The biological basis of conscious experience:

Global workspace dynamics in the brain.

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Society for Mind-Brain Sciences.
The limited capacity paradox:
Conscious contents are estimated at 1 item to
a maximum of 4 items at any time.
(N. Cowan, 2005).
With that kind of limited capacity
How did you and I ever get here?

Our Ancestors …
With that kind of limited capacity ...

How did you and I ever get here?

The Answer is: We wouldn't!
This question suggests that conscious cognition provides compensatory benefits.
Just like any other biological capacity, conscious and unconscious events have pros and cons. for survival and reproduction.

Some brain sizes in primates.
Conscious cognition creates many kinds of access...
Conscious cognition creates many kinds of access...

Between the observing “I” and the objects of perception...
Conscious cognition creates many kinds of access...

Between Implicit goals and voluntary actions...
Conscious cognition creates many kinds of access...

Between sensory input and learning...
Conscious elements can recruit unconscious Working Memory functions.


**Unconscious executive**
Provides goals, resolves goal competition, makes decisions on action plans

**Brain: DL-PfC, Anterior Cing, PPC**

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**Global Workspace**
(conscious perception, images, inner speech, reportable goals, recruitment of unconscious subsystems)

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**Unconscious verbal automatisms**

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**Unconscious items in immediate memory**
(Working Memory)

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**Unconscious visuospatial Automatisms**
(Motor habits)

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Input
(sensory & endogenous
Inner speech & visual imagery)

Phonological conscious Loop – just inner speech

Voluntary output
E.g., Pointing to conscious contents
Selective attention lights up the conscious bright spot.

Many “backstage” activities control the conscious show but are unconscious...

The small, conscious bright spot on the stage of working memory.

The audience has vast capacity.

The unconscious audience receives input from the bright spot on stage.
The anatomical basis of conscious contents:
The cortex and thalamus.

Notice that Waking and Dreaming are both conscious states, as shown by EEG and other empirical indices, including behavioral reportability.
The thalamo-cortical complex shows small-world connectivity.

(from: Izhikevich & Edelman, PNAS, 2008)
Brains are massively parallel bio-computers... and oscillations are functional ...

Phase-locked oscillations from .1 Hz – 600 Hz coordinate and transmit information.

(from: Izhikevich & Edelman, PNAS, 2008)
Hypothesis 1: The conscious objects of experience are associated with momentary “broadcasts” in the wave-medium of the t-c core. (“t-c” = “thalamo-cortical”).

The arrow shows the direction of momentary propagation for visual conscious content. (About .1 sec per cycle.)
In the small-world network of the T-C system, any coalition of dynamically linked hubs could bind a Gestalt and broadcast it.

From Shanahan, 2010, based on Haggard et al, white matter connectivity
Global workspace dynamics (2012).

Where do conscious contents emerge in the brain?
Global workspace dynamics (2012).

Where do conscious contents emerge in the brain?

Dehaene & Changeux: prefrontal cortex

Zeki, V3/V4
Lamme
Logothetis et al.
Nobody --- because HM had normal-seeming consciousness

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Global workspace dynamics (2012).
Prediction:
Conscious contents can emerge ANYWHERE in the CT core, depending on stimulus and task conditions.

Dehaene & Changeux
Prefrontal cortex

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Prefrontal cortex for Feelings of Knowing, effort, etc.
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Early visual cortex for a single bright star on a dark night.

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IT (etc) for a coffee cup on a table.

MTL/IT/LOC for conscious episodes

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Global gamma/theta/alpha synchrony is one plausible substrate for global broadcasting.

Gamma coherence increase for conscious vs. unconscious stimuli ‘broadcasting’ from occipital to temporal and parietal regions.

Gaillard, Dehaene et al, 2009, PLOS ONE.
Typical topography and time course of VAN

VAN is illustrated as the posterior negativity (blue color), which develops between 100-200 ms and is maximal at occipital and posterior temporal sites around 250 ms. Late positive difference (LP) is demonstrated by the parietal positivity (red color) peaking after 400 ms. (The maps have been calculated from the data of Koivisto et al. 2006).
Global workspace dynamics (2012).

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Basic theory, on Amazon Kindle:

Most detailed, see Chapter 8: