

# (A)phantasia and SDAM: Personal, Scientific and Human Perspectives.

Nick Watkins

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# Description of Slide Deck

- Given by Nick Watkins at the Eye's Mind conference in UEA, Norwich on 21<sup>st</sup> May 2016, & hosted by the team's website.
- Slides edited slightly to improve attribution of figures and citations. Some unused spares are included relating to points that arose in wider discussions.
- The slides are not medical advice.
- To contact the Zeman aphantasia research team see <http://medicine.exeter.ac.uk/research/neuroscience/theeyesmind/getintouch/>
- The Levine lab is at <http://levinelab.weebly.com>, see also their memory study at <http://memoryinventory.com>

# Themes

- A scientist who put his head in a scanner ...
- Why did I do this ?
- What did I learn on my quest
  - about me ...
  - ... about science ...
  - and (time permitting) about human beings ?

# The penny drops

TIME IS an illusion, but you can never tell what's going to do the trick. You don't believe me? Ask any theoretical physicist, or, better still, an actual physicist, if you can find one. "Time?" he will tell you; "It's just an illusion." But he won't tell you about the trick, because he doesn't know what it is. If he did, he wouldn't be futzing around being a physicist; he'd open a business, and get rich: *Time Rolled Back While You Wait! Easy Terms For Pensioners and The Unwaged!*

Normally I hate all that stuff, 50 per cent off if you produce your benefits book and so forth. They loiter around all day like medieval potatoes, occasionally helping themselves to a delicious baked bean from the brimming bowl at their elbow, and then when they do decide to go out, they get in cheap, while the rest of us work our arses off and then have to pay through the nose for the privilege.

But, in the case of *Time Rolling Back*, it's fair enough. Pensioners and *The Unwaged* need it more than most. Stuck in a nugatory present – more like an absent, really – with bugger all to look forward to, they strain and strain, trying to recapture their past with its illusion of hope and potential. I know. I've been there. Not the past, everyone's been there, common as muck, worse than Ibiza; no, I mean that state of mind where the past is not just a collection of memories, but a sanctuary, and you strive to get back there, and you can't.

I bet you have, too. Don't lie. Your family, friends and colleagues may see you as a positive, proactive, coping sort of person, someone with a Healthy Outlook on Life and probably regular bowels to boot, but don't tell me you've never waited until the house was empty before creeping guiltily into the bedroom, like a man walking up the brothel stairs, your ear more finely tuned than any adulterer's for the sound of the key in the lock.

Then you climb into bed, fully dressed of course. It wouldn't work, otherwise. You might just go to sleep, which isn't what you're after at all. Instead, you pull the covers over you, dispose yourself like an effigy on a medieval tomb, and begin the process of Rolling

Time Back. You choose a memory, focus on it, let the rest of the mind go blank, and wait.

This time of year, from September to Christmas, is particularly rich in memorial stimuli. First terms at a new school, your new blazer neatly pressed, a brand-new fountain pen and a brand-new pencil case in your brand-new satchel, anticipating the brand-new exercise books, covers still shiny with the maker's glaze; new friends, new teachers, new resolutions, new leaves to turn over.

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voluptuary cigar displays, the shelves of cigarettes, exotic and mysterious as the bordello of your dreams (which you haven't started dreaming about yet).

There are still the clothes shops, too, with their Ben Sherman shirts, their peg-bottom, dogtooth, tweed-style trousers, their leather jackets, their aviator scarves. If you had that black polo-neck jersey and this dark green leather jacket (smart but casual blazer-cut) and were smoking *Passing Clouds*, she wouldn't be in Halford's doorway snogging someone else; she would be with you, holding your hand or, better still, walking along with her arm round your waist, leaning against you, with that special smell of girls in the autumn, wool and leaves and shampoo and woodsmoke, and the special weight of girls in autumn, too, when they lean against you as you walk along. In those

MICHAEL BYWATER



## How to have fun without taking your clothes off

long-ago autumns (as you lie fully dressed in your grown-up bed) it's still only-just-now that a girl has leaned against you as you walk along, and you're still astonished at her warmth and that she's real; she should be weightless, like a dream and the gentle leaning weight of her flesh and bone seems magically heavy, like mercury. And your arms and your body and your head grow heavy too, in reply, gravid with potential.

It's not an illusion. The illusion, under the covers in your daytime clothes, is that you're back there, in the past. But the hope and potential were real. And you don't always have to sneak off to bed for time to roll back, either I had a call the other day from a woman I haven't seen since we wear at school. Barbara Peak. She was publishing something called the *Dodo-Pad*. Would I like to come to its launch?

So I said, yes, you bet, and I rolled along to a place called Bureau in Great Newport Street, a stationery-junkie's paradise full of wonderful files and folders and writing paper and those perfect Proximity et Prat notebooks, and there was a life-sized dodo with a life-sized redhead inside, very hot but working valiantly, and there was Barbara Peak and there was the *Dodo-Pad*, and time rolled back because I used to get *Dodo-Pads* in my Christmas stocking. I loved them. They were quirky, culty diary-cum-scribbling-pads which came pre-defaced with odd cartoons, peculiar observations on life, weird maxims and general graffiti, so that you could be organised but didn't have to feel organised in that frightful, time-management, tight-arsed, purse-lipped executive fashion. The chap who invented them, a writer and artist called Sir John Verney, croaked. HarperCollins ("The Firm With The Silly Name") sold the title off. And now they're back, and with them come Mrs Vartan's dancing-classes, the steam-haunted bridge over the Victoria Station platforms, trolley buses, the Kardomah café, the skating rink, frost-bitten mornings as a Christmas-holiday postman. And the girls. Hope and potential, the past folding back like a concertina door, all for £8.95. A bargain; and you don't even have to go to bed with your clothes on. □

Independent on Sunday, December 7<sup>th</sup> 1997

# Time rolled back while you wait

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# The special weight of girls in autumn

OF THE KEY IN THE LOCK.

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# I'm not having what he's having

- Suddenly realised that I
  - didn't "see pictures in my head"
  - and have no "Proustian recall" of type he describes (of pictures, sound, or any other sensory memory). Fascinatingly, piece textural and multi sensory-not explicitly visual
- So I Googled-first useful pointers were late 19<sup>th</sup> Century ...

# Galton, Bain & James

- **Galton:** *To my astonishment, I found that, the great majority of the men of science to whom I first applied protested that mental imagery was unknown to them* **[Mind,1880]**
- **Bain:** *At first blush it seems to be nothing more than a determination, by accurate statistics, of the relative preponderance of certain varieties of mind that we already [sic] know to exist* **[Mind,1880]**
- **James:** *Some people undoubtedly [sic] have no visual images at all worthy of the name, and instead of seeing their breakfast-table, they tell you that they remember it or know what was on it. This knowing and remembering takes place undoubtedly by means of verbal images* **[The Principles of Psychology,1890]**

# Clues: counterculture, academia, web

Could have stopped in 1890, but wanted to know i) why was I “different” & ii) could I do anything about it ?

- **Wally Minto** “Alpha Awareness” tailored training in 70s
- **Steven Kosslyn** “Image and Brain” [1994]
- **Daniel Schacter** “Searching for Memory” [1997]
- **Rubin & Greenberg** Visual Memory Deficit Amnesia [‘98]
- **Nigel Thomas** [1999-] (& review in *Humanities* [2014])
- **Tony Birch** QuickTopic Online Discussion [2003-]
- **Adam Zeman & colleagues** Patient MX paper [2010]
- And even a song: “No Mind’s Eye” [2002] by Canadian indie rock band **Mecca Normal** ... So just the key steps

# Eureka #1: Bill Faw [2009]



While they only challenged my *confidence of knowing* that I am a non-imager, the sharpest response that psychologists and philosophers have given to my conference papers on mental imagery is disbelief that I (or anyone) *can be* a wakeful non-mental-imager — that I must be mistaken (or worse!) when I report that when I close my eyes I see nothing, I silently think and silently read (with no auditory ‘voice’), and am haunted by silent tunes (with no auditory sound). But that when asleep I have frequent vivid and occasionally-lucid dreams in all sensory modalities. While awake I have good non-visual *spatial* imagery and *motor* imagery. I can *understand* other peoples’ surprise over my ‘dis-ability’, because I was 35 or so before I realized (while reading a pop psychology book) that anyone *had* actual mental pictures, including my wife of 15 years; and I was about 50 before a

*Conflicting Intuitions May Be  
Based On Differing Abilities*

*Evidence from Mental Imaging Research*



# Oliver Sacks

## Musicophilia

From the bestselling author of  
THE MAN WHO MISTOOK HIS  
WIFE FOR A HAT

NATIONAL  
BESTSELLER

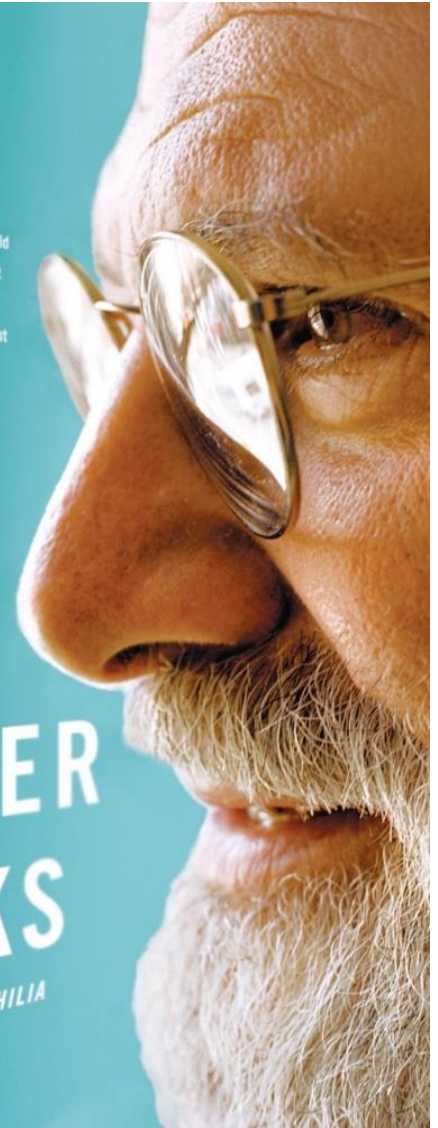
"Remarkably graceful . . . Sacks would seem to be the ideal doctor: observant but accepting, thorough but tender, training his full attention on one patient at a time."

—*The New York Times Book Review*

THE  
MIND'S  
EYE

OLIVER  
SACKS

AUTHOR OF MUSICOPHILIA



# Eureka #2: **Tulving** & episodic memory

**Endel Tulving** distinguished in 1970s between **episodic** and **semantic** memory. Episodic means re-experiencing past (“remembering”) while semantic is about facts we store about it (“knowing”).



# A prediction [By 2004]

According to **Tulving**, animals like his cat have no episodic memory ... [and he] believes that **some perfectly intelligent and healthy people also lack the ability to remember personal experiences. These people have no episodic memory; they know but do not remember.** Such people have not yet been identified, but Tulving predicts they soon will be – [science.ca](http://science.ca)



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So I contacted **Tulving**, and his colleague **Brian Levine**, & went to Toronto, in 2011





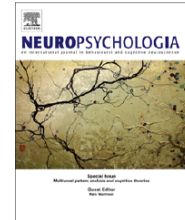


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# Neuropsychologia

journal homepage: [www.elsevier.com/locate/neuropsychologia](http://www.elsevier.com/locate/neuropsychologia)



## Severely deficient autobiographical memory (SDAM) in healthy adults: A new mnemonic syndrome



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Wayne Khuu<sup>a,b</sup>, Brian Levine<sup>a,b,d,\*</sup>

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# SDAM[2015]

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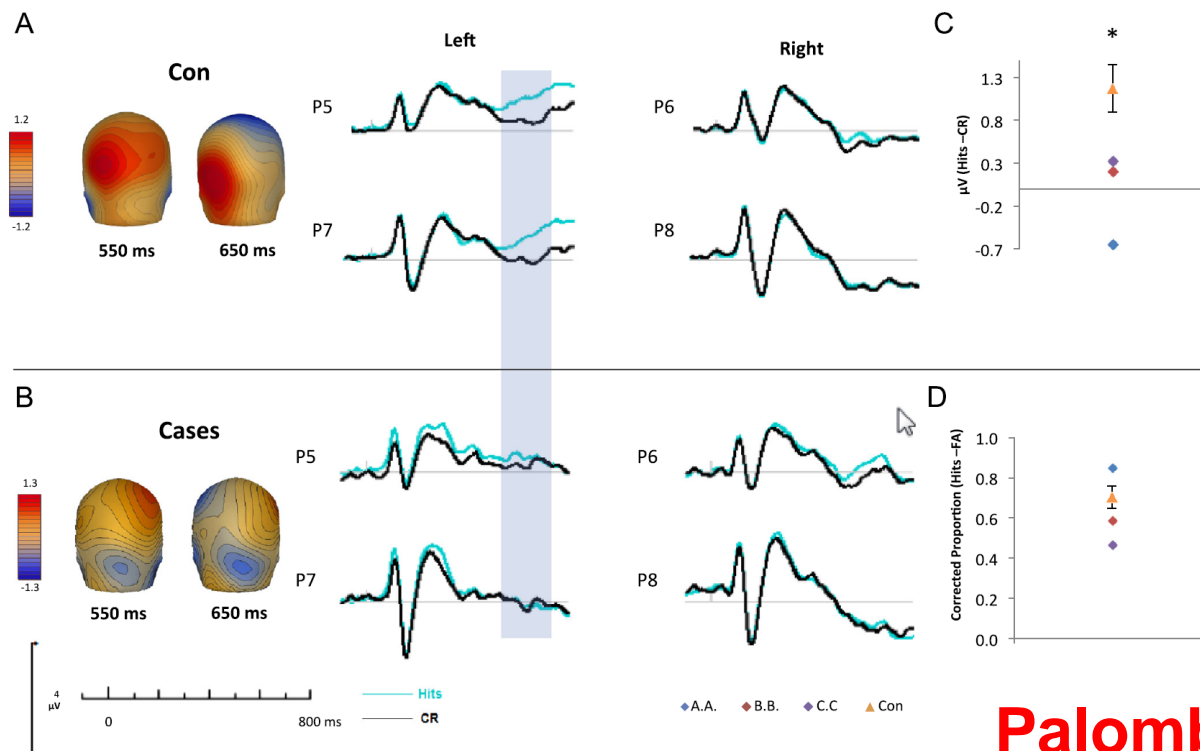
Case study

### ABSTRACT

Recollection of previously experienced events is a key element of human memory that entails recovery of spatial, perceptual, and mental state details. While deficits in this capacity in association with brain disease have serious functional consequences, little is known about individual differences in autobiographical memory (AM) in healthy individuals. Recently, healthy adults with highly superior autobiographical capacities have been identified (e.g., LePort, A.K., Mattfeld, A.T., Dickinson-Anson, H., Fallon, J. H., Stark, C.E., Kruggel, F., McGaugh, J.L., 2012. Behavioral and neuroanatomical investigation of Highly Superior Autobiographical Memory (HSAM). *Neurobiol. Learn. Mem.* 98(1), 78–92. doi: 10.1016/j.nlm.2012.05.002). Here we report data from three healthy, high functioning adults with the reverse pattern: lifelong severely deficient autobiographical memory (SDAM) with otherwise preserved cognitive function. Their self-reported selective inability to vividly recollect personally experienced events from a first-person perspective was corroborated by absence of functional magnetic resonance imaging (fMRI) and event-related potential (ERP) biomarkers associated with naturalistic and laboratory episodic recollection, as well as by behavioral evidence of impaired episodic retrieval, particularly for visual information. Yet learning and memory were otherwise intact, as long as these tasks could be accomplished by non-episodic processes. Thus these individuals function normally in day-to-day life, even though their past is experienced in the absence of recollection.

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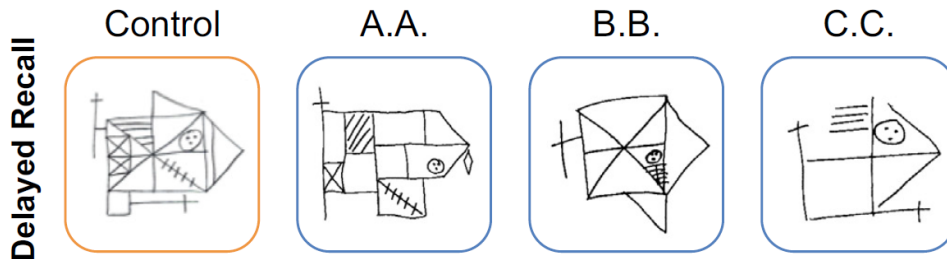
# The dog that didn't bark



**Palombo et al, 2015**

- EEG: Event Related Potential at ~600 ms normally present during re-experiencing not shown by the 3 SDAM cases in correctly recognised items. Suggests our intact recognition supported by non-episodic processes.

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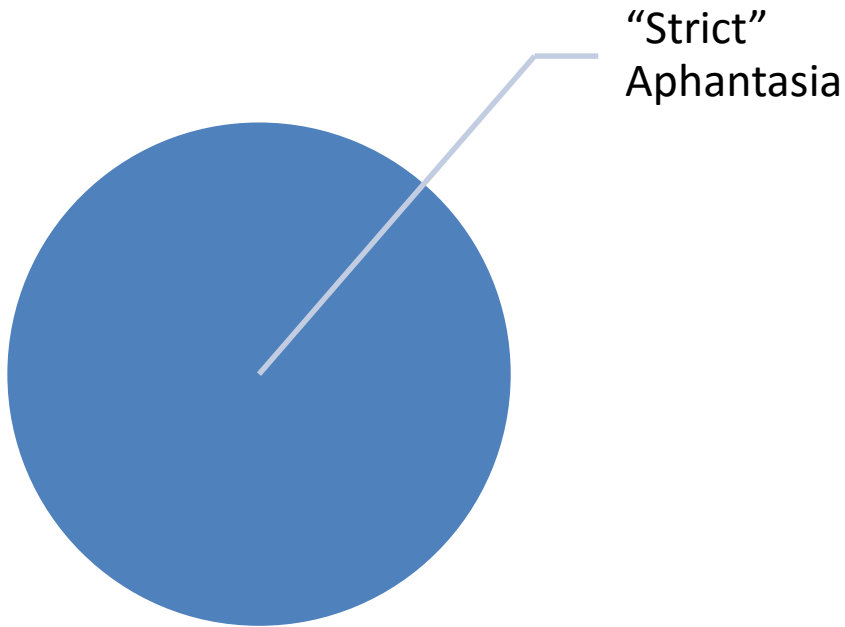
# SDAM

Palombo et al, 2015

- Visual Memory: poor performance on neuropsychological and experimental tasks - ***only area of impairment in terms of behavioural assessment***
- Autobiographical: Demonstrable ***relative sparseness of recollected detail***, especially for decades-old memories
- ***Smaller right hippocampal*** volume (~10%)
- fMRI data: some ***regions known to be associated with autobiographical memory less activated***

# Aphantasia & SDAM

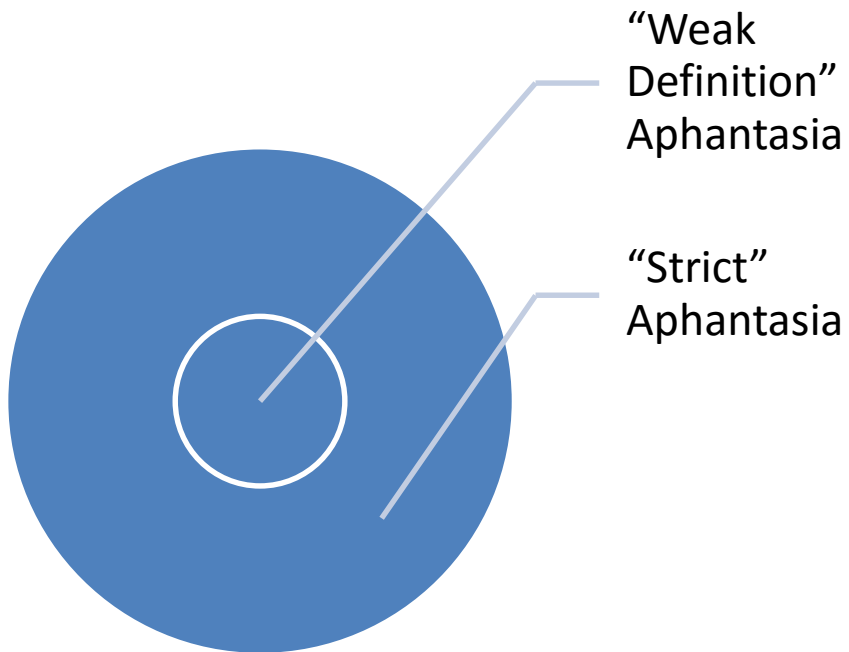
- No voluntary images  
– e.g. Sacks [\*]



\* Except when taking amphetamines  
in 1960s ... see “Musicophilia”,  
“Hallucinations” & “The Mind’s Eye”

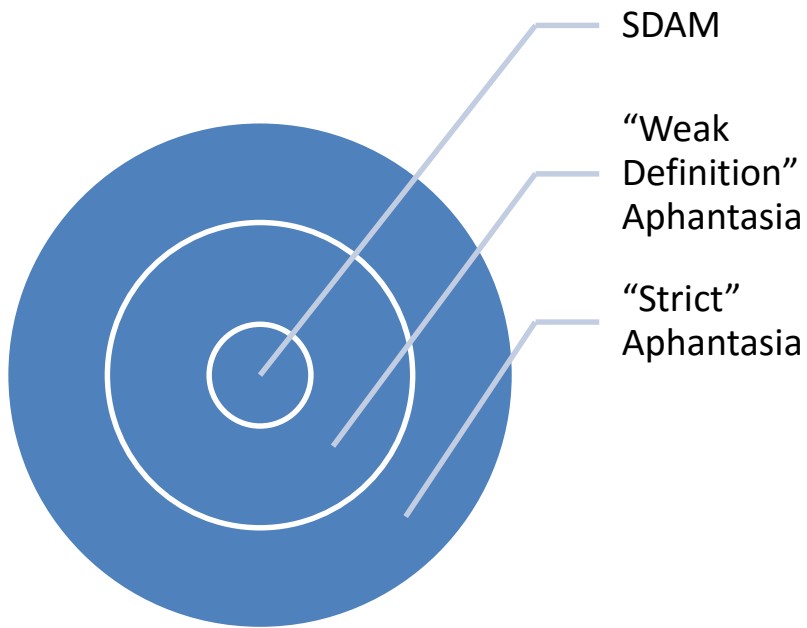
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- No waking images – e.g. Faw



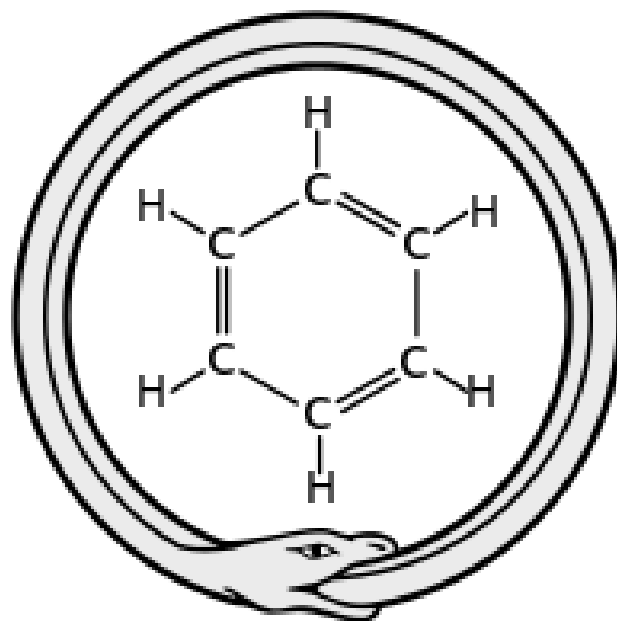
\* Except when taking amphetamines in 1960s ... see “Musicophilia”, “Hallucinations” & “The Mind’s Eye”

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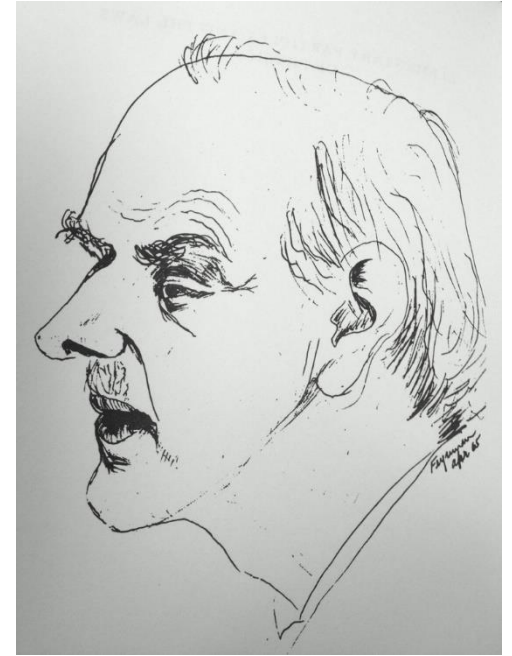
- No voluntary images – e.g. Sacks [\*]
- No waking images – e.g. Faw
- No images and no episodic memory – me
- Do all people with SDAM have aphantasia ?



# PHANTASIA AND SCIENCE ...

**Haltopub, Wikimedia Commons**

# Paul Dirac



- *“Her fundamental laws do not govern the world as it appears in our mental picture in any very direct way, but instead they **control a substratum of which we cannot form a mental picture without introducing irrelevancies.**”*

- **Principles of Quantum Mechanics [1930]**

Portrait by Feynman

*“Like Temple Grandin, Dirac was certain that his mind was “essentially a geometrical one”. He was **always uneasy with algebraic approaches to physics, and with any mathematical process he could not picture**”. – **Graham Farmelo, “The Strangest Man”.***



# Lagrange, Russell and “N. Bourbaki”

*“Lagrange [1736-1813] proudly stated, in his textbook on mechanics, **“You will not find any drawing in my book!”**”*

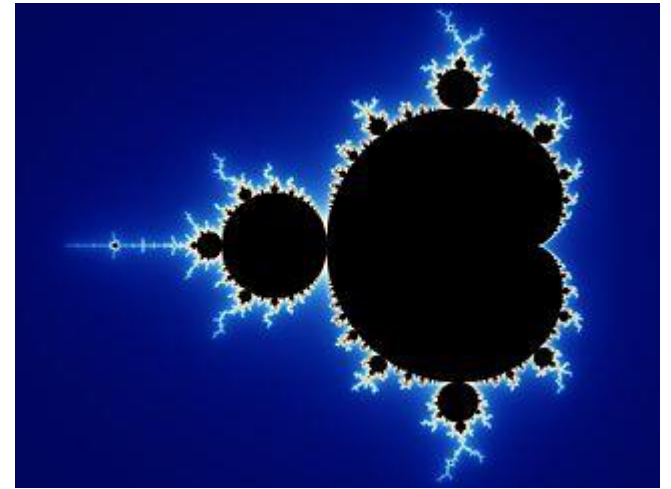
*... [the ] analytical spirit was part of the French ... & German tradition. and I suppose ... also due to the influence of people like Russell, [1872-1970] who claimed that they could prove everything formally—that so-called **geometrical intuition was not reliable in proof.***

*“N. Bourbaki's” [1934-] **abstractions and disdain for visualization** were part of a global fashion, as illustrated by the abstract tendencies in the music and the paintings of that period”*

**Pierre Cartier interviewed by M. Senechal [1998]**



# Benoit Mandelbrot



*“It's very strange that in high school I never knew ... that I had this very particular gift, but in that year in that special cramming school it became more and more pronounced, and in fact in many ways saved me.... I didn't learn much algebra. **I just learned how better to think in pictures because I knew how to do it. I would see them in my mind's eye, intersecting, moving around, or not intersecting, ... and could describe what I saw ... Having described it, I could write two or three lines of algebra, which is much easier if you know the results than if you don't”** - **Mandelbrot interview [1998],***

**[www.webofstories.com](http://www.webofstories.com)**

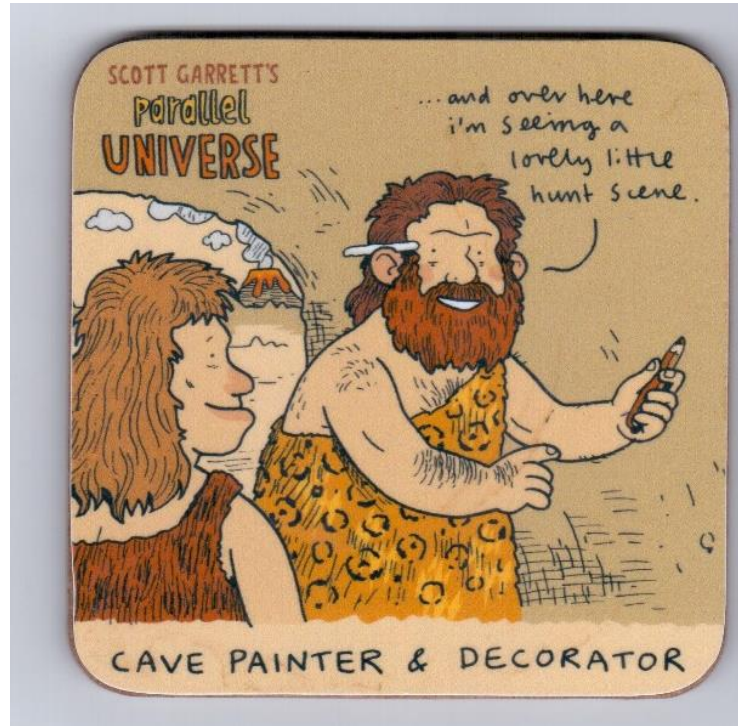
# Diversity

- Science not just deductive
- It's constructive
- Constructed by a “society of minds” ...



how did their diversity shape it ...

E.g. evidence (“**The Fractalist**”) that Mandelbrot’s visual mind both enabled him to see connections and made it difficult to explain what he saw



# AUTONOETICS AND THE DAWN OF MAN ...

Scott Garrett, see <http://www.heartagency.com/artist/ScottGarrett/biog>

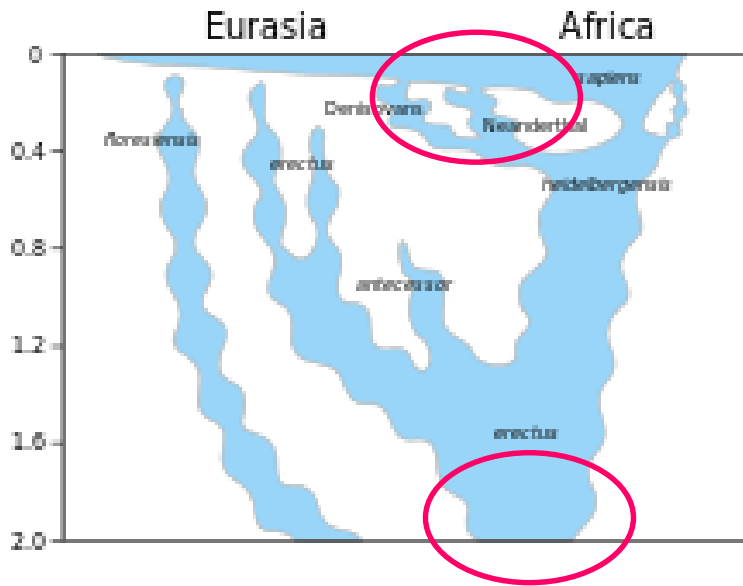
# Autonoetic consciousness

fMRI studies are now linking centres of the brain used in episodic memory to simulation of future events, leading to idea of constructive episodic simulation of past and future [e.g. Schacter & Addis, 2007]. Tulving sees this as human “mental time travel” capability, an element of “autonoetic” consciousness e.g. Tulving, 2002:

If there is hope for a more appropriate assessment of the uniqueness of episodic memory and autonoetic consciousness, it may come through the realization that mental time travel involves awareness not only of what has been but also of what may come. This awareness allows autonoetic creatures to reflect on, worry about, and make plans for their own and their progeny’s future in a way that those without this capability possibly could not. *Homo sapiens*, taking full advantage of its awareness of its continued existence in time, has transformed the natural world into one of culture and civilization that our distant ancestors, let alone members of other species, possibly could not imagine.

It took biological evolution a long time to build a time machine in the brain, and it has managed to do it only once, but the consequences have been enormous: By virtue of their mental control over time, human beings now wield powers on earth that in many ways rival or even exceed those of nature itself. It is difficult to imagine a marvel of nature greater than that.

# The Inheritors



After Stringer, Nature, 2012



"2001: A Space Odyssey", MGM, 1968

*"With the emergence of the genus Homo, brain size increased rapidly from around 2 Ma ago. Possible reflecting selection for ... theory of mind, language, and, we propose, mental time travel ...*

*... One of the final steps that may have given us a decisive edge over one of the last nonhuman Hominins, the Neanderthals, may have been autonomous speech ...*

*... We may be the only species capable of mental time travel because the others competing in our niche have become (or have been made) extinct"*

-Suddendorf and Corballis, 2007

# Conclusions

- After 20 years or so, what did quest get me ?
- Empirical evidence that my SDAM is real, but limited in its scope.
- Satisfaction of contribution to science.
- An awakened curiosity about how differently scientists use imagery - Mandelbrot
- and possible auto-noetic differences between Hom Sap and Neanderthals – what happened in “period of coexistence” (10000 yr ?)

*"I think what makes us human is that we know we're the galactic punchline, but we can still laugh at the setup. The cosmos got me good on this one. How beautiful that such electrical epiphany is not just the province of the child"*

- Blake Ross

*All the oceans I have seen  
Are in this ocean, in between  
Each wave, each sigh, a thousand lands  
A thousand dreams and miracles*

- Sandra Chapman



# Acknowledgements

- Adam Zeman
- Endel Tulving, Brian Levine and Daniela Palombo
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- Sandra Chapman
- My father, brother and sister
- and many other people

**SPARES**

# Nigel Thomas

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## Mental Imagery

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Mental imagery (varieties of which are sometimes colloquially referred to as “visualizing,” “seeing in the mind’s eye,” “hearing in the head,” “imagining the feel of,” etc.) is *quasi-perceptual experience*; it resembles perceptual experience, but occurs in the absence of the appropriate external stimuli. It is also generally understood to bear *intentionality* (i.e., mental images are always images *of* something or other), and thereby to function as a form of mental representation. Traditionally, *visual* mental imagery, the most discussed variety, was thought to be caused by the presence of picture-like representations (*mental images*) in the mind, soul, or brain, but this is no longer universally accepted.

Very often, imagery experiences are understood by their subjects as echoes, copies, or reconstructions of actual perceptual experiences from their past; at other times they may seem to anticipate possible, often desired or feared, future experiences. Thus imagery has often been believed to play a very large, even pivotal, role in both memory (Yates, 1966; Paivio, 1986) and motivation (McMahon, 1973). It is also commonly believed to be centrally involved in visuo-spatial reasoning and inventive or creative thought. Indeed, according to a long dominant philosophical tradition, it plays a crucial role in *all* thought processes, and provides the semantic grounding for language. However, in the 20th century vigorous objections were raised against this tradition, and it was widely repudiated. More recently, it has once again begun to find a few defenders.

- 1. Meanings and Connotations of ‘Mental Imagery’

13:45  
16/05/2016

# Mecca Normal [2002]



*You don't need to see an orange every time ... to know what an orange is.*

# Cognitive styles:

Importance can be seen from simple thought experiment, and the fact we don't know the answer to it ...

If we could not only see and hear these talks, but also see the pictures drawn (or not) in individual audience members' minds by them ---how much variety would we see ?

Many steps made over millions of years to allow human beings to be convinced that we are communicating about same thing. Language itself, cave painting [c.f. **Herzog's film The Cave of Forgotten Dreams**], maths, blackboards, visualisation ....

# Cognitive styles:



How can we (will we) make further leaps towards this collective communication while discovering and appreciating why (it is evolutionary advantage ?) that we don't all see the same thing ?

# Dichotomies :

I am fascinated by the possible ways in which Tulving's episodic vs semantic and James' verbal/visual dichotomies may illuminate :

... the tension (metaphorical, and by Mandelbrot's own account sometimes literal !) between the very visual thinking of **BBM** and the non-visual, formal proofs of e.g. the **Bourbaki**, of which his uncle, **Szolem Mandelbrojt** was a founder member ...

And various reports about mathematical and scientific thought in the 19<sup>th</sup> and 20<sup>th</sup> centuries.

# Euclid

“In Euclid, you find some drawings but it is *known that most of them were added after Euclid*, in later editions. *Most of the drawings in the original are abstract drawings*. You make some reasoning about some proportions and you draw some segments, but they are not intended to be geometrical segments, just representations of some abstract notions.”

The Continuing Silence of Bourbaki—An Interview with Pierre Cartier [Bourbaki 1955-83], June 18, 1997

by Marjorie Senechal in The Mathematical Intelligencer, № 1 (1998) · pp.22–28



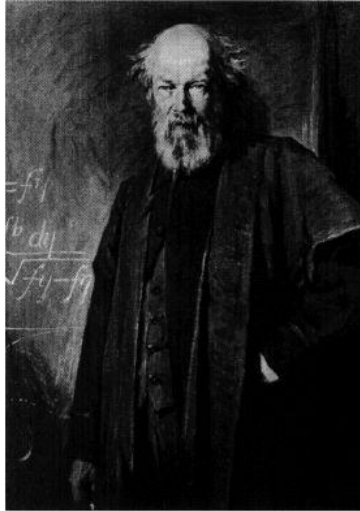
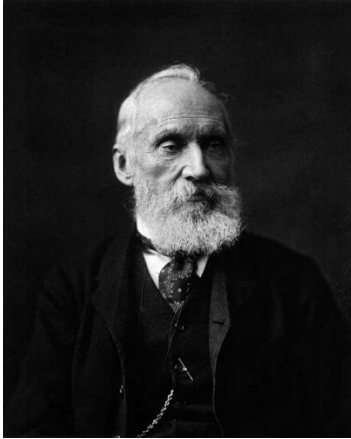
# Fashion ? Or selection ??

Even British and continental European approaches differed  
e.g. different attitudes to construction of models.

\$64000 question ---was Galton's sample real

And, if so, why would it not be same now ?

# Formula versus fact



*James Clerk  
P.G. Tait*

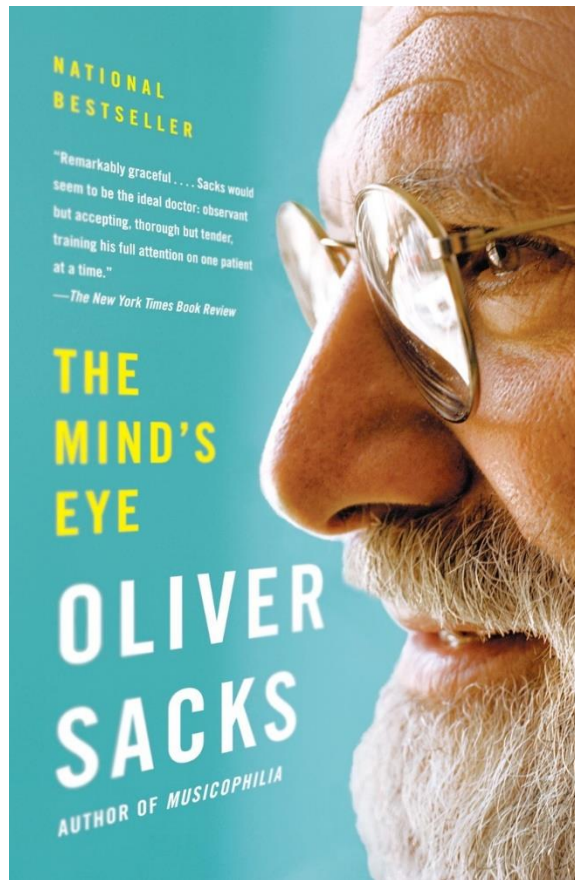


*“Nothing can be more fatal to progress than a too confident reliance on mathematical symbols; for the student is only too apt to ... **consider the formula and not the fact as the physical reality**”.*

**Thomson (Kelvin) & Tait, 1890 edition.**

*“Like the ear, **the eye is very sensitive to features that the spectrum does not reflect**. Seen side by side, different  $1/f$  noises, Gaussian [i.e.  $fGn$ ], dustborne [i.e. fractional renewal] and multifractal, **obviously** differ from one another”-*  
**Mandelbrot, Selecta N, 1999.**

# Oliver Sacks



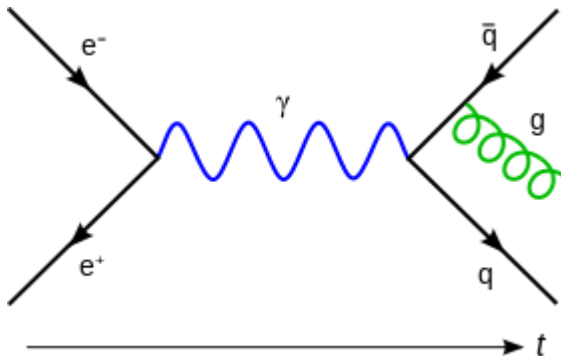
*“Simple visual imagery such as [Galton] describes may suffice for the design of a screw, an engine, or a surgical operation, and it may be relatively easy to model these essentially reproductive forms of imagery or to simulate them by constructing video games or virtual realities of various sorts. Such powers may be invaluable, but there is something passive and mechanical and impersonal about them, which makes them utterly different from the higher and more personal powers of the imagination, where there is a continual struggle for concepts and form and meaning, a calling upon all the powers of the self. Imagination dissolves and transforms, unifies and creates, while drawing upon the "lower" powers of memory and association. It is by such imagination, such "vision," that we create or construct our individual worlds”.*

# Feynman



*“First of all, it’s like asking the centipede which leg comes after which, it happens quickly and I’m not exactly sure what flashes and stuff go in the head, but I know it’s a crazy mixture of partially equations, partial solving the equations, and having some sort of picture of what’s happening- that the equation’s saying is happening, but they are not that well separated as the words I’m using ... I suspect that what goes on in every man’s head might be very, very, different. The actual imagery or semi-imagery which comes ... ”*

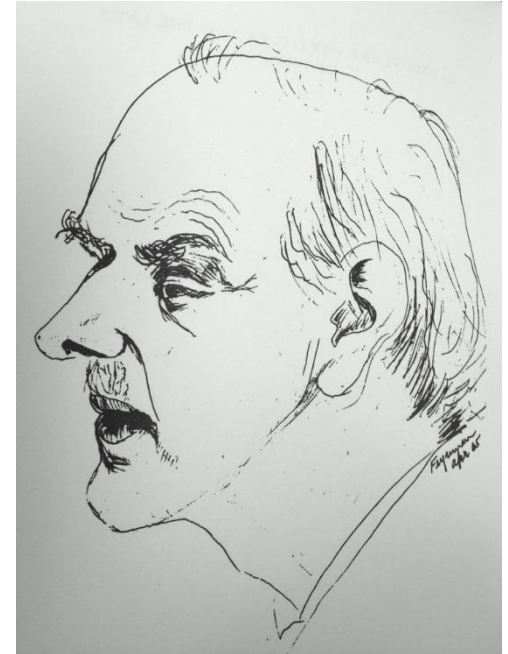
---**Feynman, in “Fun To Imagine” [1983]**



# Paul Dirac

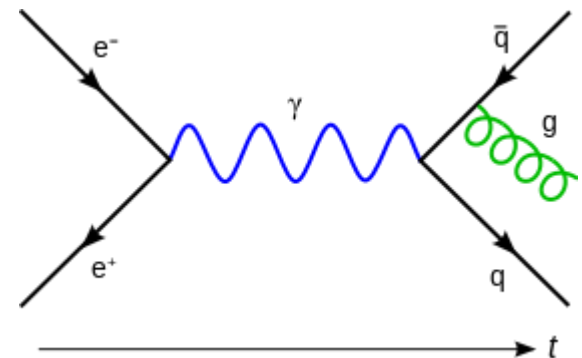
- “Her fundamental laws do not govern the world as it appears in our mental picture in any very direct way, but instead they *control a substratum of which we cannot form a mental picture without introducing irrelevancies.*”

--- Preface to **The Principles of Quantum Mechanics [1930]**



**Portrait of Dirac by Feynman**

“Dirac was my hero” – **Feynman**  
Dirac memorial lecture, 1986



## Suddendorf and Corballis, 2007

One problem for such an account is to explain why the cognitive arms race seems to have persisted longer in humans than in other primates, resulting in apparently unique cognitive skills, including, perhaps, mental time travel. A potential explanation, suggested by Alexander and colleagues (Alexander 1989; Flinn et al. 2005), is that once early hominins obtained a certain level of “ecological dominance,” perhaps partly through technological advances as discussed earlier, they were faced with increased competition from their own species – “humans uniquely became their own principal hostile force of nature” (Alexander 1989). This may have resulted in a runaway social competition between (and within) groups towards greater intelligence, and enhanced abilities for both cooperation and deception. These may have included the ability to entertain alternative future scenarios (mental time travel), to read others’ minds (theory of mind), and to communicate (language).

This “coalitionary arms race” (Flinn et al. 2005) also offers an answer to one of the greatest mysteries of human evolution: Why have all the other hominin species become extinct? One only needs to extend the proposal from “intra-species” competition to “intra-genus” competition to see a solution. Our ancestors may have competed with an array of other bipedal species that once graced this planet, and perhaps simply outsmarted them, contributing to their demise (Suddendorf 2004). One of the final steps that may have given us a decisive edge over one of the last nonhuman hominins, the Neanderthals, may have been

autonomous speech (Corballis 2004). This suggestion that humans played a role in displacing other hominins is in line with recorded human history in that human groups perpetually compete with each other and often violently displace other groups, as well as with various other human characteristics, such as our unique obsessions with inter-group competitive play (e.g., sports). This intra-genus competition may have ultimately been won by human groups because of continued advances in foresight, language, culture, and coordinated aggression, leaving us as the sole survivors of an extraordinary evolutionary arms race. We may be the only species capable of mental time travel because the others competing in our niche have become (or have been made) extinct.

Like the “just-so stories” about throwing or fire, an account emphasizing intra-species or intra-genus competition may exaggerate the importance of a single factor. Claiming that the hostile forces of nature turned into “relative trivialities” (Alexander 1989) probably underestimates the selective pressure of catastrophic environmental changes such as ice ages, volcanic eruptions, and meteorite impacts on life in general. Such events may well have produced bottlenecks in evolutionary history where social competition was of far less import than ecological factors and cooperation. Rather than endorsing one or the other scenario, we present them here merely to make the point that plausible accounts exist that can explain why humans may have capacities, such as mental time travel, that other species do not have. Darwinian continuity need not demand greater mental powers in nonhuman animals than is currently evident.