Some neurological studies on intellectually giftedness –

a discussion about relations btw nature and nurture under Actiotope model

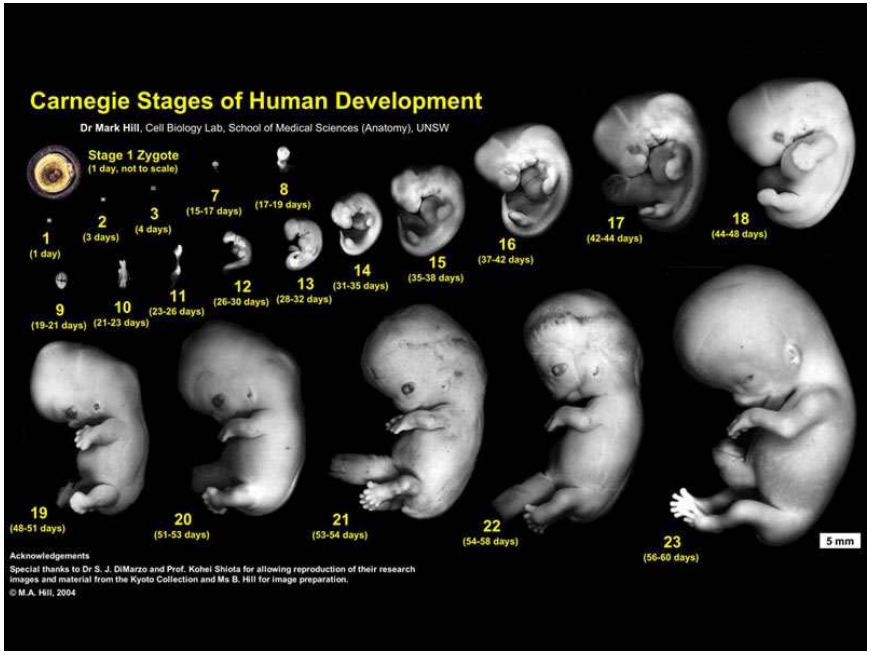
Jiannong SHI

Institute of Psychology,
Chinese Academy of Sciences
shijn@psych.ac.cn
http://www.iratde.org
http://cngifted.psych.ac.cn

(HKIE, Hong Kong, Aug.1, 2011)

What makes an individual be excellent –

nature or nurture?



http://embryology.med.unsw.edu.au/wwwhuman/Stages/Images/Cst800.jpg

The Education of Karl Witte; Or, the Training of the Child;

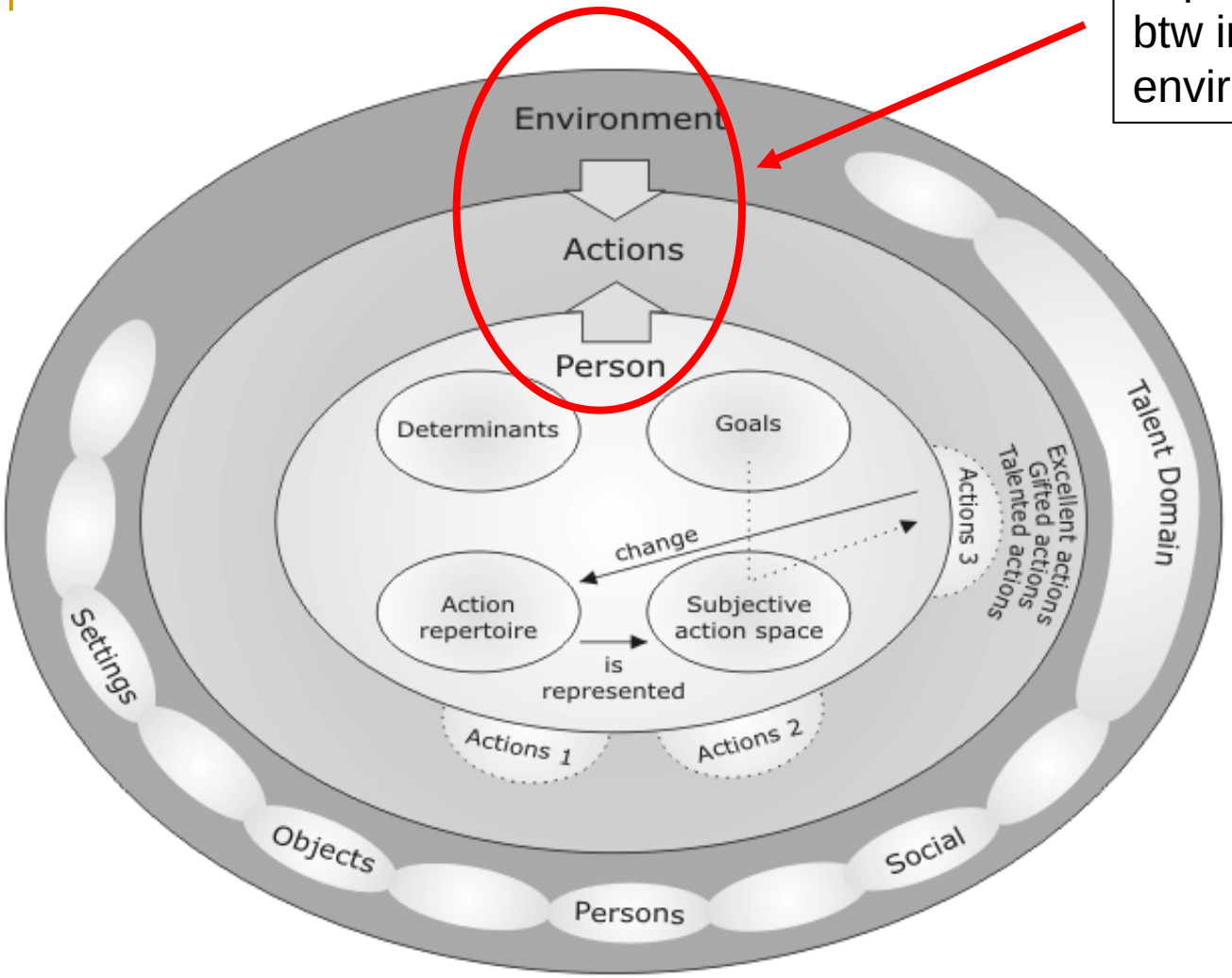
Karl Heinrich Gottfried Witte

Genius can be made?

or

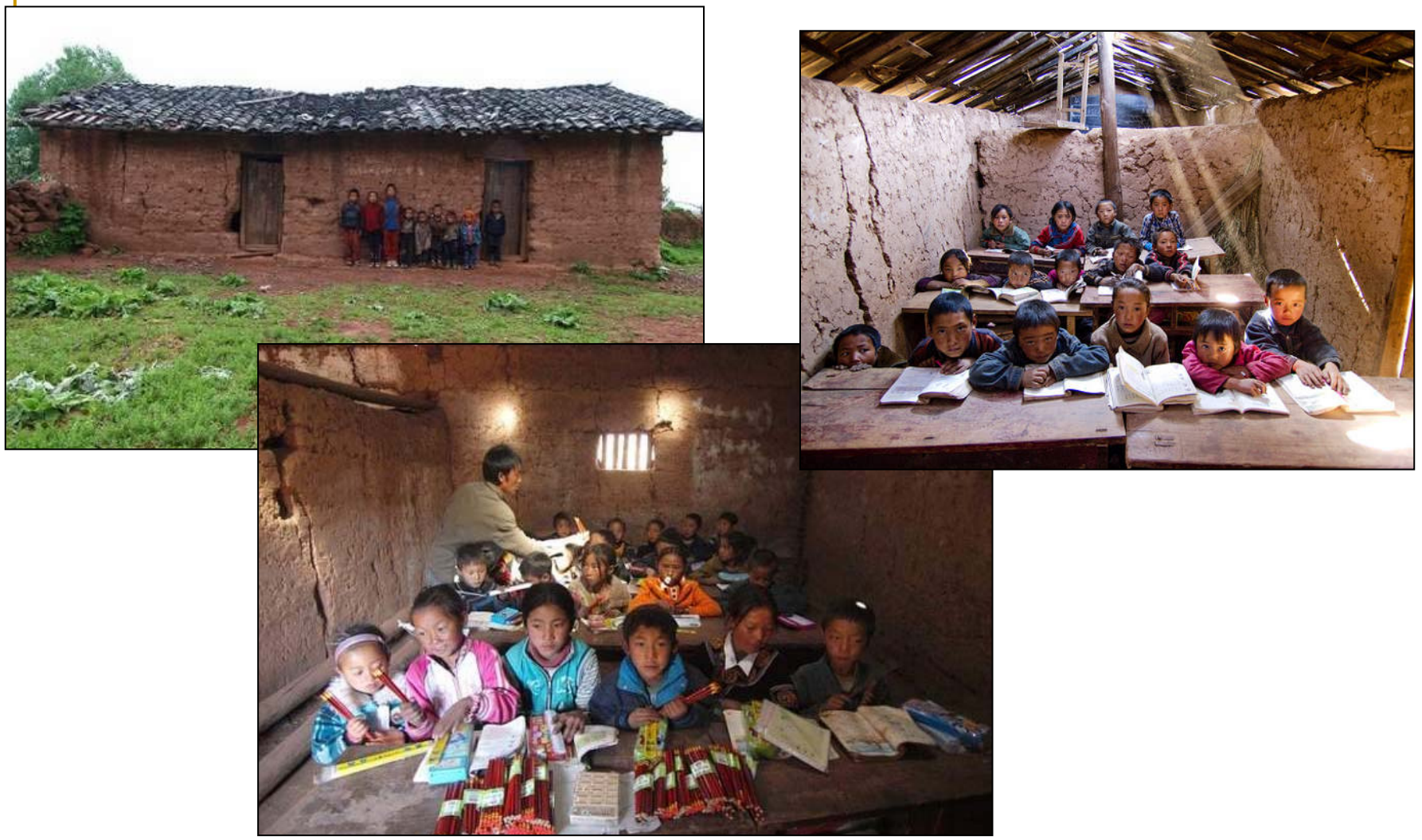
An ounce of heredity is worth a ton of education?

Importance of interaction btw individual and environment



Actiotope Model of Giftedness (Ziegler & Stoerger, 2004)

Environment & child development



Environment & child development

A Fact

More than 600 of adolescents with average age of 14 have graduated from Beijing No.8 Middle School and been enrolled into top universities in China since 1989.

However, this is not a unique case. There are many individuals who are even more intelligent and their achievements are more attractive.

Why can they achieve so much?

They can achieve this because they are intellectually gifted and superior to their average peers

Why are gifted children superior to average children?

Because they have some significant characteristics

Significant characteristics

- Perception & observation
- Attention & memory
- Language & expression
- Thinking & reasoning

(Zha et al, 1981, 1993)

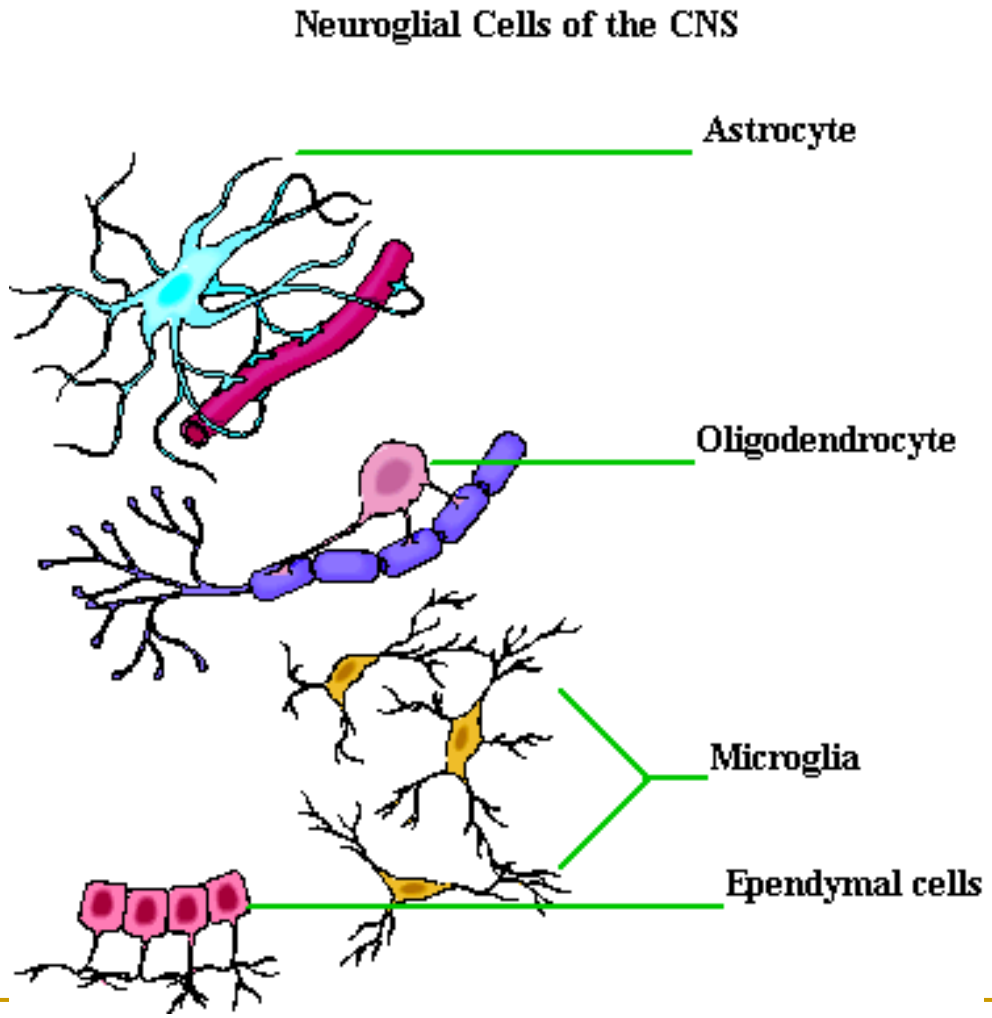
Previous studies suggested that intellectually gifted individuals had much better attention focusing and memory abilities (Schweizer, Moosbrugger, 2004; Jaušovec, Jaušovec, 2000).

Why do gifted children have these characteristics?

Because they have efficient brains and better nerve systems.

Biological Differences:

Increasing neuroglial cell production, Accelerated synaptic activity, Accelerated thought processing (Thompson, Berger, and Berry, 1980).



Functions of Glial cells

- They provide mechanical support to neurons
- Act as insulators between the neurons
- Remove the foreign material and cell debris by phagocytosis.
- Repair the damaged areas of nervous tissue
- Take up and store neurotransmitters released by the neighboring synapses
- Maintain a suitable metabolic and ionic environment for the neurons.
- Exchanges of materials between brain and Cerebrospinal Fluid.

Tuned Resp
Their Influe
Signals in

James Schummers,* Hongb

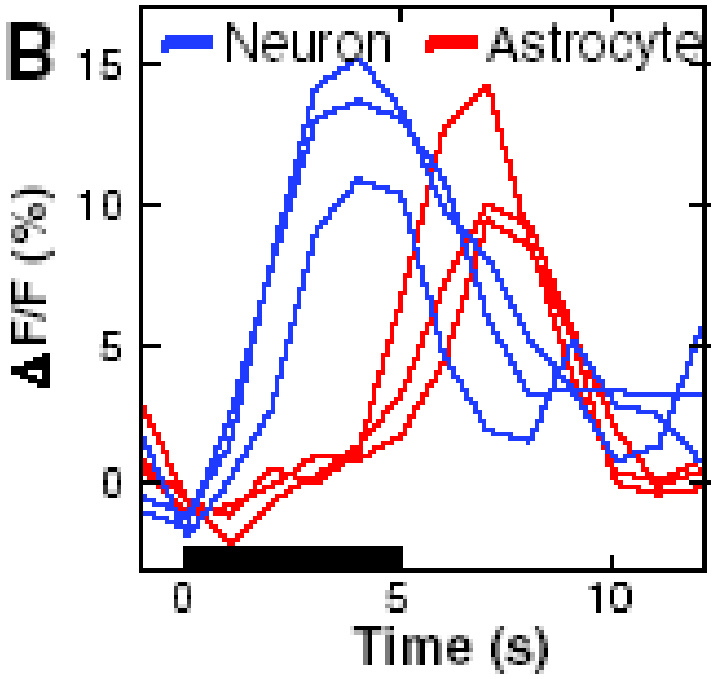
Astrocytes have long been t
information representation
ferret visual cortex in vivo t
distinct spatial receptive fie
and spatial frequ
across the cortical
specific component o
activation, indicating th
signals critical for nonin
transporters influenced the

We used two-photon imaging of calcium signals in the ferret visual cortex in vivo to discover that astrocytes, like neurons, respond to visual stimuli, with distinct spatial receptive fields and sharp tuning to visual stimulus features including orientation and spatial frequency. … Furthermore, blocking astrocyte glutamate transporters influenced the magnitude and duration of adjacent visually driven neuronal responses.

Though astrocytes are th
nonneuronal cell in the brai
in brain function is unresolved. Ev
has accumulated for an active role of astrocytes in brain function (*1–3*). Astrocytes are closely apposed to many central synapses (*4*, *5*) and mate and other neuroactive substances (*7–10*) that affect neuronal activity (*11*) and can modulate synaptic strength (*10*, *12*, *13*). Astrocytes

*These authors contributed equally to this work.
†To whom correspondence should be addressed. E-mail: msur@mit.edu

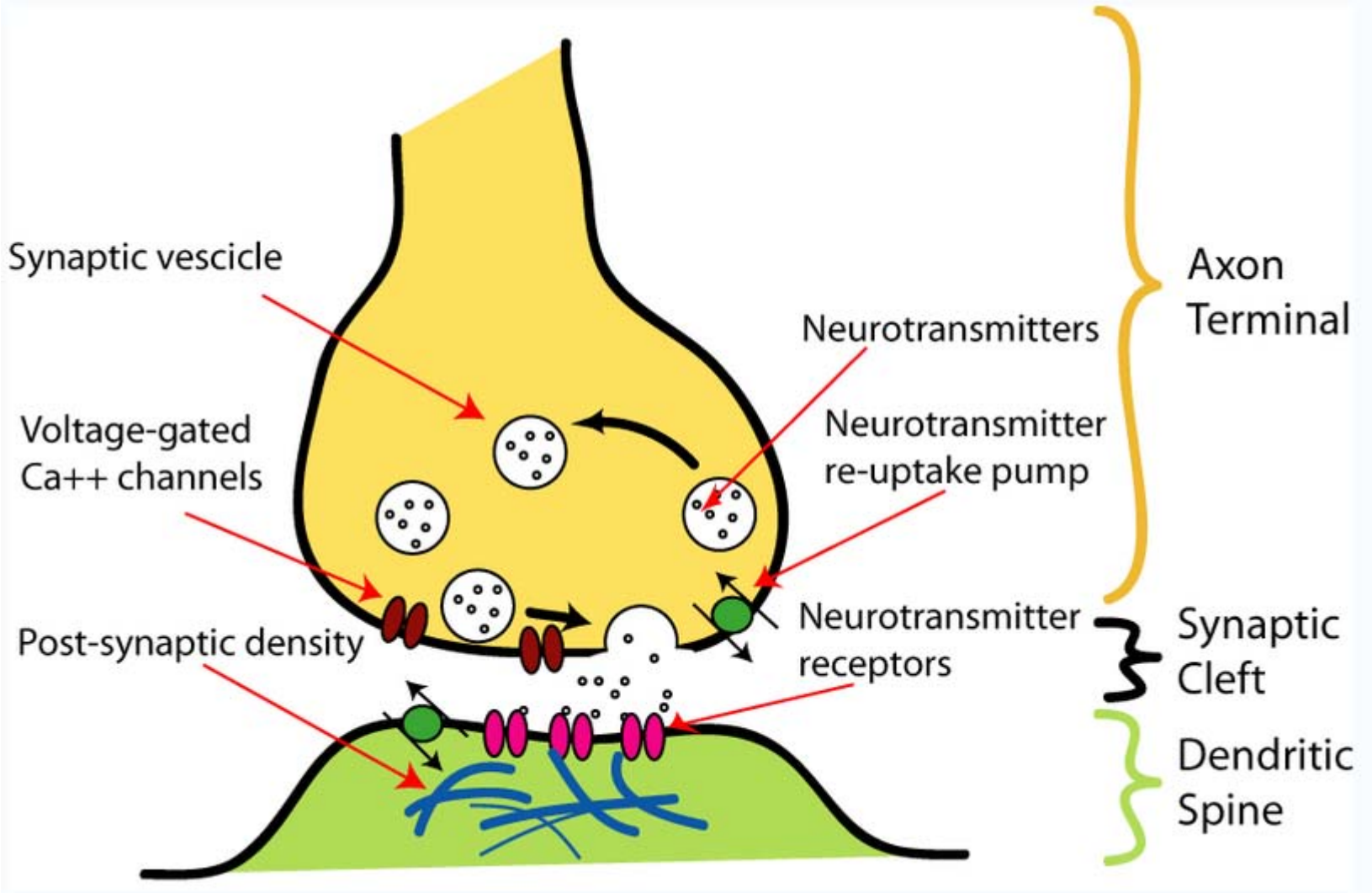
New function of neuroglia



(J. Schummers, H.Yu, & M. Sur, 2008)

Biological Differences:

- Biochemically richer, more complex patterns of thought (Rosenzweig,1966: Krech, 1969).



(http://www.edb.utexas.edu/robinson/Perception/images/synapse.jpg)

Biological Differences:

- More active in the prefrontal cortex of the brain, more future planning, insightful thinking, and intuitive experiences (Restak, 1979; MacLean, 1978).

Biological Differences:

- More alpha wave activities within more areas of the brain, more relaxed and concentrated learning, higher levels of retention, and more integration of hemispheric modalities (Lozanov; 1977, Martindale, 1975).

Biological Differences:

- More coherence and synchronicity of brain rhythms more often, allowing heightened concentration, focused attention, and in depth probing and inquiry (Millay, 1981).

Science The World's Leading Journal of Original Scientific Research, Global News, and Commentary.

Science Home | Current Issue | Previous Issues | *Science* Express | *Science* Products | My *Science* | About the Journal

Home > *Science* Magazine

functional genomics resc

epigenetic

Epigenetics

For dec

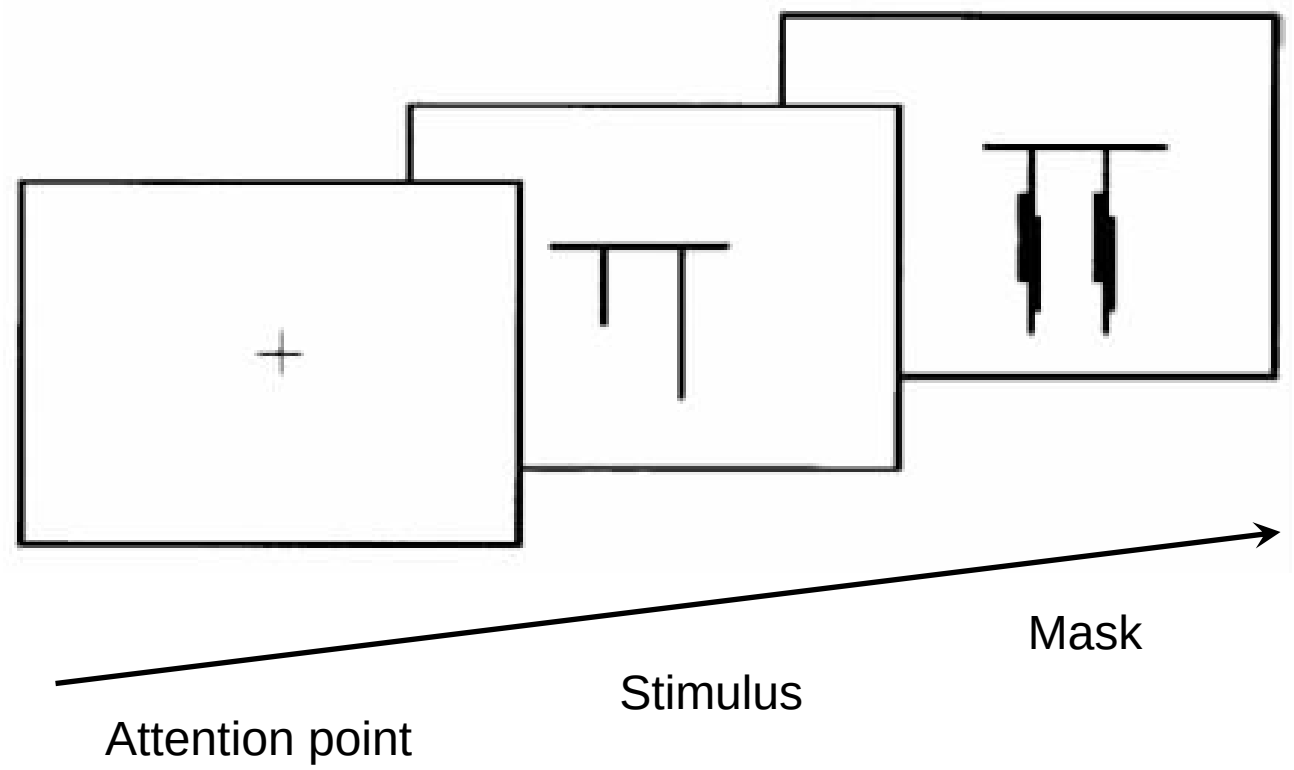
genetic mutations and recombi

are handed down from one genera , as is amply demonstrated in *Science*'s special issue of 10 August 2001 veries in the field of epigenetics -- the study of heritable changes in gene fu hat occur without a change in the DNA sequence -- have blurred that neat picture, a are changing the way researchers think about heredity. Epigenetic mechanisms such as DNA methylation, histone acetylation, and RNA interference, and their effects in gene activation and inactivation, are increasingly understood to be more than "bit players" in phenotype transmission and development. And, with the prospect of human cloning now being actively discussed in some quarters, understanding the twists and turns of epigenetic inheritance has become especially important.

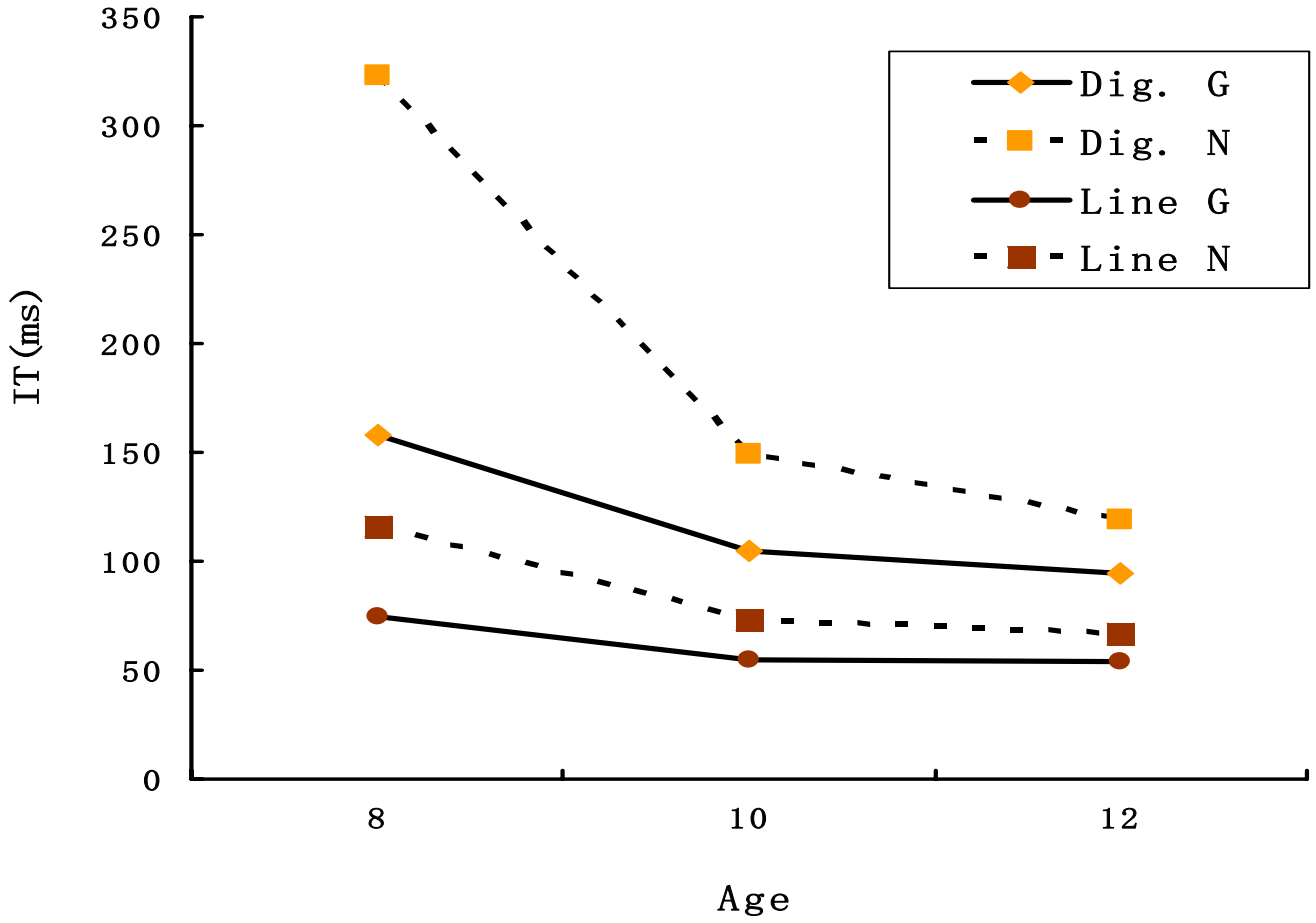
To provide an extra dimension to coverage in the 10 August 2001 special issue, we're launching a new epigenetics section here on the *Science* Functional Genomics Web site. On this page, you'll find a collection of links to interesting Web resources on chromatin, methylation, imprinting, and a variety of other topics with an epigenetics bend. Also, we've gathered together a selection some groundbreaking research papers, Reviews, and Perspectives published in *Science* over the past five years, in a special new epigenetics section of our Functional Genomics Research Archive.

Recent discoveries in the field of epigenetics -- the study of heritable changes in gene function that occur without a change in the DNA sequence -- have blurred that neat picture, and are changing the way researchers think about heredity.

Typical IT pattern



(Nettelbeck & Rabbitt, 1992)



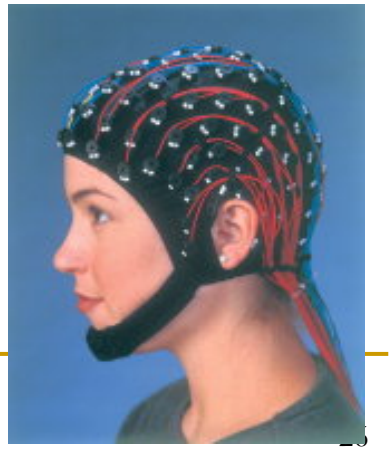
Notes: G. Dig. – Digital IT of gifted children; N. Dig. – Digital IT of non-gifted children; G. Line – Line IT of gifted children; N. Line – Line IT of non-gifted children

(Cheng, Shi et al, 2004)

- Highly intelligent individuals are always regarded as the ones who have fast brains, and they use much less time to finish cognitive tasks with much better performances than normal individuals (Chalke, Ertl, 1965).

Neuropsychological studies

The purpose of neuropsychological study is to record the activities of human brain and connect these brain activities to meaningful behaviours.



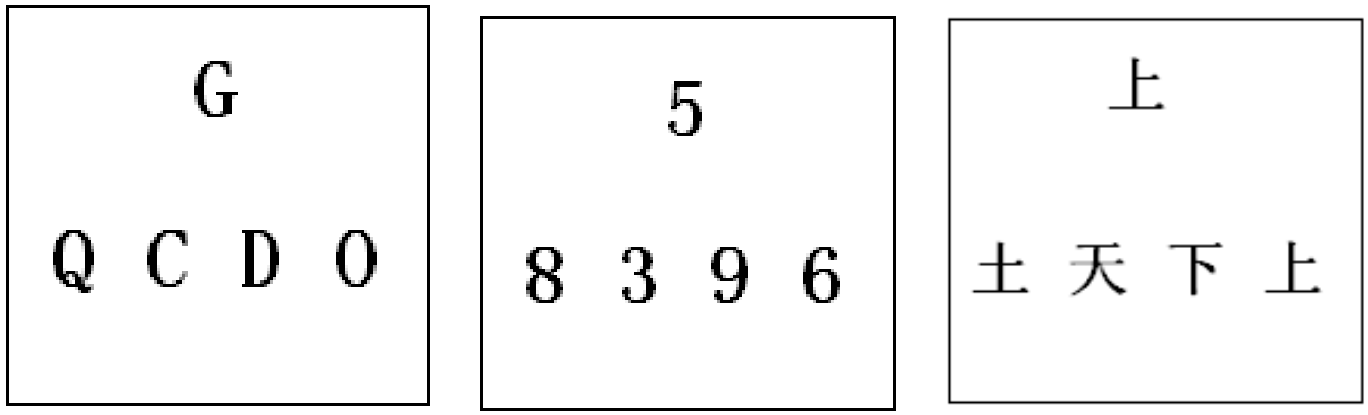
Study 1: ERP of visual search btw G/NG

- 15 intellectual gifted students
  (9b, 6g: 11.7±0.2)
- 13 average students
  (7b,6g:11.7±0.3)

(Zhang & Shi, 2006)

Stimuli materials

- Chinese characters
- Arabic number
- English letters



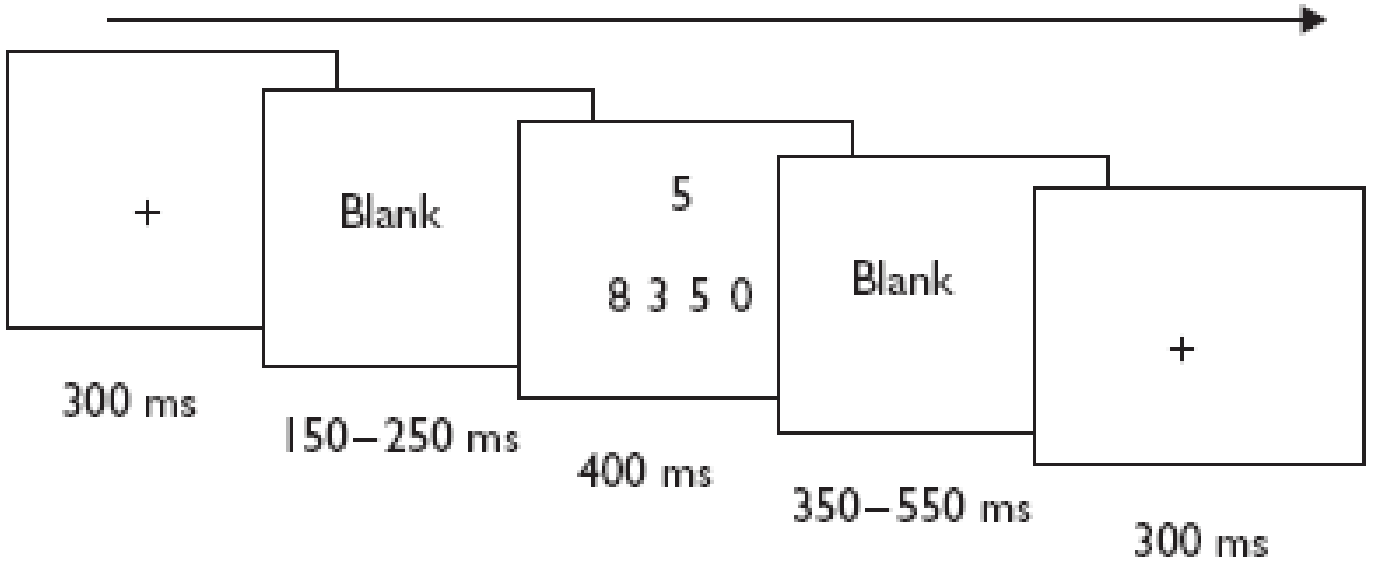
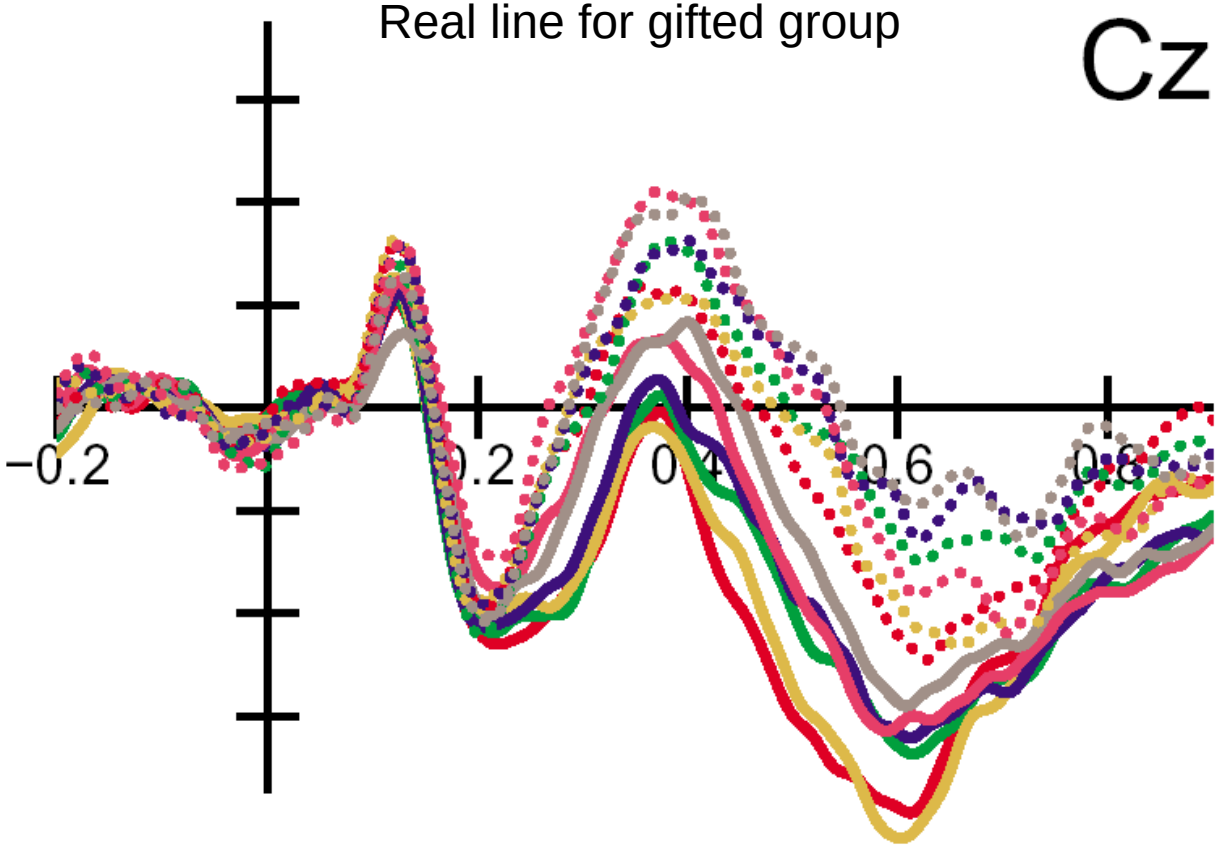


Fig. 1 Illustration of visual search tasks.

Doted line for average group
Real line for gifted group



(Zhang & Shi et al, 2006)

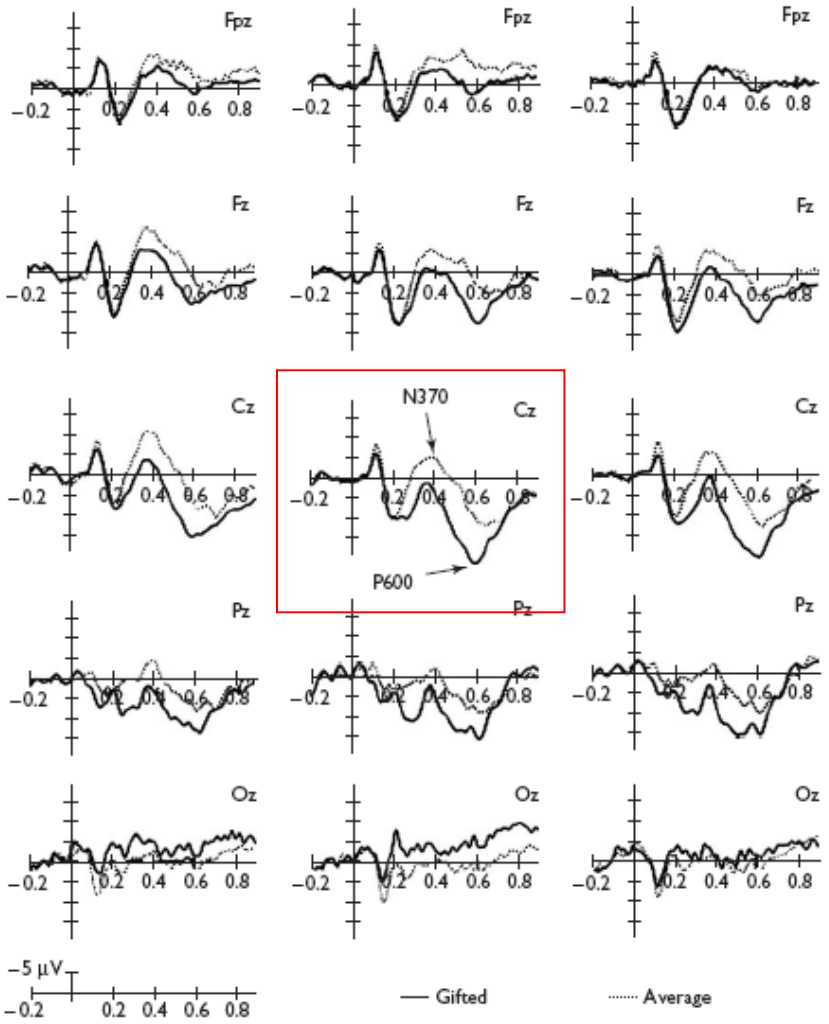
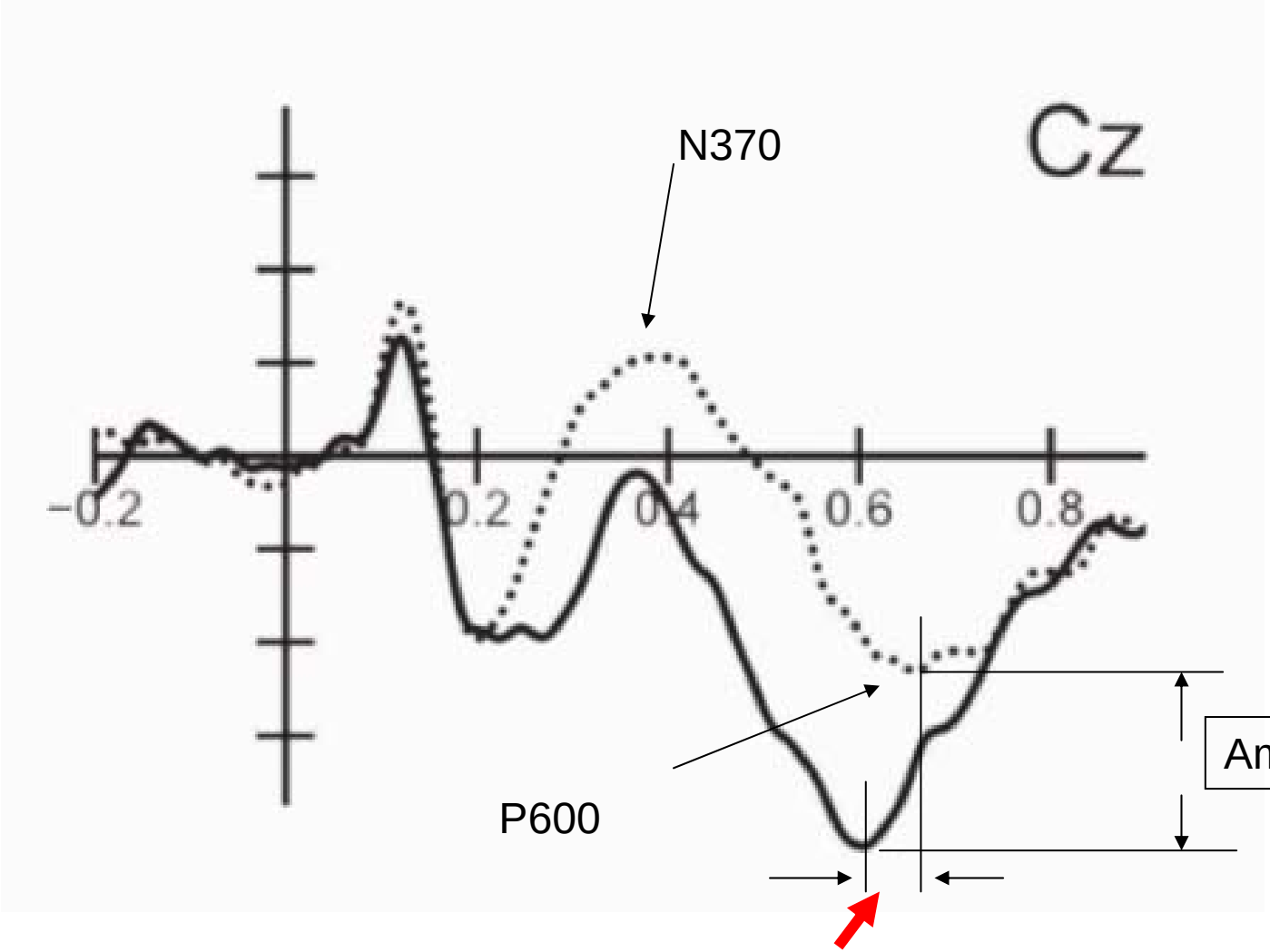


Fig. 2 Children's grand average event-related potential waveforms to Chinese words (the first column), English letters (the second column), Arabic numbers (the third column). Stimulus onset is the vertical calibration bar, and negative is plotted up. Solid line: gifted group; dotted line: average group.



Latency differences btw gifted and average children at P600

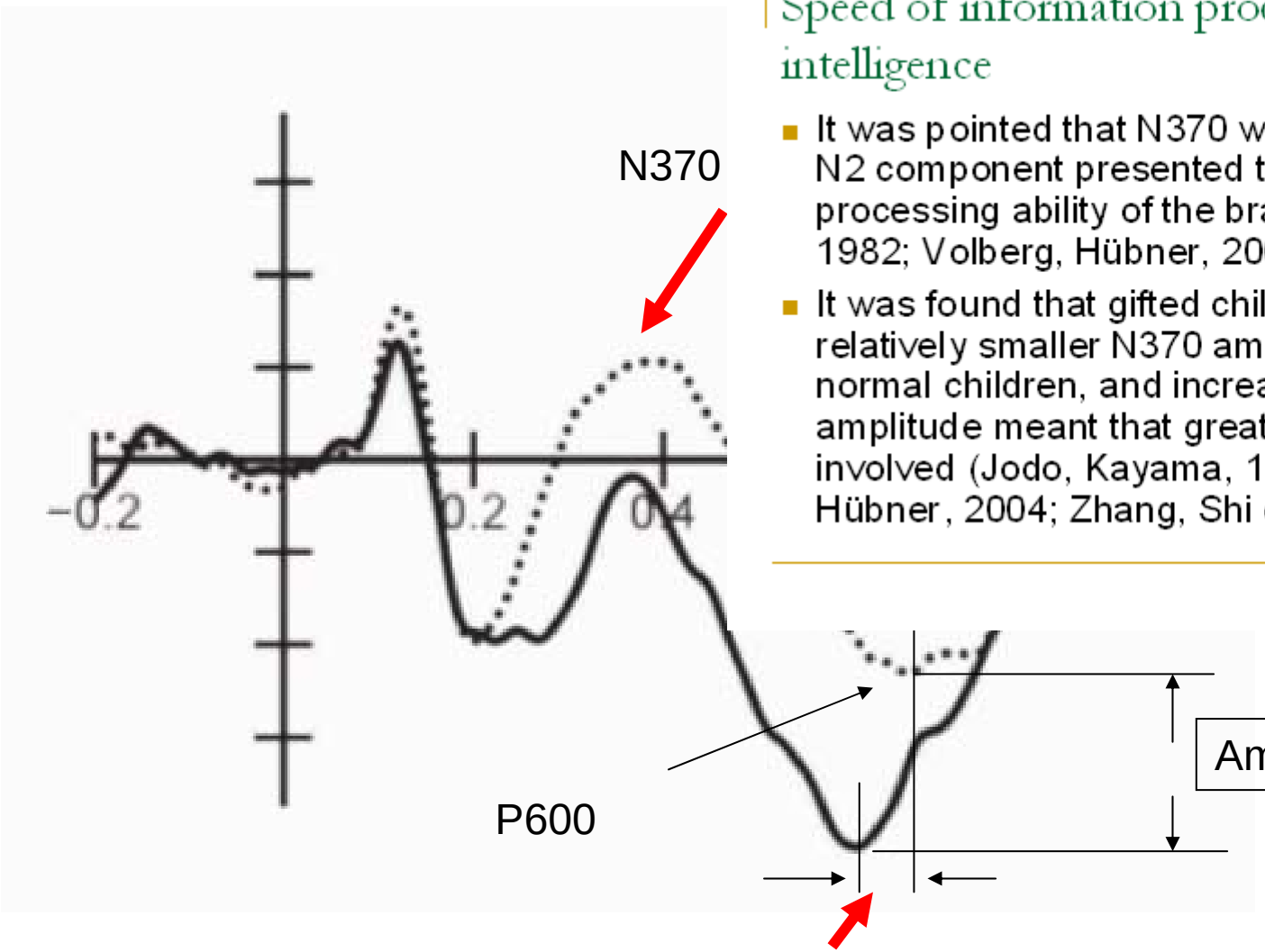
..... Average

——— Gifted

(Zhang & Shi, 2006)

Speed of information processing and intelligence

- It was pointed that N370 which was similar to N2 component presented the inhibition processing ability of the brain (Jodo, Kayama, 1982; Volberg, Hübner, 2004).
- It was found that gifted children had a relatively smaller N370 amplitude than normal children, and increased N370 amplitude meant that greater effort was involved (Jodo, Kayama, 1982; Volberg, Hübner, 2004; Zhang, Shi et al., 2006)



Latency differences btw gifted and average children at P600

..... Average

——— Gifted

(Zhang & Shi, 2006)

Implication of study 1

The results suggest comparatively increased P3 amplitudes and shorter P3 latencies in brighter individuals than in less intelligent individuals, but this expected neural efficiency effect interacted with task content. The differences were explained by a more spatially and temporally coordinated neural network for more intelligent children.

Study 2: Auditory sensory processing of G/NG children

- 18 intellectual gifted students

  (10b, 8g,11.8(age range:11.4-12.4))
- 13 average students

  (9b,9g,11.7(age range:11.2-12.2))

(Liu, Shi et al, 2007)

Stimuli materials

- Standard sound ‘ka’
- Deviant sound ‘ta’
- 120 Novel sound

Experiment paradigm

- Typical Odd Ball paradigm was employed
- Probability of ka/ta/novel sound is 0.8/0.1/0.1

Results

Table I Mean peak latency (ms) and amplitude (μV) of the MMN and LDN to deviant stimuli and the eMMN and P3a to novel stimuli in both groups

Group	MMN		LDN		eMMN		P3a	
	Latency	Amplitude	Latency	Amplitude	Latency	Amplitude	Latency	Amplitude
Highly intelligent	311.5 (49.02)	−3.79 (1.7)	480.22 (39.51)	−3.96 (1.77)	168.09 (18.87)	−4.28 (1.77)	329.65 (27.94)	3.57 (2.58)
Normal	298.57 (41.04)	−3.25 (1.48)	507.65 (62.31)	−3.62 (1.5)	171.3 (25.19)	−3.82 (1.27)	338.75 (26.82)	2.94 (1.88)

LDN, late discriminative negativity; eMMN, early mismatch negativity.

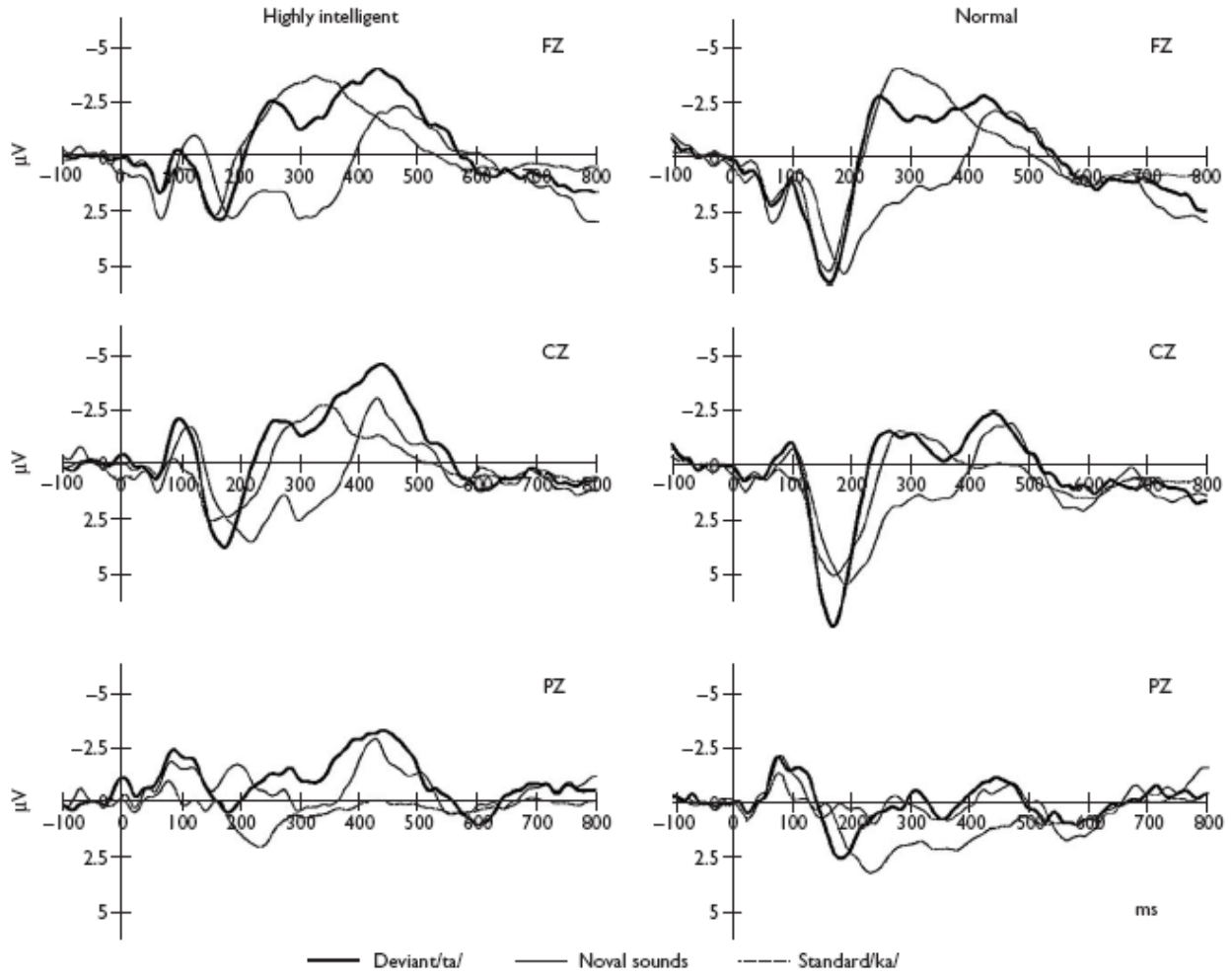


Fig. 1 The ERPs elicited by the standard, deviant, and novel sounds are presented for both groups. ERP, event-related potential.

Implication of study 2

The results indicated that children with high intelligence had comparatively larger MMN, LDN, early MMN, P3a amplitudes, and earlier peak latency in LDN than average children. The enhanced neural function of the intellectually gifted children might be due to more spatially and temporally coordinated neural network, faster neural processing speed and more efficient neural activation functions.

Implication of study 2 (cont.)

- These findings indicated that gifted children have better neural automatic processing and involuntary attention switch. It further supported that gifted individuals have more efficient brain and faster nerve system.

Epigenetics is a term in biology used today to refer to features such as chromatin and DNA modifications that are stable over rounds of cell division but do not involve changes in the underlying DNA sequence of the organism. These epigenetic changes play a role in the process of cellular differentiation, allowing cells to stably maintain different characteristics despite containing the same genomic material. Epigenetic features are inherited when cells divide despite a lack of change in the DNA sequence itself and, although most of these features are considered dynamic over the course of development in multicellular organisms, some epigenetic features show transgenerational inheritance and are inherited from one generation to the next.

Mapping chromosomal regions with differential DNA methylation in MZ twins by using comparative genomic hybridization for methylated DNA. (Fraga, M. F. et al. , 2005)

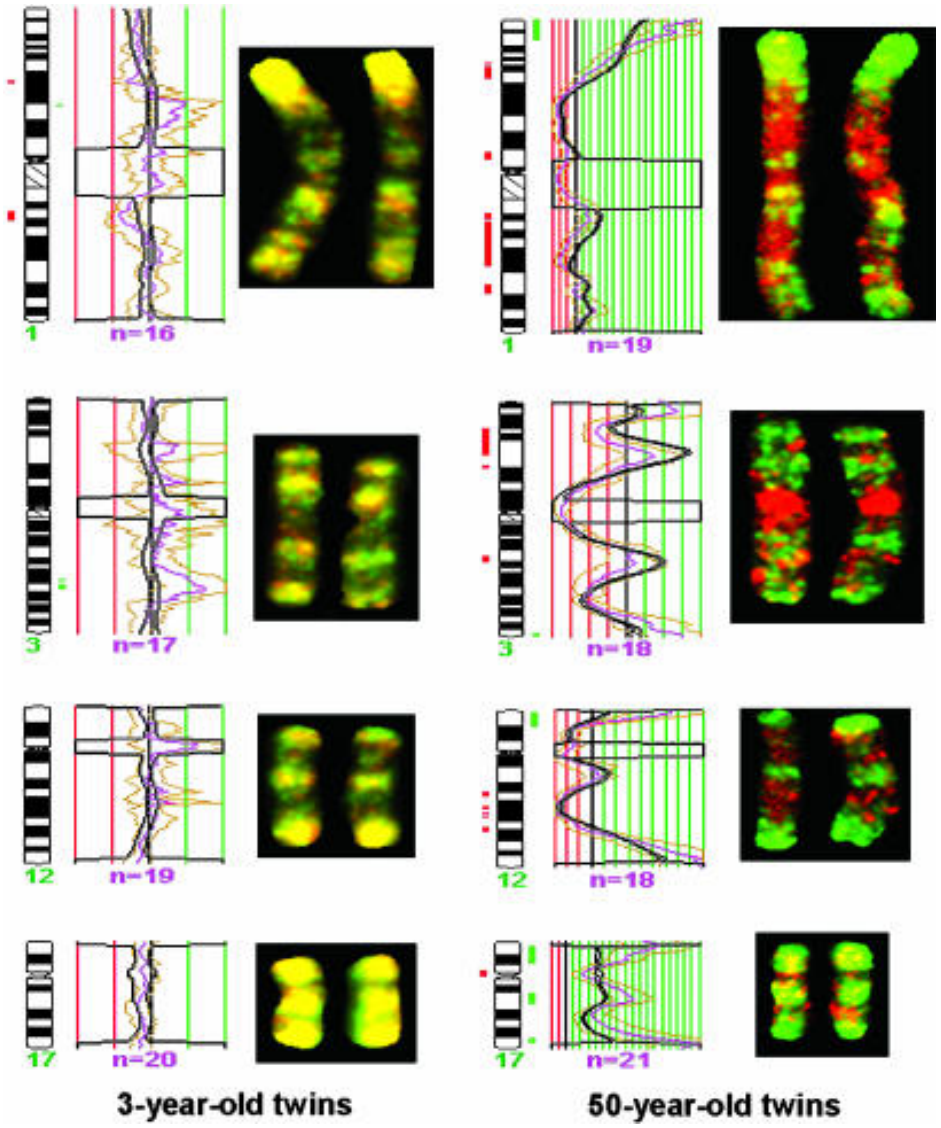
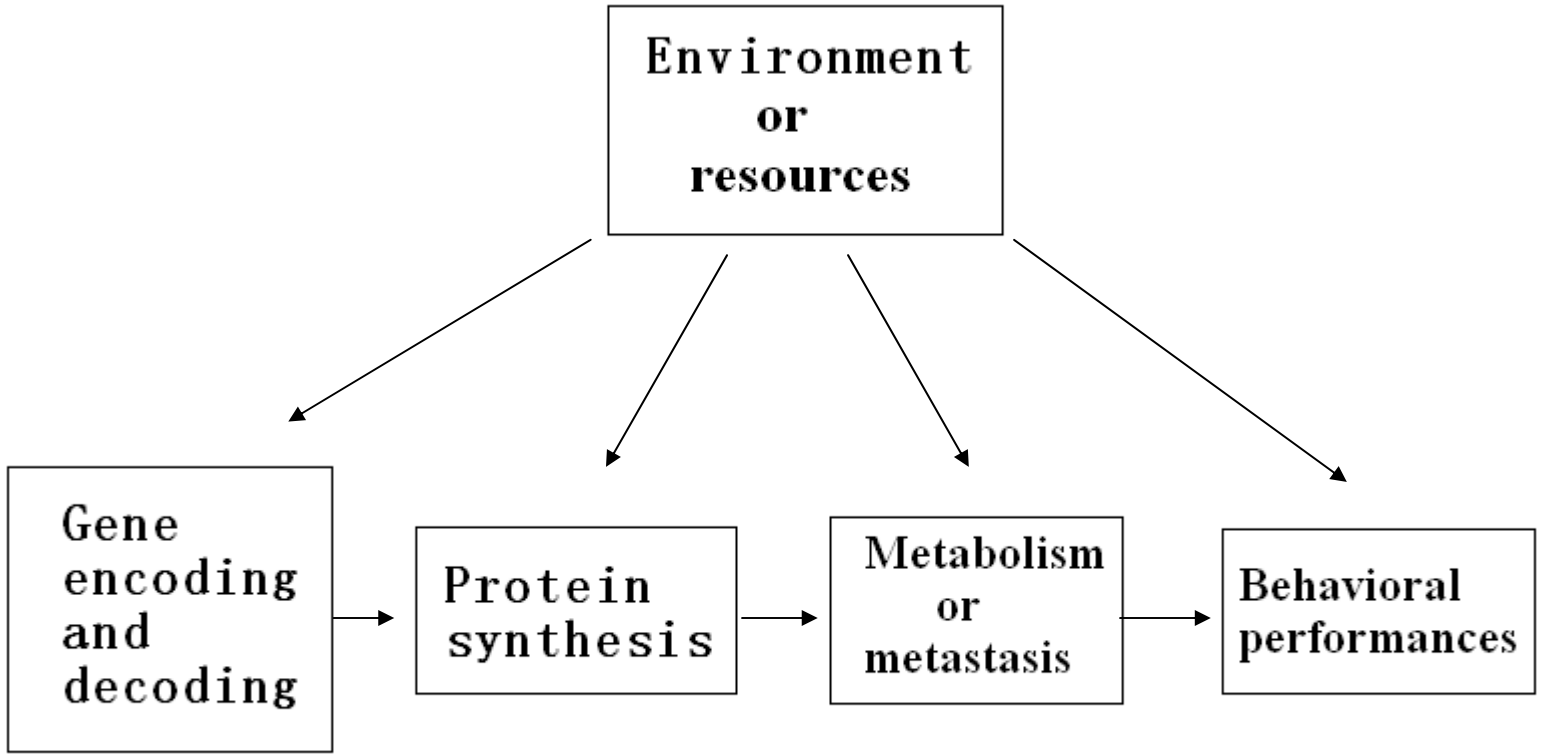
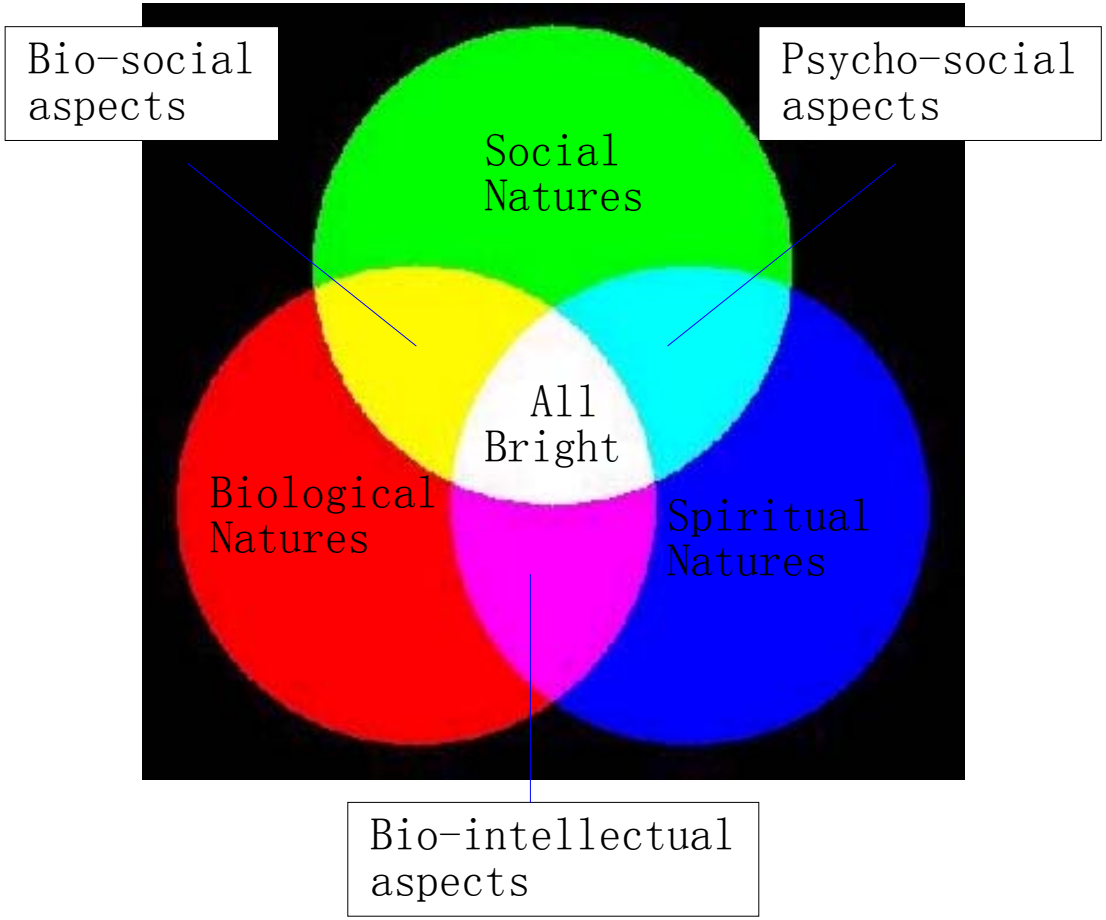


Fig. cited from
www.biox.cn/content/20051002/38333.htm

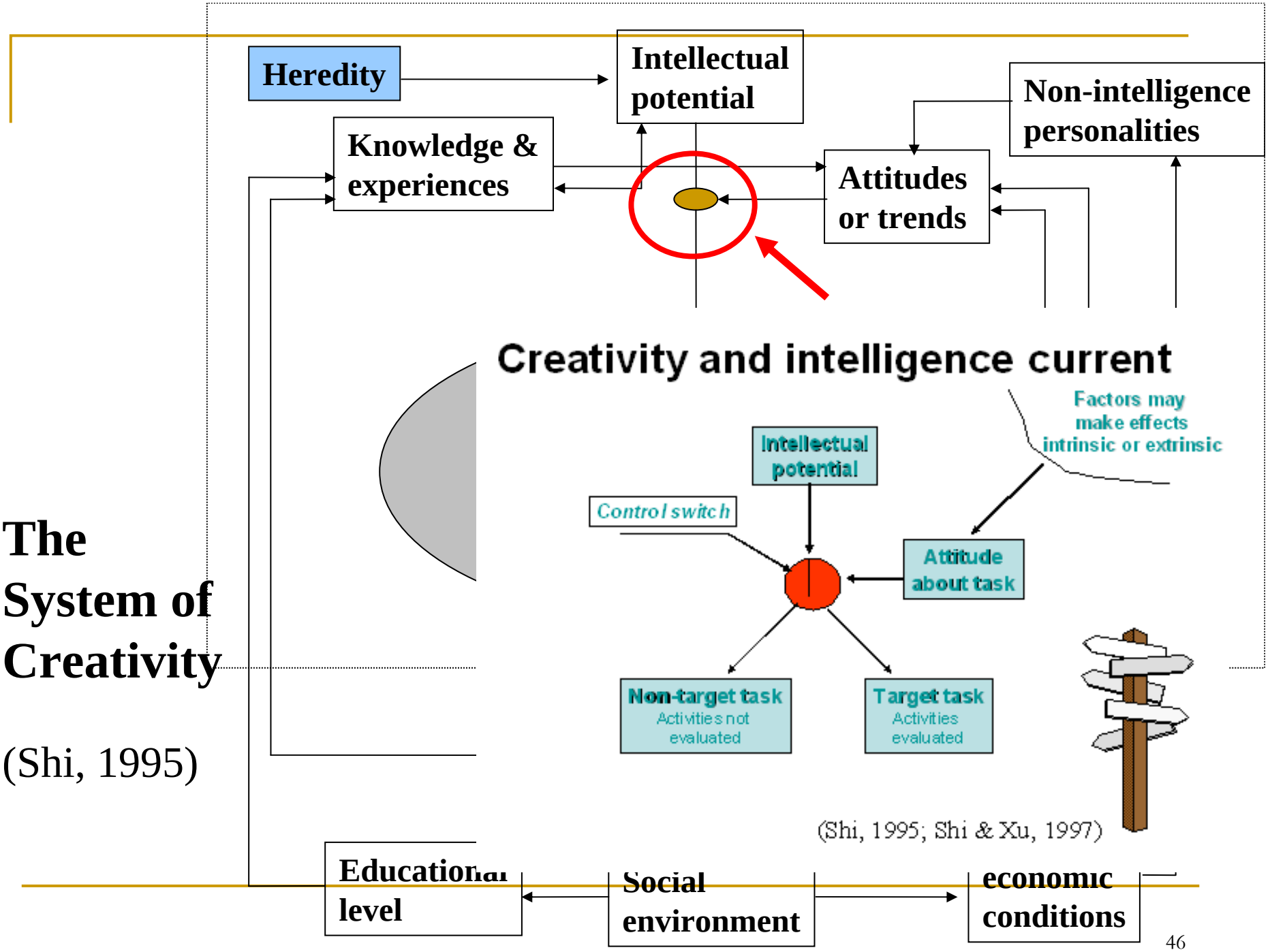

Environment or resources
Gene encoding and decoding
Protein synthesis
Metabolism or metastasis
Behavioral performances



Bio-socio-psychological model of giftedness (Shi, 2002, 2007)

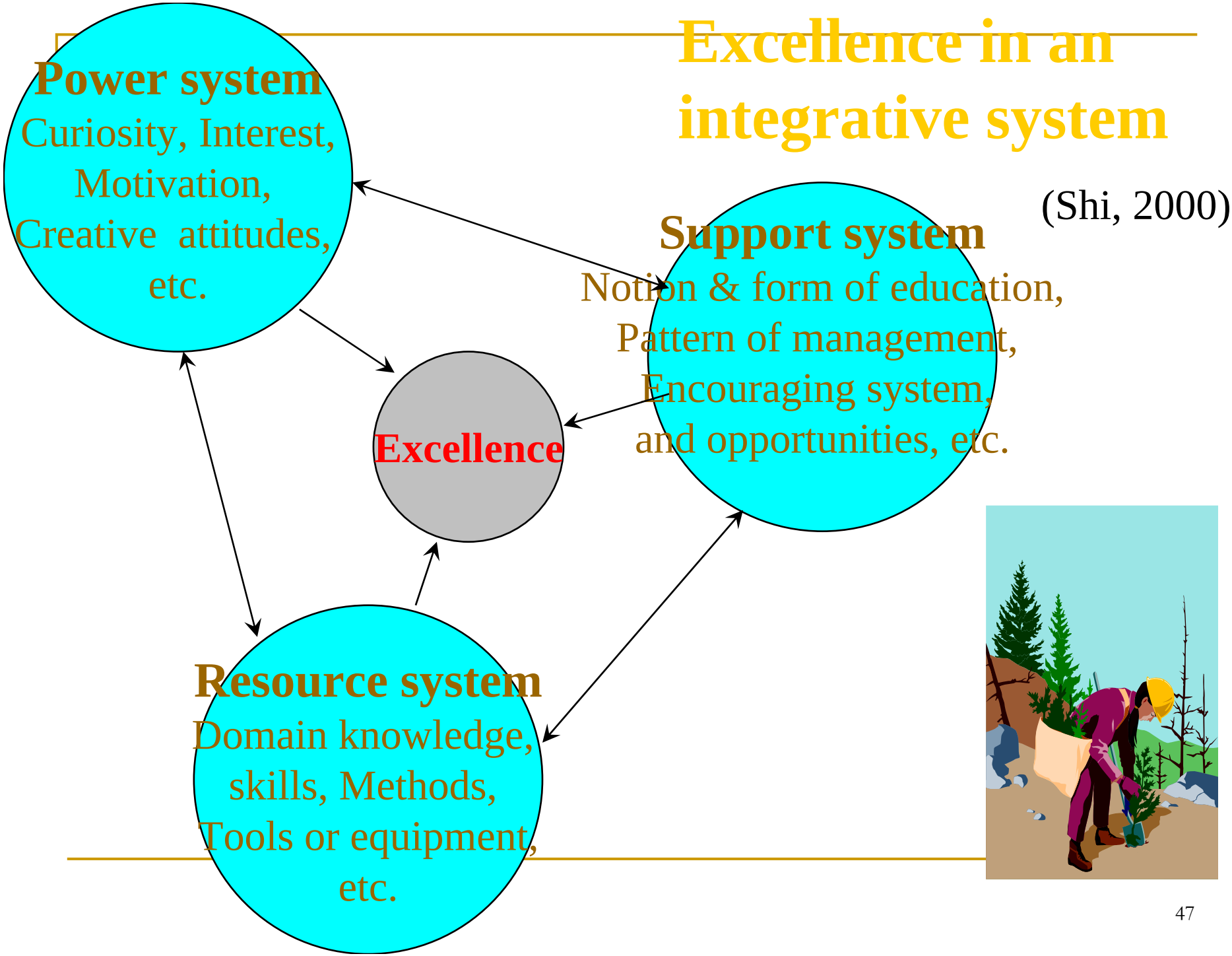
The System of Creativity

(Shi, 1995)



Excellence in an integrative system

(Shi, 2000)



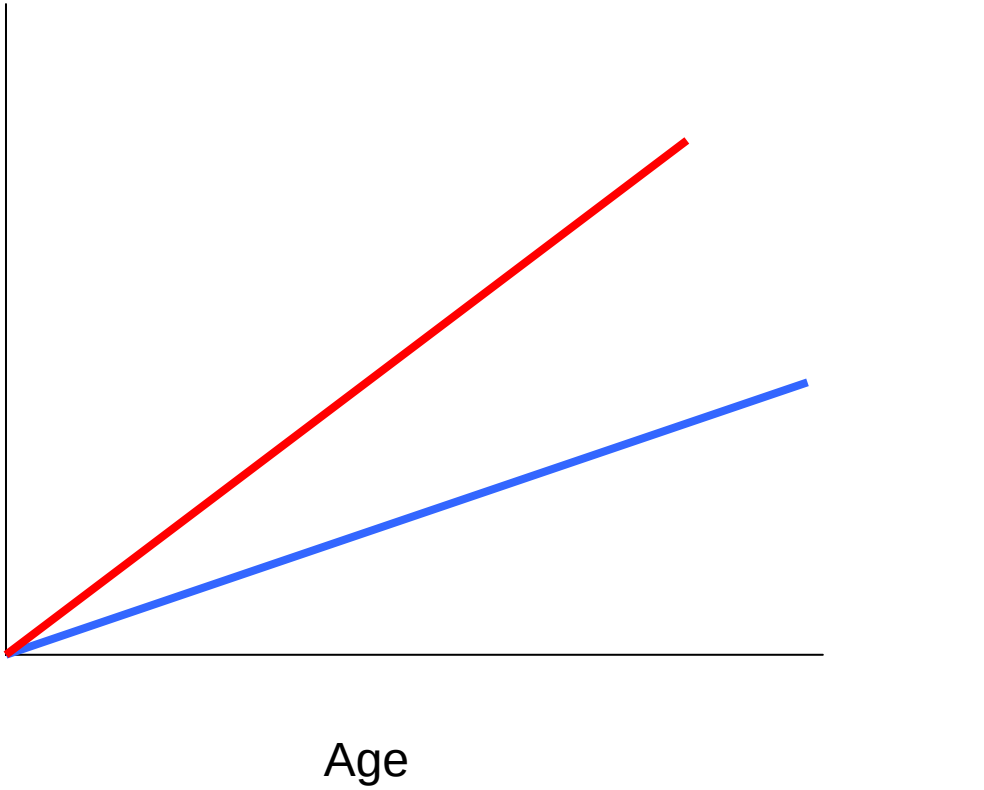
A Fact

More than 600 of adolescents with average age of 14 have graduated from Beijing No.8 Middle School and been enrolled into top universities in China since 1989 and became excellent graduate students and high achievers later on.

Summary

- Although the underpinning of giftedness is not quite clear, it is stable and lasts long-time.
- It can be explained, or partly explained the basis of cognitive behaviors, such as creativity, intelligence and so on. With the understanding of the biological, and even the genetic background, we can learn much more about giftedness and the question why they are gifted and what people can do for the gifted individuals.
- Only can education help children develop better without denying the biological foundation of their mental abilities.

Intelligent individuals gain faster & more from a better & richer environment, and are injured more seriously by bad environment



Acknowledgement

- Special thanks to students, parents & teachers from Beijing No.8 Middle School, Beijing Yumin Primary School, Beijing Yihai Primary School, Beijing Yucai School, and Beijing Happy Time Kindergarten.
- My students Shang Guan Fang Fang, Liu Tongran, & Lu Liping assisted me to prepare slides of this presentation
- Most studies are/were supported by NSFC

Thanks!

IRATDE
International Research Association for Talent Development and Excellence