

CENTER FOR MIND AND BRAIN

# Attention and Working Memory in Health and Disease

Steven J. Luck  
Center for Mind & Brain  
University of California, Davis

Quirkology Channel

# THE COLOUR CHANGING CARD TRICK

www.RichardWiseman.com

<https://www.youtube.com/watch?v=v3iPrBrGSJM>



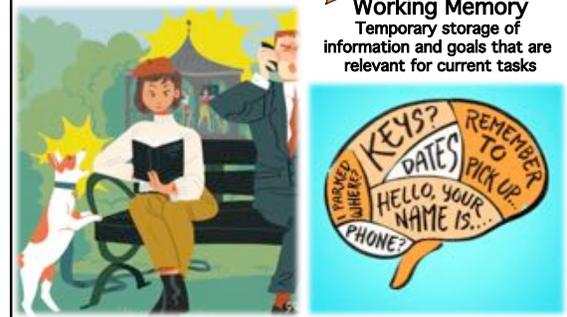
Was this a failure of attention or a failure of memory?

<https://www.youtube.com/watch?v=v3iPrBrGSJM>

**Attention**  
Concentrating your processing resources on relevant information and filtering out distractions

Attention controls what we store in working memory

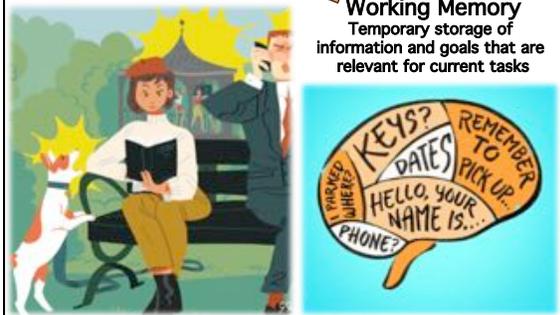
**Working Memory**  
Temporary storage of information and goals that are relevant for current tasks



**Attention**  
Concentrating your processing resources on relevant information and filtering out distractions

Working memory controls what we attend to

**Working Memory**  
Temporary storage of information and goals that are relevant for current tasks



## Attention & Competition



Try to perceive the house

### Attention & Competition



Try not to perceive the house

### Attention & Competition



Try to perceive the face

### Attention & Competition



Try not to perceive the face

### Attention & Competition



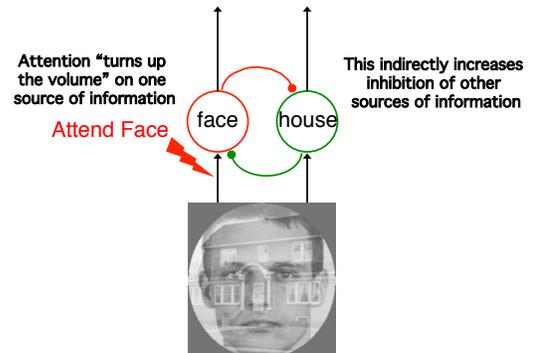
Try to perceive the face and not the house

### Attention & Competition



Try to perceive the house and not the face

### Attention: The Basic Neural Circuit



### Attention: The Basic Neural Circuit

Attend Face

face house

Attention doesn't have much impact in the absence of competition

### Attention: The Basic Neural Circuit

Attend Face

face house

It's really hard to ignore something if there is no attended competitor

We can actually filter better when we're overloaded

### Attention: The Basic Neural Circuit

Attend Face

face house

It's really hard to ignore something if there is no attended competitor

We can actually filter better when we're overloaded

### Attention: The Basic Neural Circuit

Attend Face

face house

We can actually filter better when we're overloaded

### Attention is particularly difficult when we must filter out a potent distractor or overcome an automatic response

Algebra YouTube

Attend YouTube

It's easy to attend to YouTube and filter out your algebra homework

### Attention is particularly difficult when we must filter out a potent distractor or overcome an automatic response

Attend Algebra

Algebra YouTube

It's hard to attend to your algebra homework and filter out YouTube

### The Stroop Task

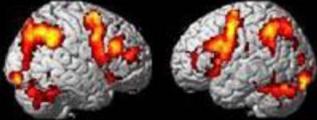
Easy Condition: Read the Words

red blue green green blue yellow red yellow  
 yellow red blue yellow green blue red green

### The Stroop Task

Difficult Condition: Name the Ink Colors

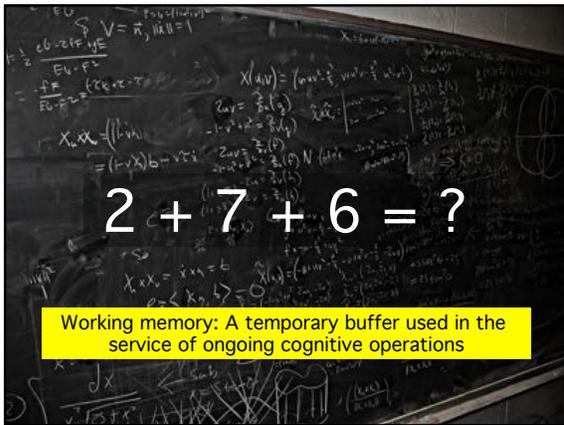
red blue green green blue yellow red yellow  
 yellow red blue yellow green blue red green



Hugdahl et al. (2015, Frontiers in Human Neuroscience)

### Working Memory

Temporary storage of information and goals that are relevant for current tasks

$2 + 7 + 6 = ?$

Working memory: A temporary buffer used in the service of ongoing cognitive operations

### Visual Working Memory



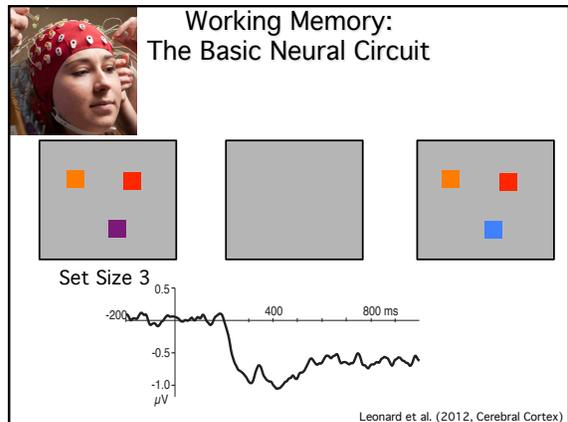
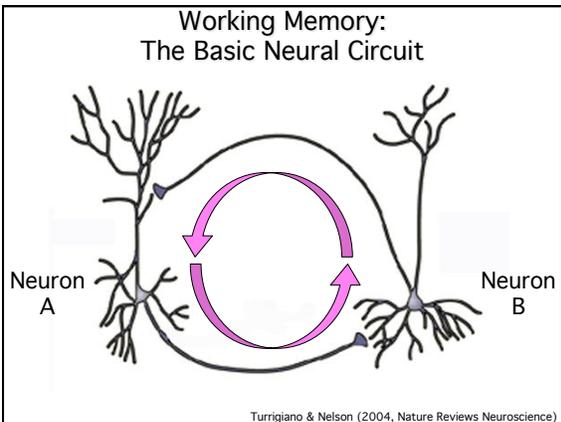
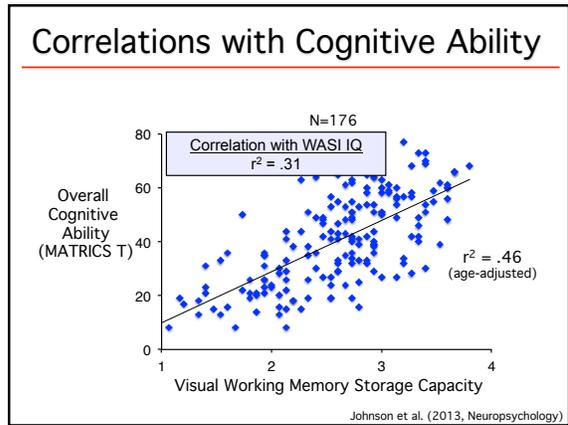
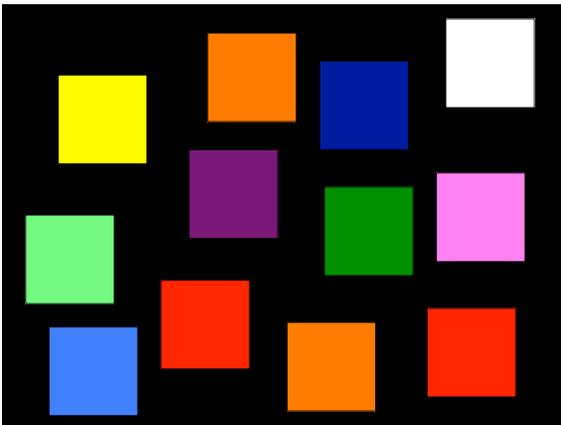
[https://en.wikipedia.org/wiki/Spot\\_the\\_difference](https://en.wikipedia.org/wiki/Spot_the_difference)

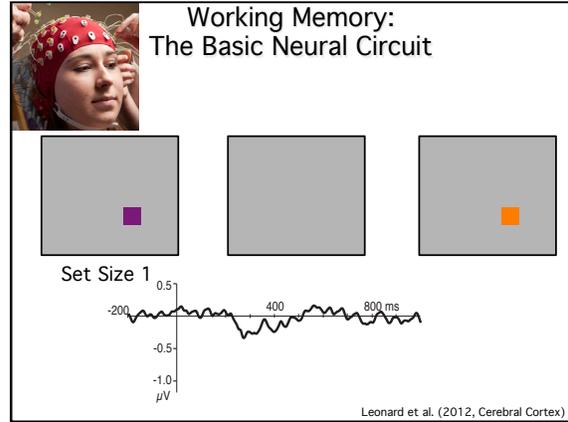
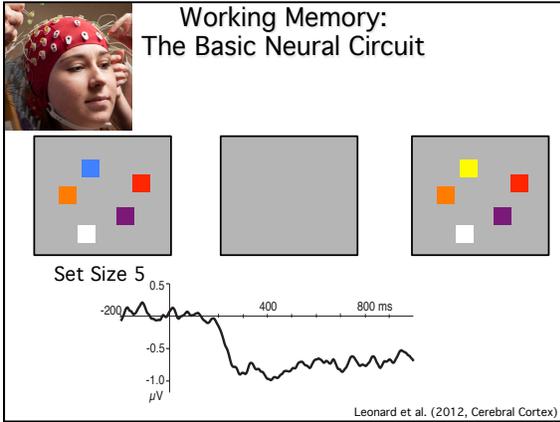
### Two Key Properties of Working Memory

- Maintains information over short periods of time
- Very limited storage capacity



Was this panel on the left or right side of the original image?





**Schizophrenia**  
1-2% lifetime prevalence  
Characterized by hallucinations, delusions, disorganized thought

Degree of impairment in basic cognitive functioning is a much better predictor of long-term outcome than degree of hallucinations, delusions, and disorganized thought

**Schizophrenia**  
1-2% lifetime prevalence  
Characterized by hallucinations, delusions, disorganized thought

**The Impaired Filtering Hypothesis**

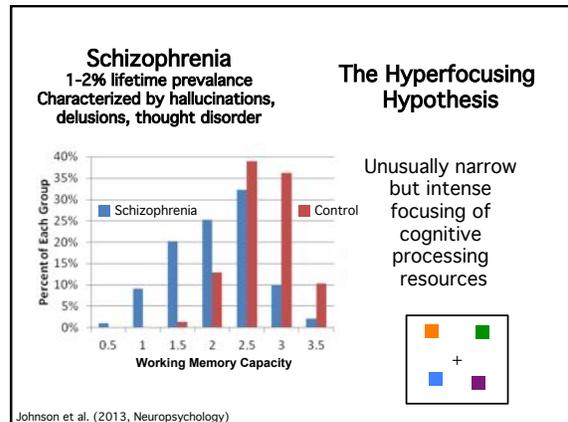
“I remember one day when I got caught in the rain. Each drop felt like an electric shock and I found it hard to move because of how intense and painful the feeling was.”

-Djinn (<http://forum.schizophrenia.com/t/sensory-overload/4910>)

**Schizophrenia**  
1-2% lifetime prevalence  
Characterized by hallucinations, delusions, disorganized thought

**The Hyperfocusing Hypothesis**

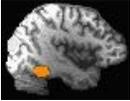
Unusually narrow but intense focusing of cognitive processing resources



**Schizophrenia**  
1-2% lifetime prevalence  
Characterized by hallucinations, delusions, thought disorder

**The Hyperfocusing Hypothesis**

Unusually narrow but intense focusing of cognitive processing resources



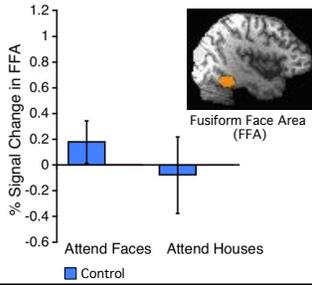
Fusiform Face Area (FFA)




**Schizophrenia**  
1-2% lifetime prevalence  
Characterized by hallucinations, delusions, thought disorder

**The Hyperfocusing Hypothesis**

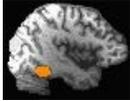
Unusually narrow but intense focusing of cognitive processing resources



% Signal Change in FFA

Attend Faces Attend Houses

Control



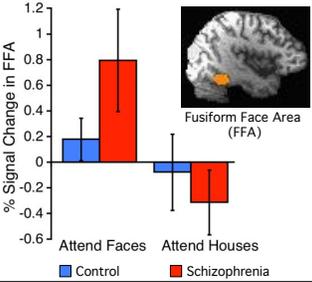
Fusiform Face Area (FFA)



**Schizophrenia**  
1-2% lifetime prevalence  
Characterized by hallucinations, delusions, thought disorder

**The Hyperfocusing Hypothesis**

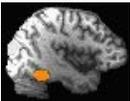
Unusually narrow but intense focusing of cognitive processing resources



% Signal Change in FFA

Attend Faces Attend Houses

Control Schizophrenia



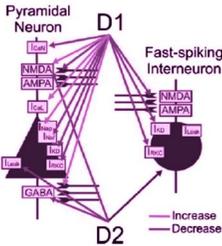
Fusiform Face Area (FFA)



**Schizophrenia**  
1-2% lifetime prevalence  
Characterized by hallucinations, delusions, thought disorder

**The Hyperfocusing Hypothesis**

Unusually narrow but intense focusing of cognitive processing resources



Pyramidal Neuron D1 Fast-spiking Interneuron D2

— Increase — Decrease

Durstewitz & Seamans (2008)

**Schizophrenia**  
1-2% lifetime prevalence  
Characterized by hallucinations, delusions, disorganized thought

**The Hyperfocusing Hypothesis**

“I remember one day when I got caught in the rain. Each drop felt like an electric shock and I found it hard to move because of how intense and painful the feeling was.”

-Djinn (<http://forum.schizophrenia.com/t/sensory-overload/4910>)



**What Have We Learned?**

Attention Boosting & Competition

Working Memory Short Duration Limited Capacity

Schizophrenia Impaired Cognition Hyperfocusing

