dreammachine

SYSTEMS ARCHITECTURE FOR THE HUMAN MIND

HALLUCINATION AUDIT

EMPIRICAL TRACEABILITY LOG

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LOG ID	BOOK REFERENCE	RCT FILTER	CONFIDENCE TIER
SEC 3.1	CHAPTER 3: PROCESSOR (Conscious Management)	**OFF**	**CONSENSUS**

AUDITED CLAIM

BOTTLENECK (ATTENTION VS. PERIPHERAL AWARENESS)

SYSTEMS MODEL — AS STATED IN THE BOOK

The **10-bit limit** is a physical constraint of your prefrontal cortex. While your physical hardware passively absorbs **1 Billion bits** of raw data per second, your conscious mind can only neurologically render a highly restricted fraction of it.

VALIDATION QUERY

Is conscious working memory constrained by a severe capacity bottleneck while early unconscious sensory systems process information in a vastly parallel manner?

EMPIRICAL FINDING

Cognitive neuroscience paradigms demonstrate that conscious working memory operates through a severe **computational bottleneck**. By contrast, early unconscious sensory systems process information in a **vastly parallel and distributed manner**, empirically validating the architectural divide between focal attention and peripheral awareness.

PRIMARY ANCHORS

→ Mashour et al., 2020, Neuron

→ Marois & Ivanoff, 2005, Trends in Cognitive Sciences

ABOUT THIS RECORD

Each claim in the book is decompiled from its IT metaphor into a naked, falsifiable scientific claim, then anchored to a **primary peer-reviewed source**. Claim and anchor are queried against the Consensus academic database (200M+ papers) under a fixed protocol — top-tier **Q1/Q2 journals only**, preprints excluded, human studies only. If a hypothesis fails the audit, the build is rejected: the AI generates the syntax; the peer-reviewed grid validates the physics.

CONFIDENCE TIERS

- **CONSENSUS ◀ this log** — broadly established, highly replicated mechanics.
- **EMERGING** — plausible, actively researched; no universal consensus yet.
- **EXPERIMENTAL** — contested, extrapolated, or purely theoretical.

RCT FILTER — Controlled Studies is ON for interventions (a forced action must beat a control) and OFF for mechanisms (so foundational neuroscience isn't blocked).

Yes, **conscious working memory is bottlenecked**, while **early unconscious processing** is far more parallel.

1. Introduction

The literature supports the core contrast in the question, but with important limits. Conscious working memory is consistently described as a sharply capacity-limited system, typically supporting only about 3–4 simple items at once, with bottlenecks appearing in storage, attentional selection, retrieval, and dual-task coordination (Eriksson et al., 2015; Marois & Ivanoff, 2005; Vogel & Machizawa, 2004). By contrast, early sensory processing can preserve substantial stimulus-specific information without conscious access, and many models place unconscious processing in distributed, feature-selective sensory systems that operate in parallel before late conscious access occurs (Mashour et al., 2020; MacLean et al., 2023).

That said, neither side of the contrast is absolute. Working-memory limits vary with chunking, stimulus complexity, meaning, and context binding demands, so "severe bottleneck" is truest for simple individuated items under attention-demanding conditions, not for every form of active memory (Eriksson et al., 2015; Brady & Störmer, 2020; Gosseries et al., 2018). Likewise, unconscious processing is not simply "vastly parallel" in any unlimited sense: unseen representations can persist for seconds and even resist distraction, but they tend to be weaker, decaying, and less transformable than conscious active states (Mashour et al., 2020; Eriksson et al., 2015).

Is conscious working memory constrained by a severe capacity bottleneck while early unconscious sensory systems process information in a vastly parallel manner?
Requires at least 5 papers that directly answer your question. Try adjusting your query to find more papers.

FIGURE 1 Consensus on working memory bottlenecks and unconscious parallel processing

2. Methods

This Deep Search ran across more than 170 million research papers indexed in Consensus, including Semantic Scholar, PubMed, and related sources. The workflow identified 16,034 directly relevant search hits for the exact query, expanded the evidence base by citation crawling from 50 seed papers, and screened 240 papers after machine-learned relevance filtering. Of these, 176 papers passed eligibility review, and the 50 most relevant human studies and reviews were included for synthesis.

The search strategy combined six targeted groups: foundational models, capacity bottlenecks, unconscious and parallel sensory processing, critiques and alternative models, terminology variants, and adjacent constructs such as attention and cognitive control.

Search Strategy

40M Retrieved → **2.1K** Eligible → **50** Included

22 searches

1 citation graph use

All papers retrieved from 22 searches and 1 citation graph use.

Papers meeting relevance and quality criteria, after deduplication

Top papers selected to be included in the final analysis

FIGURE 2 Paper identification, screening, eligibility, and inclusion flow

3. Results

3.1 Key Papers

A small set of papers anchors the corpus because they define the mainstream position on capacity-limited conscious working memory and late conscious access. Reviews by Eriksson et al., Marois and Ivanoff, and Mashour et al. synthesize the strongest evidence for small-capacity active maintenance and for a separation between preserved early sensory processing and later conscious ignition (Eriksson et al., 2015; Marois & Ivanoff, 2005; Mashour et al., 2020).

Paper	Summary
(Vogel & Machizawa, 2004)	Working memory usually holds **3–4 items** (Eriksson et al., 2015)
(Mashour et al., 2020)	Identifies major **perception-action bottlenecks** (Marois & Ivanoff, 2005)
(MacLean et al., 2023)	Early processing can persist **without consciousness** (Mashour et al., 2020)

FIGURE 3 Foundational papers anchoring this literature

3.2 Capacity Bottlenecks

Across paradigms, conscious working memory appears strongly bottlenecked. Visual short-term memory reaches an asymptote around three to four objects in both behavioral and neural measures, and this plateau varies systematically across individuals (Vogel & Machizawa, 2004). Whole-report evidence indicates that when six simple items must be stored, only about three to four retain non-zero information, with the remainder best explained as guesses (Adam et al., 2017).

The bottleneck is not only visual. When visual and auditory arrays are stored together under masking conditions, total bimodal capacity is no greater than visual capacity alone, supporting a central limit on simultaneously maintained conscious contents (Saults & Cowan, 2007). Retrieval also shows serial limits: psychological refractory period effects occur for both perceptual report and memory recall, suggesting that internal and external selection share an attentional bottleneck (Logan et al., 2023).

3.3 Boundary Conditions

Dimension	Strong-Bottleneck View	Qualified/Alternative View	Citations
Simple items	About **3–4 items**	Stable core finding	(Eriksson et al., 2015)
Meaningful objects	Limit looks less fixed	More can be stored with deeper encoding	(Brady et al., 2016)
Encoding dynamics	Fast saturation for simple features	Parallel accumulation can improve precision	(Brady et al., 2016; Bays et al., 2011)
Modality structure	Some central sharing	Some modality-specific parallel storage	(Saults & Cowan, 2007; Katus & Eimer, 2018)
Capacity source	Item limit	Resource, binding, and control all contribute	(Luck & Vogel, 2013; Gosseries et al., 2018)

FIGURE 4 Major qualifications on strict bottleneck models

The strongest challenge to a simple all-or-none bottleneck is that capacity depends on what is being remembered. Real-world objects can show more active storage than simple colors or orientations, especially with longer or sequential encoding, implying that knowledge and meaningful structure increase effective capacity (Brady et al., 2016; Brady & Störmer, 2020). Binding and grouping also matter: features from different dimensions can be stored in parallel more easily than same-dimension features, but maintaining integrated objects requires focused attention and is vulnerable to interference (Wheeler & Treisman, 2002).

The architecture is also not purely central. Some studies support parallel, modality-specific maintenance mechanisms, such as independent tactile and visual load effects and segregated feature-selective sensory memory systems (Katus & Eimer, 2018; Pasternak & Greenlee, 2005). Other studies still find cross-modal competition and shared attentional limits, so the best-supported account is a hybrid one with both central and specialized constraints (Barrouillet et al., 2007; Li & Cowan, 2021).

3.4 Unconscious Parallel Processing

Early unconscious sensory processing is preserved well beyond the point where conscious report fails. The first ~200 ms of perceptual activity can remain intact on unseen trials, and conscious access instead correlates with later events such as P300-like ignition (Mashour et al., 2020). Meta-analytic evidence likewise places unconscious visual processing mainly in posterior regions such as lateral occipital cortex, whereas conscious perception engages broader frontoparietal and control-related networks (MacLean et al., 2023).

Unconscious retention can also exceed classic feedforward “momentary” processing. Subliminal cues can be encoded, maintained online despite visible distractors, and later guide explicit discrimination above chance (Soto et al., 2011). Even so, this unconscious retention seems weaker than conscious active working memory: unseen signals decay, lack global ignition, and appear unable to support the same flexible transformations unless reinstated into active conscious states (Mashour et al., 2020).

Results Timeline

Working-memory theory has moved from fixed-capacity stores to hybrid architectures with both central bottlenecks and distributed sensory representations.

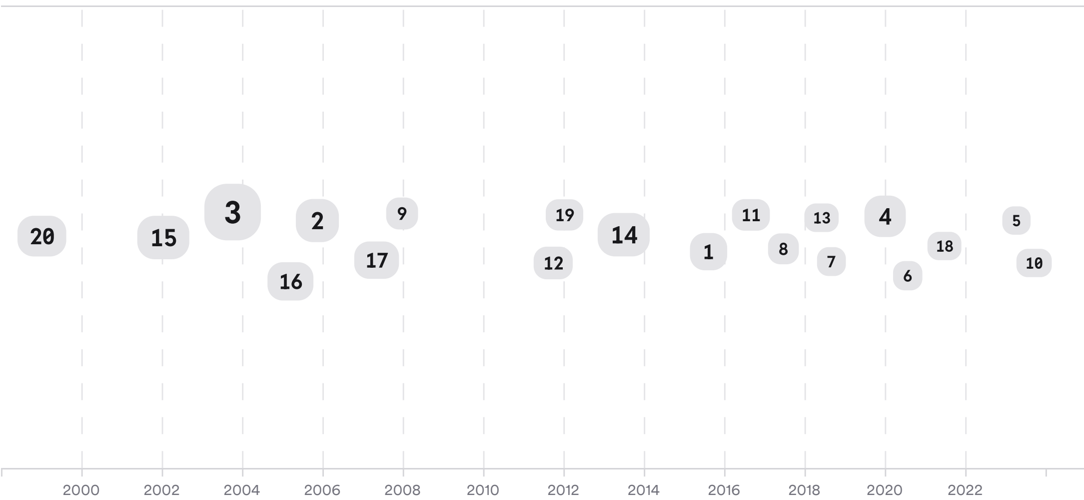

FIGURE 5 Research timeline; larger markers indicate more citations

Early work localized physiological capacity constraints to dorsolateral prefrontal and parietal systems and linked them to load-dependent plateaus (Callicott et al., 1999). More recent work added sensory-cortex maintenance, multiplexing of remembered and incoming stimuli, and dynamic coding that helps separate working-memory and distractor representations (Rademaker et al., 2019; Degutis et al., 2025).

Top Contributors

Type	Name	Papers
Author	N. Cowan	[e5d471b1c4f4523f9313250a592b61b1][839c0c3683db580e913a3912ff5f442a][9f74daf553895b8f850125bc5543b5e2][167feb3a71f350ce99d20c9885e2e391]
Author	E. Vogel	[e7e2f3b68735570f92aee5c53beedd0b][926663aaea82520995f5e26bba9a2818][5865de1c16ef58089263a8d50d8f0d3a]
Author	R. Marois	[560343344c64500e8c9f3e551a33ab38][196ff6ccba68555c97248c8ec5049caf]
Journal	*Journal of Experimental Psychology. General*	[1585e2063e495b958a6dd46b154f9b47][e5d471b1c4f4523f9313250a592b61b1][75f6ffdb70c75f86b940df385550b769]
Journal	*Nature Neuroscience*	[c4d7d19853b850f8ade0ef5630dc321d][52db12371474572a85c41ff5e77519dd]
Journal	*Neuron*	[e7e2f3b68735570f92aee5c53beedd0b][a5c9ef9cbcba5284b17d2b25870812f7]

FIGURE 6 Authors and journals appearing most in included papers

4. Discussion

The strongest consensus is on the first half of the question: conscious working memory is capacity limited, and for simple active representations the limit is severe enough to function as a bottleneck for perception, storage, retrieval, and downstream learning (Marois & Ivanoff, 2005; Forsberg et al., 2020; Greene et al., 2024). This conclusion is replicated across behavior, EEG, fMRI, dual-task paradigms, and multimodal designs (Vogel & Machizawa, 2004; Callicott et al., 1999; Johnston et al., 2011; Murphy et al., 2020).

The second half is also broadly supported, but more cautiously. Early sensory systems do process multiple features and inputs in parallel, and much of this processing occurs without awareness (Pasternak & Greenlee, 2005; Rademaker et al., 2019; MacLean et al., 2023). However, the evidence base does not justify an unlimited “vastly parallel” caricature, because unconscious signals can decay, be disrupted, and fail to support flexible manipulation or globally accessible report (Mashour et al., 2020; Rademaker et al., 2019).

A key limitation of the literature is that “capacity” is not a single thing. Item count, representational precision, context binding, controlled attention, and modality-specific storage make separable contributions, which explains why some papers emphasize a central bottleneck while others find distributed or parallel maintenance (Logie, 2011; Bays et al., 2011; Gosseries et al., 2018; Kotyusov et al., 2023). The best synthesis is therefore a layered model: broad parallel preprocessing in sensory systems, followed by sharp restrictions when information must be bound, selected, manipulated, or broadcast into conscious working memory.

Claim	Evidence Strength	Reasoning	Papers
Conscious working memory for simple active contents is strongly capacity limited	Strong	Replicated across reviews, behavior, EEG, and imaging	(Eriksson et al., 2015; Adam et al., 2017; Vogel & Machizawa, 2004)
Early sensory processing often proceeds without conscious awareness	Strong	Supported by theory reviews and meta-analysis	(Mashour et al., 2020; MacLean et al., 2023)

Claim	Evidence Strength	Reasoning	Papers
Unconscious information can sometimes be retained briefly	Moderate	Multiple studies, but concept remains controversial	(Soto et al., 2011; Eriksson et al., 2015)
Working-memory limits are purely central and domain-general	Weak	Contradicted by modality-specific and sensory-cortex evidence	(Katus & Eimer, 2018; Pasternak & Greenlee, 2005; Rademaker et al., 2019)
The bottleneck is fixed regardless of stimulus meaning or encoding strategy	Weak	Challenged by real-world object and deeper-processing studies	(Brady et al., 2016; Brady & Störmer, 2020)

FIGURE 7 Key claims and supporting evidence in this corpus

5. Conclusion

The literature supports the claim that conscious working memory is constrained by a severe bottleneck, especially when information must be actively maintained, bound, selected, or manipulated. It also supports the idea that early unconscious sensory processing is more parallel and more distributed than conscious access, with substantial processing preserved before late ignition into awareness. The main correction is that both properties are graded rather than absolute.

Research Gaps

The biggest open issue is how unconscious retention relates mechanistically to conscious working memory, rather than whether it exists at all. Another gap is explaining when apparent fixed item limits dissolve for meaningful stimuli, multisensory content, or dynamic sensory coding.

Topic/Outcome	Study Design	Mechanism	Manipulation	Long-Term Relevance
Nonconscious working memory	4	2	3	1
Meaningful vs simple stimuli	5	3	4	2
Cross-modal capacity limits	4	2	3	1
Context binding vs load	3	3	3	1

Open Research Questions

Future work needs to test which computations truly require conscious active states and which can proceed in unconscious or activity-silent formats.

Question	Why
Which mental operations fail unless information is globally broadcast into conscious working memory?	This would separate mere storage from transformation, rule use, and reportable access.
When do meaningful real-world objects escape the classic 3-4 item limit?	This would clarify whether knowledge changes storage capacity, encoding efficiency, or both.

Question	Why
How do central and modality-specific limits combine during multisensory working memory?	This would resolve why some studies find shared bottlenecks while others find parallel storage.

In sum, conscious working memory is bottlenecked, early unconscious sensory processing is more parallel, and the frontier lies in mapping exactly where one regime gives way to the other.

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