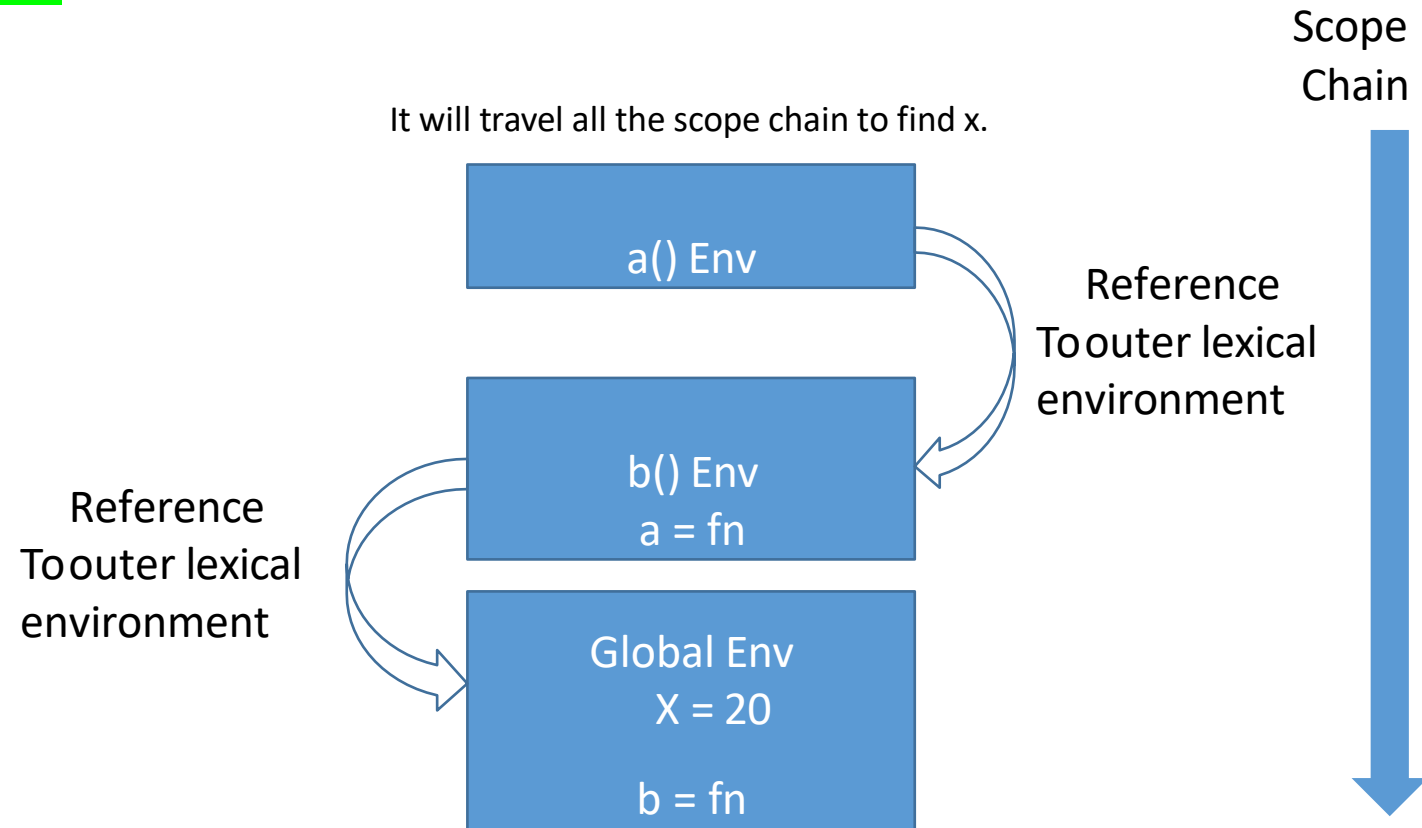
## Scope Example 2: Inner function

```
function b() {  
  function a() {  
    console.log(x);  
  }  
  const x = 10;  
  a();  
}  
const x = 20;  
b();
```



# Environment exercise: Scope Example 3

```
function b() {  
  function a() {  
    console.log(x);  
  }  
  a();  
}  
const x = 20;  
b();
```



# Main Point Preview: Closures

Closures are created whenever an inner function with free variables is returned or assigned as a callback. Closures provide encapsulation of methods and data. Encapsulation promotes self-sufficiency, stability, and re-usability.

**Science of Consciousness:** Closures provide a supportive wrapper for actions that will occur in another context. Transcendental consciousness provides a supportive wrapper for our actions that will occur outside of meditation.

# What is a Closure?

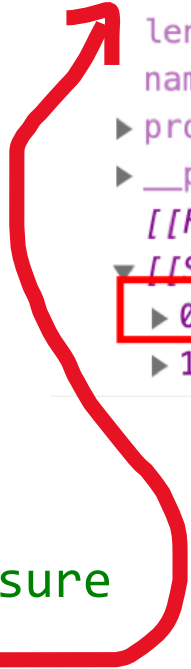
- (def) A **closure** is the combination of function bundled together (enclosed) with references to its surrounding state (the **lexical environment**).
  - some define closures to be (only) when there is an inner function with free outer variable
    - “free” variables (not defined in the local function and global)
- A closure is created:
  - To **expose a function**, return it or pass it to another function.
  - **inner function will have access to variables in the outer function scope, even after outer function has returned (removed from execution context stack).**

# Closure Details

```
let x = 1;
```

```
function foo(y) {  
  return function(z) {  
    return x + y + z;  
  }  
}
```

```
let f = foo(2); // f is closure  
console.dir(f);
```



```
▼ f anonymous(z) ⓘ  
  arguments: null  
  caller: null  
  length: 1  
  name: ""  
  ► prototype: {constructor: f}  
  ► __proto__: f ()  
  [[FunctionLocation]]: VM1644:3  
  ▼ [[Scopes]]: Scopes[2]  
    ► 0: Closure (foo) {y: 2}  
    ► 1: Global {parent: Window, postMessage: f, blur: f, focus: f, close:...
```

## Closure Scope

```
arguments: { 0: 2, length: 1 }
```

```
this: window
```

```
y: 2
```

# Execute Closure Details

```
let x = 1;
```

```
function foo(y) {  
  return function(z) {  
    return x + y + z;  
  }  
}
```

```
let f = foo(2); // f is closure  
console.dir(f);  
f(5);
```

## Closure Scope

```
arguments: { 0: 2, length: 1 }
```

```
this: window
```

```
y: 2
```

## anonymous Execution Context

```
Phase: Creation
```

```
arguments: { 0: 5, length: 1  
}
```

```
this: window
```

```
z: 5
```

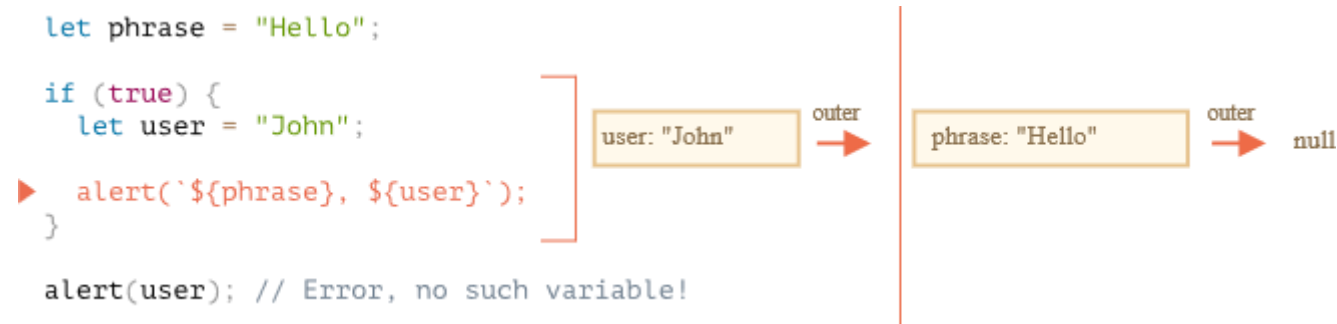
# Main Point: Closures

Closures are created whenever an inner function with free variables is returned or assigned as a callback. Closures provide encapsulation of methods and data. Encapsulation promotes self-sufficiency, stability, and re-usability.

**Science of Consciousness:** Closures provide a supportive wrapper for actions that will occur in another context. Transcendental consciousness provides a supportive wrapper for our actions that will occur outside of meditation.

# Code blocks and scope

- a Lexical Environment exists for any code block { . . . }
- created when a code block runs and contains block-local variables.



- When execution gets to the `if` block,
  - new “`if-only`” Lexical Environment is created for it
  - has the reference to the outer one, so `phrase` can be found.
  - all variables and Function Expressions declared inside `if` reside in that Lexical Environment
    - can’t be seen from the outside
    - after `if` finishes, the `alert` below won’t see the `user`, hence the error.



# For, while

- For a loop, every iteration has a separate Lexical Environment.
  - If a variable is declared in `for (let ...)`, then it's also in there:

```
for (let i = 0; i < 10; i++) {
  // Each loop has its own Lexical Environment
  // {i: value}
}
alert(i); // Error, no such variable
```

- `for let i` is visually outside of `{ ... }`.
  - The `for` and `while` constructs are special
  - each iteration of the loop has its own Lexical Environment with the current `i` in it.
- like `if`, after the loop `i` is not visible.

# Bare code blocks

- can use “bare” code block {...} to isolate variables into a “local scope”.
  - in web browser all scripts share the same global area.
  - create a global variable in one script, it becomes available to others.
  - source of conflicts if two scripts use the same variable name
    - Last one loaded overwrites and becomes source of values for early script too
    - if the variable name is a widespread word, e.g., lat, long
- to avoid that, can use a code block to isolate the whole script or a part of it:

```
{  
    // do some job with local variables that should not be seen outside  
    let message = "Hello";  
    alert(message); // Hello  
}  
alert(message); // Error: message is not defined
```

- code outside block doesn't see variables inside the block
  - Every block has own Lexical Environment.

# The old “var”

- In the very first chapter about variables, we mentioned three ways of variable declaration:
  1. `let`
  2. `const`
  3. `var`
- `let` and `const` behave exactly the same way in terms of Lexical Environments.
  - `var` is a very different beast,
  - originates from very old times.
  - generally not used in modern scripts, but still lurks in the old ones.
- If you don't plan on meeting such scripts, you may even skip this chapter or postpone it
  - But is used in millions of programs – anything prior to ES6
- function scope
  - Ignores blocks
  - Are always ‘hoisted’, which means they are visible throughout the function
    - Even if defined at the end! (like a function declaration)
    - Only the declaration is hoisted, not the assignment
    - Undefined until assignment reached

# IIFE

- Before ES6 no block-level lexical environment in JavaScript.
  - Only function scope
- “immediately-invoked function expressions” (abbreviated as IIFE).
  - Special syntax to wrap code and protect global namespace
  - declare a Function Expression and run it immediately
  - nowadays there’s no reason to write such code

```
(function() {  
    var message = "Hello";  
    alert(message); // Hello  
})();
```

# Main Point Preview: Timeout callbacks

The asynchronous global methods `setTimeout` and `setInterval` take a function reference as an argument and then callback the function at a specified time.

Science of Consciousness: Accepting an assignment and carrying it out at a designated time is a fundamental capability required for intelligent behavior. A clear awareness and mind promotes good memory and the ability to successfully execute tasks.

# Timers

- `setTimeout` allows to run a function once after the interval of time.
- `setInterval` allows to run a function regularly with the interval between the runs.



# setTimeout

```
let timerId = setTimeout(func, [delay], [arg1], [arg2], ...)
```

- **Func**: Function or a string of code to execute.
- **Delay**: delay before run, in milliseconds (1000 ms = 1 second), by default 0.
- **arg1, arg2...**: Arguments for the function

```
function sayHi() {  
    alert('Hello');  
}  
setTimeout(sayHi, 1000);
```

- With arguments:

```
function sayHi(phrase, who) {  
    alert(phrase + ', ' + who);  
}  
setTimeout(sayHi, 1000, "Hello", "John"); // Hello, John
```

# Pass a function, but don't run it

- Novice developers sometimes make a mistake by adding brackets ()

// wrong!

```
setTimeout(sayHi(), 1000);
```

- doesn't work,
  - `setTimeout` expects a reference to a function.
  - here `sayHi()` runs the function,
  - result of its execution is passed to `setTimeout`.
  - result of `sayHi()` is `undefined` (the function returns nothing), so nothing is scheduled
- function call versus function binding
  - `sayHi()` versus `sayHi`
  - execute the function versus reference to the function
  - **fundamental concept!!**



# Canceling with `clearTimeout`



\*

A call to `setTimeout` returns a “timer identifier” `timerId` that we can use to cancel the execution.

```
let timerId = setTimeout(...);  
clearTimeout(timerId);
```

schedule the function and then cancel it

```
let timerId = setTimeout(() => alert("never happens"), 1000);  
alert(timerId); // timer identifier  
clearTimeout(timerId);  
alert(timerId); // same identifier (doesn't become null after canceling)
```



# setInterval

The `setInterval` method has the same syntax as `setTimeout`:

```
let timerId = setInterval(func, [delay], [arg1], [arg2], ...)
```

Repeatedly calls the function after the given interval of time.

To stop further calls, we should call `clearInterval(timerId)`.

```
// repeat with the interval of 2 seconds
```

```
let timerId = setInterval(() => alert('tick'), 2000);
```

```
// after 5 seconds stop
```

```
setTimeout(() => { clearInterval(timerId); alert('stop'); }, 5000);
```

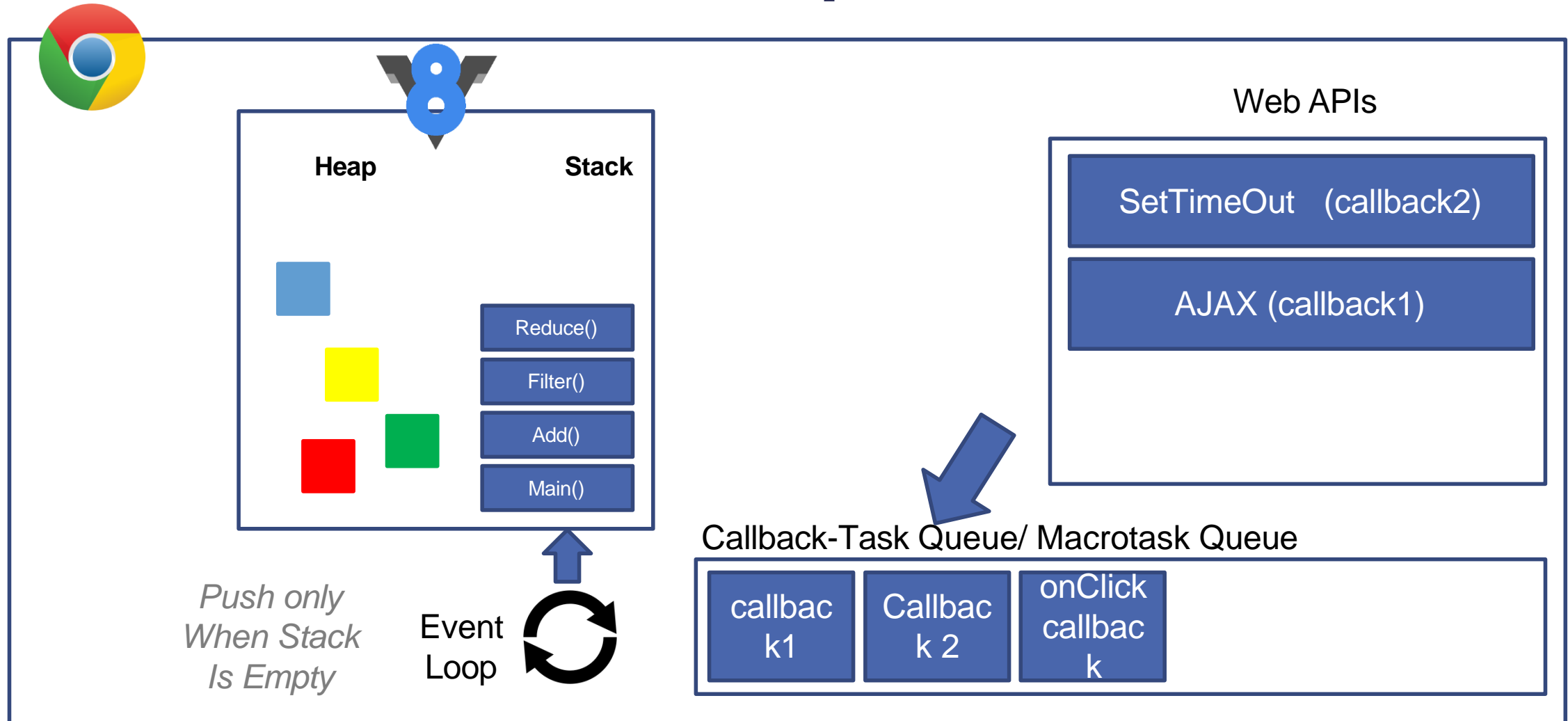
# Zero delay setTimeout



- There's a special use case: `setTimeout(func, 0)`, or just `setTimeout(func)`.
- schedules the execution of `func` as soon as possible.
  - after the current code is complete.

```
setTimeout(() => alert("Hello"), 0);  
alert("World");
```

# Chrome – The Event Loop



*If you block the stack, browser can't run the render queue*



**Heap**

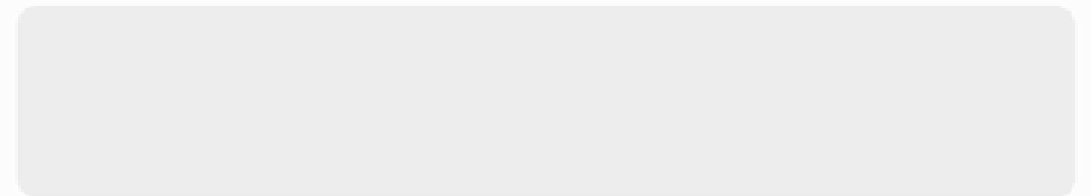
**Call Stack**

```
console.log("start");  
  
// 1 sec delay  
setTimeout(function() {  
  console.log("1 sec delay");  
}, 1000);  
  
console.log("end");
```

**Web APIs**

**Callback Queue**

**Event Loop**



# Main Point: Timeout callbacks

The asynchronous global methods `setTimeout` and `setInterval` take a function reference as an argument and then callback the function at a specified time.

Science of Consciousness: Accepting an assignment and carrying it out at a designated time is a fundamental capability required for intelligent behavior. A clear awareness and mind promotes good memory and the ability to successfully execute tasks.

# CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

Actions Supported by All the Laws of Nature

1. Closures are a feature of functional programming languages that allow state information to be encapsulated with functions when they are passed among objects.
  2. The scope of variables in modern JavaScript is defined by the lexical environment.
- 
3. **Transcendental consciousness.** Is the home of all the laws of nature.
  4. **Impulses within the transcendental field:** Thoughts encapsulated by this deep level of consciousness will result in actions in accord with all the laws of nature.
  5. **Wholeness moving within itself:** In unity consciousness all thoughts and perceptions are enhanced by this supportive experience.

