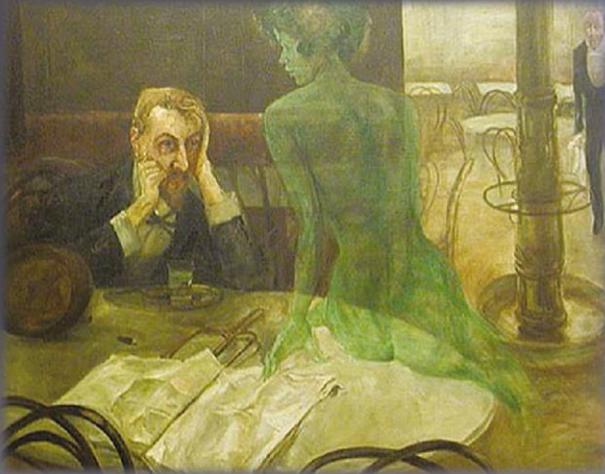


# Synesthesia and Hallucinations

A brief introduction (adapted from B. Stücky)  
Daniel Kiper  
October 26, 2023



# Synesthesia



- The capacity to join sensory experiences across sensory modalities
- 1:25,000 people (Cytowic, 1988)
- Nabokov
- Genetic component undetermined
- Tasting shapes, colored hearing (speech and music have color),

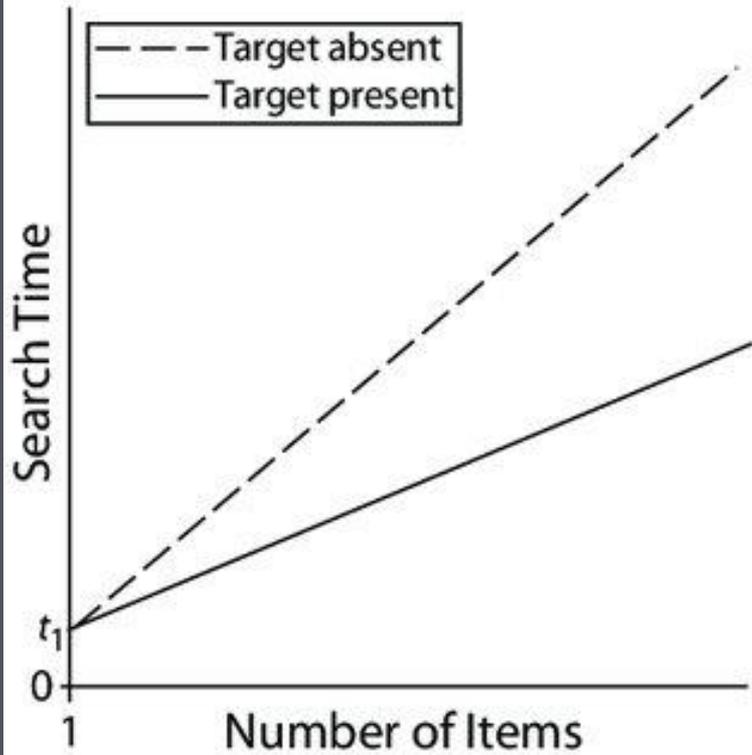


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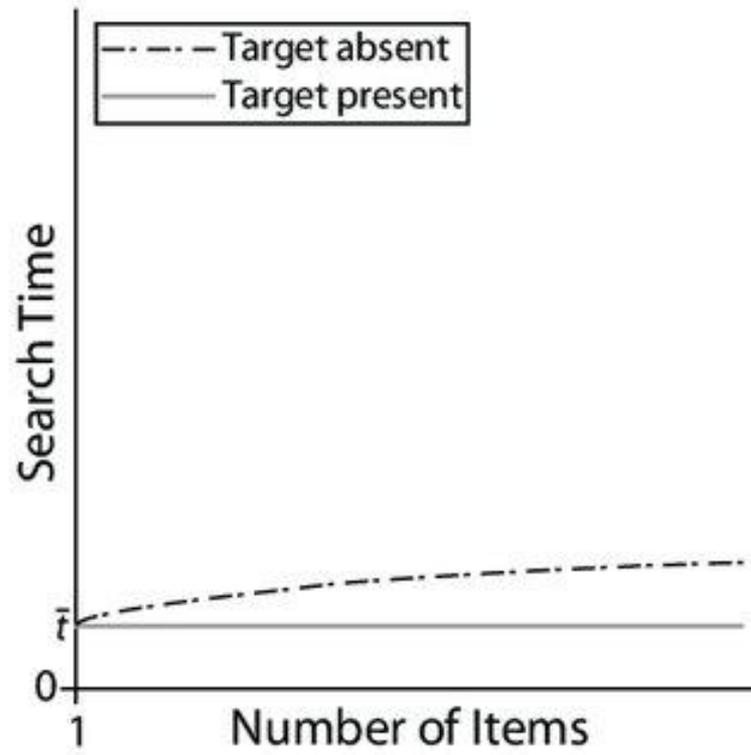
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### Serial Search



### Parallel Search



# Hallucinations



# Defining the unreal



“The intimate conviction of actually perceiving a sensation for which there is no external object.” - Esquirol E. *Mental Maladies; A Treatise on Insanity*. 1845.

“An hallucination is a strictly sensational form of consciousness, as good and true as a sensation as if there were a real object there. The object happens to not be there, that is all” – William James, 1890

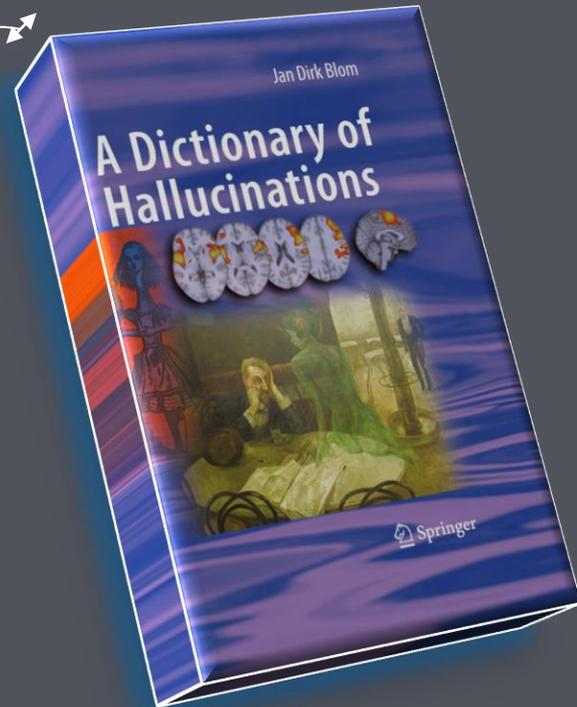
Sensory perceptions which disagree with those of other observers in the same setting. A percept out of sync.

# Map of hallucinations



Suspiciously, the diversity of hallucinations are as diverse as perceptions themselves.

~550 pages



We'll have to focus on a few cases, especially medical conditions

# Charles Bonnet Syndrome



Visual hallucinations experienced by patients who have lost some or all of their sight.

“People in Eastern dress! ... in drapes, walking up and down stairs ... a man who turns towards me and smiles, but he has huge teeth on one side of his mouth. Animals, too. I see this scene with a white building, and it is snowing – a soft snow, it is swirling. I see this horse with a harness, dragging snow away...but it keeps switching ... I see a lot of children; they’re walking up and down stairs. They wear bright colours - rose, blue, like Eastern dress.”

# Charles Bonnet Syndrome



Are these people just different to the rest of us?

# Sensory deprivation



There are many ways to be deprived of sensation

We can take away light and sound and touch, or just remove environmental change



# Sensory deprivation



There are many ways to be deprived of sensation

We can take away light and sound and touch, or just remove environmental change



Example footage

(Disclaimer: some may find this footage disturbing)

# Sensory deprivation

EEG studies:

Heightened alpha band (7.5–12.5 Hz) activity seen, which is also seen in visually-dominant dreams and 'daydreaming' / fantasizing<sup>[1]</sup>

Tendency to hear voices predicted from questionnaires<sup>[2]</sup>

Theoretical approaches link this to 'maladaptive' predictive processing<sup>[3]</sup>



# The Dream State



But sensory deprivation is a very abnormal state.

How often does the brain 'lose' sensation?

# The Dream State



The gating of sensory inputs to different brain areas changes at different stages of sleep

In combination with this reduced sensory traffic, there are often fewer stimuli when we sleep (ideally)



# Sensory ghosts

Phantom limb: the sensation (including perceived control) of a limb which has been removed



Should we call this Charles Bonnet Syndrome?

# Sensory ghosts

Phantom limb: the sensation (including perceived control) of a limb which has been removed

Before there were medical descriptions, there was folklore.

Captain Ahab requesting a wooden leg in 'Moby Dick', 1851:

“...will it speak thoroughly well for thy work, if, when I come to mount this leg thou makest, I shall nevertheless feel another leg in the same identical place with it; that is, carpenter, my old lost leg; the flesh and blood and bone one, I mean. Can thou not drive that old Adam away?”



# Sensory ghosts

Mirror Box Therapy  
(Ramachandran Box)

Mirror



# Real sensory ghosts



If the brain constructs a body model based on evidence  
... can we swap bodies by giving alternative evidence?



# Real sensory ghosts



If our perception of reality is apparently under constant construction ... how big is this consciousness landscape?

How much can we play with these 'true' hallucinations of body and beliefs before they're unrecognizable?

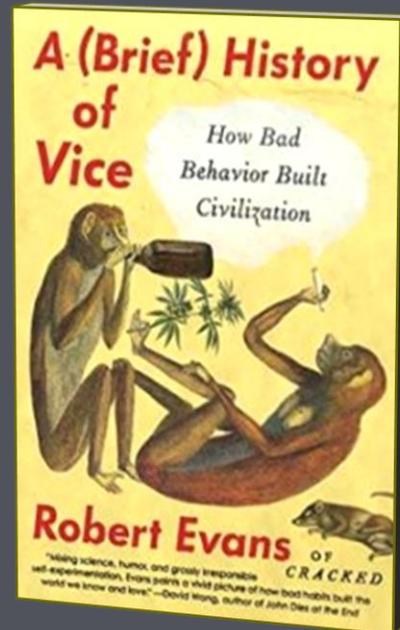
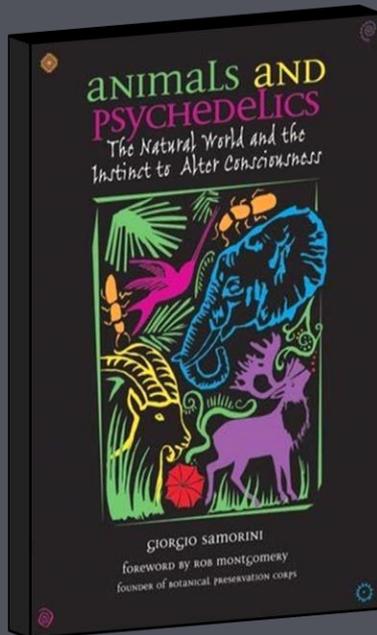
Could we, one day, discover limits to perception?



# Altered states



There appears to be a drive to recalibrate / re-assess the private universe using substances animals find in their environment



# Altered states



There appears to be a drive to recalibrate / re-assess the private universe using substances animals find in their environment

So do we know anything about the mechanisms of hallucinogenic substances? ... not as much as we should.

# Altered states

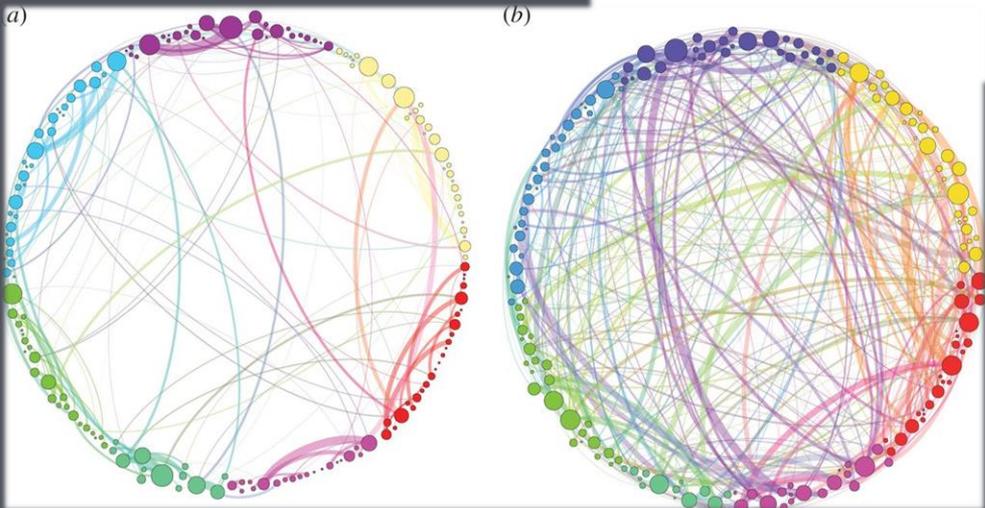


There appears to be a drive to recalibrate / re-assess the private universe using substances animals find in their environment



## Homological scaffolds of brain functional networks

G. Petri<sup>1</sup>, P. Expert<sup>2</sup>, F. Turkheimer<sup>2</sup>, R. Carhart-Harris<sup>3</sup>, D. Nutt<sup>3</sup>, P. J. Hellyer<sup>4</sup> and F. Vaccarino<sup>1,5</sup>



The width of the links is proportional to their weight and the size of the nodes is proportional to their strength. It's a strange measure of correlation/causation as a proxy for integration/communication

# Altered states

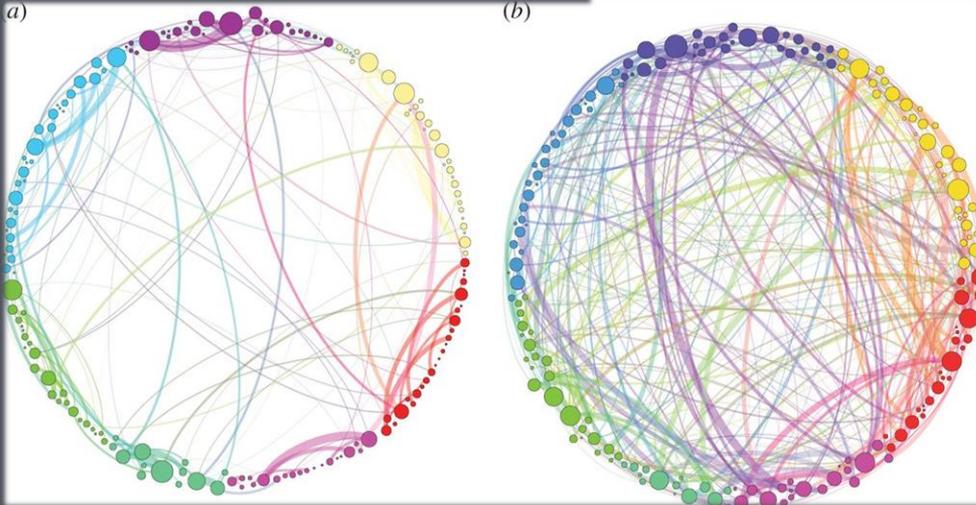


There appears to be a drive to recalibrate / re-assess the private universe using substances animals find in their environment

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SOCIETY  
**Interface**

Homological scaffolds of brain functional networks

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# Migraines



A migraine is usually a moderate or severe headache felt as a throbbing pain on one side of the head.

Migraines are occasionally accompanied by ‘auras’:

- Visual phenomena, such as seeing various shapes, bright spots or flashes of light
- Vision loss
- Hearing noises or music
- Uncontrollable jerking or other movements and bodily sensations

# Migraines



Fortification patterns: “a shimmering light appeared to my left, dazzlingly bright. It expanded, becoming an enormous arc stretching from the ground to the sky, with sharp, glittering, zigzagging borders and brilliant blue and orange colours” – O. Sacks

Inside the shimmering borders there is often a region of blindness, a ‘scotoma’ or ‘scintillating scotoma’

These patterns are thought to come from the receptive fields found in V1



# Migraines



Most migraine auras are only elementary hallucinations...

Some patients have more complex auras:

Mark Green, neurologist, describing a patient's experience\*:

“He had the same vision in every migraine attack – a hallucination of a worker emerging from a manhole in the street, wearing a white hard hat with an American flat painted on it”

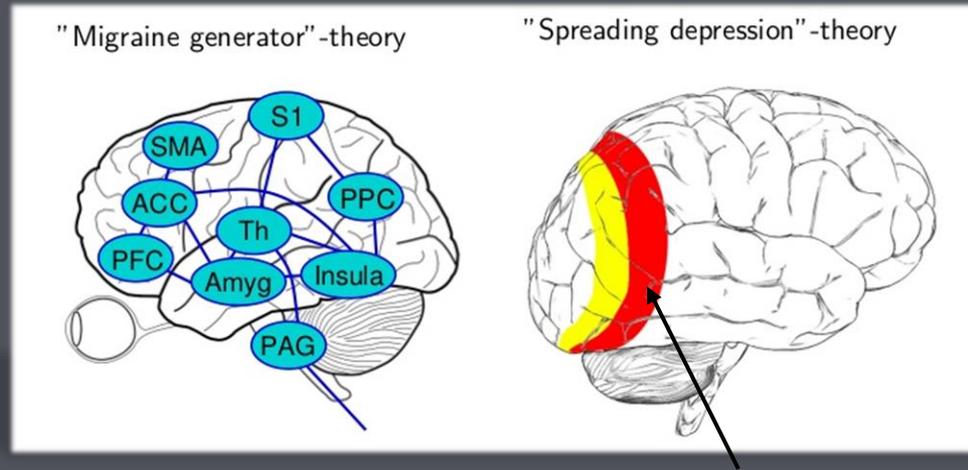


\* O. Sacks, *Hallucinations*

# Migraines



## Migraines and electrophysiology – A wave of activity



Speculation exists that this area of excitation is the aura source

# Epilepsy



Another source of research for spreading electrical activity and qualitative experience

It is not uncommon to have some forms of epilepsy misdiagnosed as migraines

Similarities: appear suddenly, run their course, then disappear; symptoms appear slowly, and 'march' as electrical disturbance progresses across the cortex

Differences: Migraines are slow (minutes-many hours), seizures can take seconds; complex hallucinations are more common in epilepsy

# Qualia before the storm



Gowers, 1881

The reliability of qualia

Described auditory and visual warning signs: “the sound of drums”, “hissing”, “ringing”, “rustling”, or “music” (later called musicogenic epilepsy \*). Very common visual signs are lights or objects swirling to the side of sight, getting closer until consciousness is lost.

Gowers’ “favourite” stereotyped seizure:

Cramping under his left ribs, a lump moves up to the chest with “thump-thump”, then “knocking”, it moves to his left ear, hears a railroad engine hissing - an old woman in a brown dress appears in front of him, offers him the smell of Tonquin [Tonka] beans, disappears, and two large round lights approach, then experiences choking, then the convulsions begin.

\* *Musicophilia*, O. Sacks

# Qualia before the storm



Polyopia and palinopsia:

Valerie, college student, saw e-mails she had received earlier in the day plastered all over her bedroom. One e-mail was multiplied, one superimposed (translucent) on her mother's face. She could read every word clearly.

'Double consciousness':

Thelma, pro singer, experiences being "in two places at once", but being remote from both; time slows down, but appears to be rushing around to other observers, checking every minute until the convulsions begin.

Thelma's sequence of experiences and behaviours during this double consciousness are very complex and consistent, and too long to fit onto a slide\*.

\* *Hallucinations*, O. Sacks, pages 144-146

# Qualia before the storm



## Spiritual experiences

Dewhurst & Beard, 1970 \*.

A bus conductor (and patient), experienced sudden bliss and was in “literal heaven”.  
He collected bus fares, and told passengers he was pleased to be in heaven  
He heard angelic voices for 2 days, and afterwards continued to believe their validity.  
2 years later he remained religious and had no peculiar beliefs  
Then he had 3 seizures in 3 days, became elated again, claimed “I am cleared”, and then lost his faith since that incident.



\* *Sudden Religious Conversions in Temporal Lobe Epilepsy, 1970*

# Things we could have said



Parkinson's disease

Sleep deprivation

Infection/fever induced delirium

The zoo of mind-altering plants

Doppelgänger

Schizophrenia

Psychosis

Generative models



Too complex for a simple lecture



# Summary



Hallucinations can tell us a lot about the landscape of possible conscious experiences

Qualia can exist without their direct sensory precursors (Sensory deprivation) and can be highly persistent and structured (Phantom limbs)

We have the tools to induce novel conscious states with hallucinogens, and could help us to place 'normal' consciousness on a known neurological spectrum

Stereotyped hallucinations in migraines and epilepsy provide reliable hallucinations to be studied

Understanding the mechanisms of hallucination could help to explain how we construct our everyday perception of 'reality'