

# Creativity and the Brain

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# Definitions of Creativity

Webster's Dictionary: productive, marked by originality.

*Problem*: Randomly hitting keys on a word processor for many days is very productive (output) and novel, but not creative.

Bronowski: Finding unity in what appears to be diversity.

*Problem*: No mention of originality or productivity.

Heilman: The ability to understand, develop, and express in a systematic fashion, novel orderly relationships.

# Stages of Creativity

- Helmholtz's (1896) Four Stages:
  - 1. *Preparation*...Learning background knowledge and skills.
  - 2. *Incubation*...Subconscious thinking about a problem.
  - 3. *Illumination*...Become aware of the answers.  
“Eureka!”
  - 4. *Verification*...Performing studies or producing work of art.

# Modified Stages of Creativity

## Modifications:

Thinking does not have to be subconscious, and during the incubation stage there is often conscious searching. Illumination is the termination of the incubation period. Thus, both incubation and illumination are combined to give the stage of *Innovation*.

## Three Stage Model:

Stage 1: Preparation

Stage 2: Creative Innovation

Stage 3: Production

# Stage 1: Preparation

- Intelligence:
  - The ability to acquire knowledge.
    - Three major factors: 1) Number of neurons; 2) Connectivity; 3) Ability to alter synaptic strengths.
  - People with high IQ are often termed “genius.” But after threshold [IQ of 110-120] is reached there is no relationship between IQ and creativity (e.g., “Terman’s geniuses” )

## Special Talents and Skills

Gall and Broca- Modularity and size.

Geschwind and Levitski- Planum temporale

Einstein’s Brain

Corpus Callosum-Moore et al study

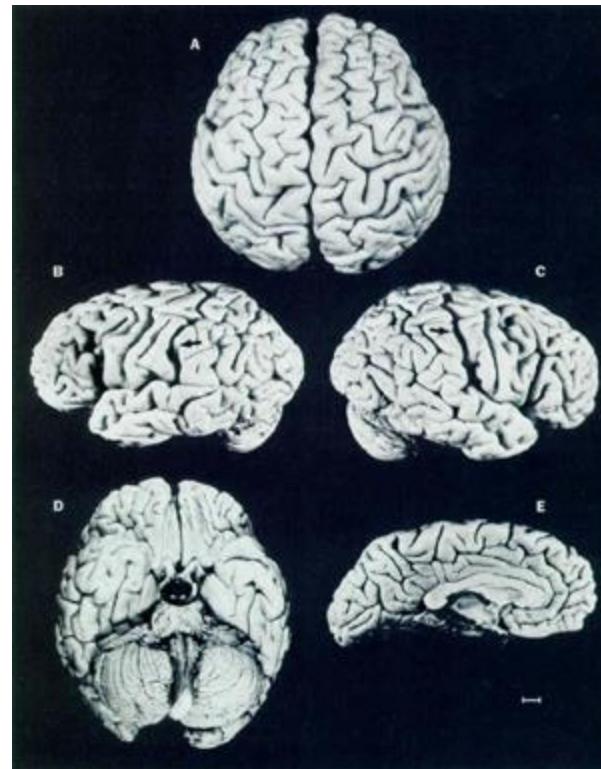
Right Parietal –Gansler et al., study

# **The Exceptional Brain of Albert Einstein**

Sandra F. Witelson

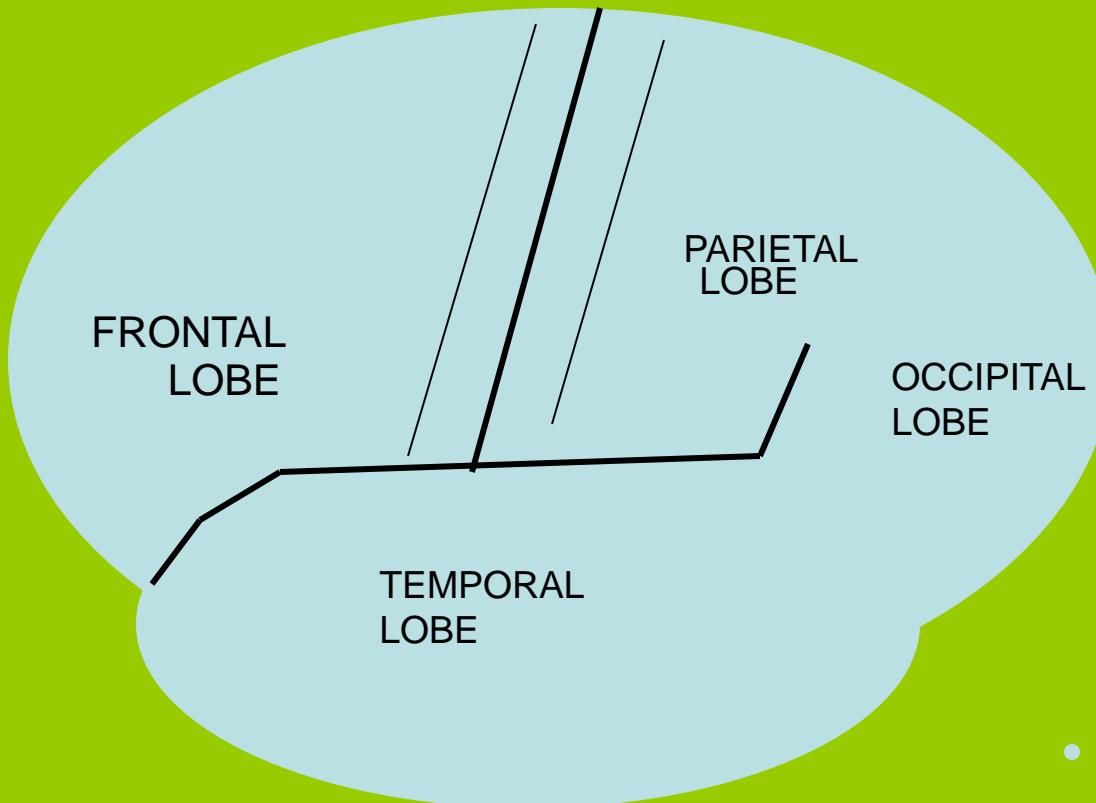
- The gross anatomy of Einstein's brain was within normal limits with the exception of his parietal lobes. In each hemisphere, morphology of the Sylvian fissure was unique, the posterior end of the Sylvian fissure has a relatively anterior position, associated with no parietal operculum.

# EINSTEIN'S BRAIN



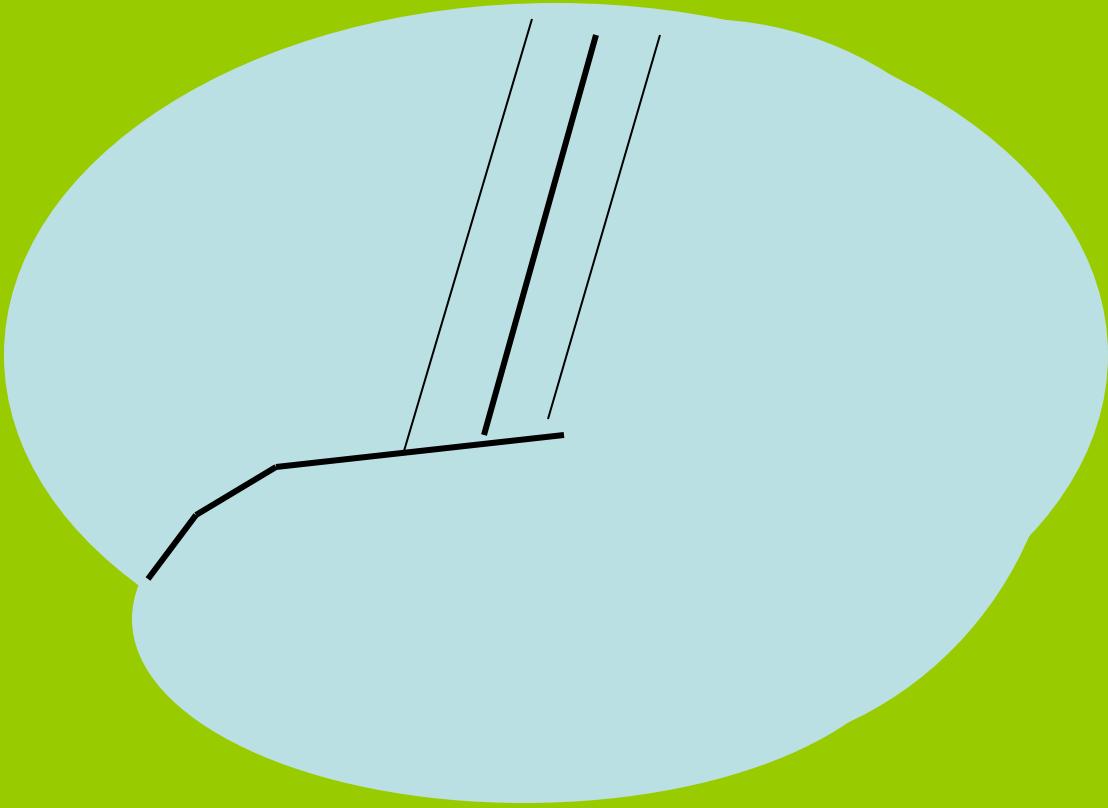
# Normal Brain

- Sylvian fissure extends to inferior parietal lobe and ascending gyrus divides the supramarginal gyrus.



# Einstein's Brain

- The Sylvian fissure ends near the sensory cortex and no ascending gyrus



# Einstein

- 1) Age of 3 parents brought him to pediatrician...not speaking.
- 2) Dyslexia
- 3) Used spatial reasoning...Possible disinhibition of right hemisphere global-spatial reasoning
- 4) Bruce Miller- semantic dementia induced artistic creativity...but Finney and Heilman (2007)

# Bogen's Callosal Hypothesis and Hemispheric Specialization

- Moore et (2009) Tested Bogen's hypothesis that people with smaller corpus callosums will be more creative than those with larger callosums. Results supported Bogen's hypothesis.
- Gansler et al. (2009) found that those of Moore's subjects who had greater visuo-spatial creativity (Torrance Test) had a larger right parietal lobe.

# Stage 2 Innovation

- Disengagement and Divergent Thinking:
  - 1) Denny-Brown: Frontal lobes mediate avoidance-parietal approach
  - 2) Berg's Wisconsin Card Sort; Brenda Miller and frontal lobes.
  - 3) Alternative Uses Test (things you can do with a brick).
- Curiosity, and Risk Taking:
  - ? Ventral striatum and ventral medial frontal lobes.
- Finding the thread that units:
  - William James (1890) "...unheard of combinations of elements and subtle associations..."

# Innovation Continued

- Spearman (1931) “Creative ideas result from the combination of ideas that have been previously isolated.”  
(e.g.,  $E = MC^2$ )
- Supporting Evidence
  - 1) Lexical Priming - Creative people have flatter association curves.
  - 2) EEG Coherence – When developing creative ideas people have greater gamma coherence.
  - 3) Bogen – Corpus callosum permits hemispheric specialization. The suspension of interhemispheric inhibition permits creative illumination. Lewis showed using the ink blot test that interpretation of these stimuli was less creative after callosal section.

# Innovation Continued

Major Hypothesis: Innovation is induced by the ability to engage large distributed networks and co-activate anatomically distributed networks, both inter and intra hemispherically.

*But how are the size of networks and the co-activation of networks mediated?*

# Innovation Continued

- Observations:

1. Before and after sleep.

Kekule (1865)-benzene ring.

2. Relaxation:

- A) Examples: Newton – mother's farm-calculus; Darwin – Beagle evolution; Einstein – late in patent office -relativity; Archimedes-bathtub – buoyancy.
- B) Raymond y Cajal – “If a solution fails to appear yet we feel success is around the corner...try resting for a while.”

3. Depression:

- A) Aristotle asked, “Why are men who are outstanding in the arts and philosophy melancholic?
- B) Kraepelin (1921) and Post (1996) noted most creative authors, artists, composers and many scientists have depression or bipolar disorder.

# Innovation Continued

- Hypothesis: Sleep – post sleep, relaxation and depression are all associated with decreased nor-epinephrine (NE). NE reduces the sizes of networks (focus) and orients attention outward. Therefore reduced NE can enhance creativity.
- Support
  - 1) Kischka (1996): Increase of RT with indirect primes when subjects give levodopa (which is converted in part to NE).
  - 2) Beversdorf- Increased ability to solve anagram with propanolol, but not with b-blockers that do not go to brain.
  - 3) Ghasbeh- Vagal stimulation, which increases NE decreases performance on Torrance Test of Creativity.

# CREATIVITY AND AGING

- 1. Simonton (1991) showed a relationship between creativity and aging.
  - A) Increase of productivity between ages of 20-30.
  - B) Peak at ages of 30-50.
  - C) The decline.
- 2. Possible neuropsychological reasons :
  - A) Run out of ideas.
  - B) Decrease in intelligence- Decrease in WAIS performance  
no change or increase of verbal IQ.
  - C) Fluid intelligence more important for creativity than crystallized.
  - D) Decreased disengagement and divergent thinking.

# CREATIVITY AND AGING CONTINUED

## 3. Changes in Aging Brain

-A) Little loss of neurons < 10% between age of 20 and 80.

however, neurons are lost in frontal lobes.

-B) Most atrophy with aging related to white matter loss. The areas that are the latest to mylinate appear to be the first to go.

-C) Frontal lobe function is heavily dependent on white matter connectivity (temporoparietal, dorsomedial thalamus and basal ganglia) and frontal lobe connection one of the last to myelinate.

-D) With aging also decrease of corpus callosum.

-E) Right hemisphere has more white matter than left. Right hemisphere important in global (versus) local attention (seeing the forest rather than the trees) important in seeing the thread that unites.

# Possible Means of Enhancing Creativity

The development of creative products requires skill and most creative people practice, practice and practice.

Rest, relaxation, and even sensory deprivation are all associated with creativity.

Immediately after awakening in the morning, many people develop creativity ideas.

Performing meditation may enhance creativity.

Anxiety is associated with increased brain NE and a reduction of anxiety might allow the activation of widely distributed networks and the ability to direct attention inward.

While not approved for treatment of creativity, propranolol may enhance creativity.

Creativity requires risk taking and while not tested some dopamine agonists increase risk taking.

Avoid injury (TBI) and diseases that can impair frontal lobe function.