Intelligence and academic achievement – with a focus on the Actiotope model of giftedness

Aljoscha C. Neubauer

Dept. of Psychology, University of Graz, Austria

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Giftedness in East-Asia,
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The Actiotope Model of Giftedness (AMG)

(Ziegler, 2005, p. 1)

Some assertions of the AMG:

- Assumption of traits makes sense only if there are entities within human psyche which correspond to these terms (i.e.gifts, talents, genius)
- Terman‘s work turned out to be of less importance for conceptions of giftedness; reason:
- lack of explanatory power intelligence has for excellence in academic domain and in the career area

- Extraordinary achievements are too diverse (intellectual, creative abilities, scientific abilties, social leadership qualities, mechanical abilities and artistics abilities): they exceed the explanatory power of one psychological construct by far
- A logical (?) consequence was to eliminate the limitations of gifts and talents to one psychological construct, instead
- Suggestions of ‚multiple intelligences‘ (Gardner) or
- ‚successful intelligence‘ (Sternberg)
- Ziegler‘s conclusion: ‚possibility that these mystic entities do not exist‘
- ‚which conception of giftedness one tends to favor is a question of taste, not a question of the thorough consideration of empirical findings‘

Traits exist and are important

- Intelligence exists (as do other traits as well)
- Intelligence (g) is the most powerful explanatory variable in all psychology with respect to prediction of
- educational outcomes
- professional success and even
- health

Overview

1. **The current status of intelligence research:** Intelligence is well researched from viewpoints of
   a) definition, psychometry and structure
   b) validity
   c) underlying elementary cognitive processes
   d) neuroscience
2. **Intelligence in the Actiotope model**
3. **Intelligence (and creativity) in China**

Communication problem:

almost no interchange between modern intelligence research and high ability research

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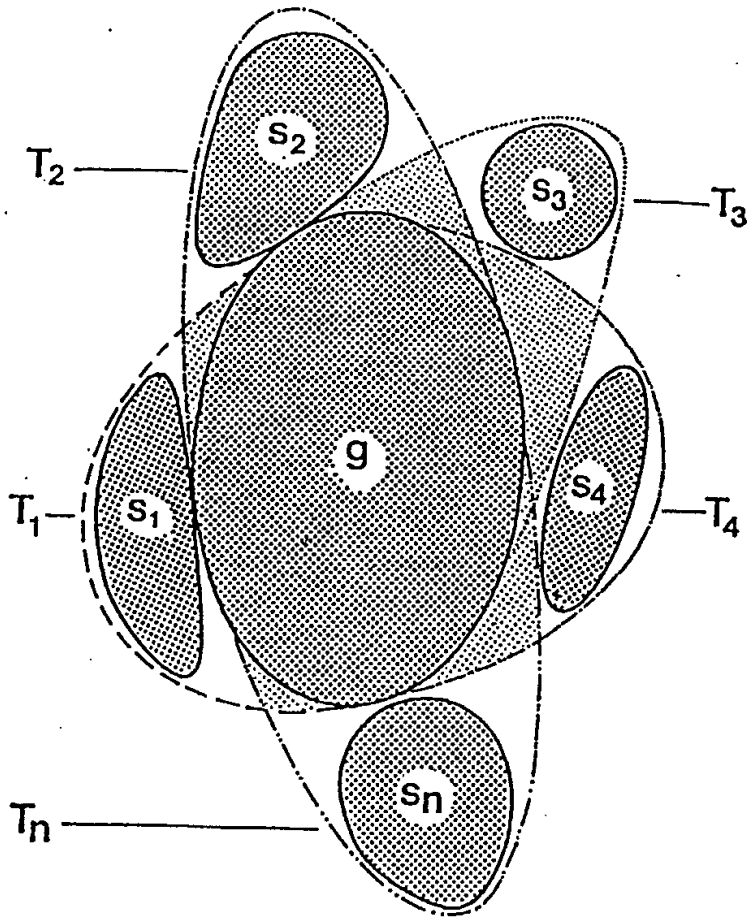
What is intelligence [g] ?

Intelligence is a very general capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly, and learn from experience… Intelligence, so defined, can be measured, and intelligence tests measure it well.

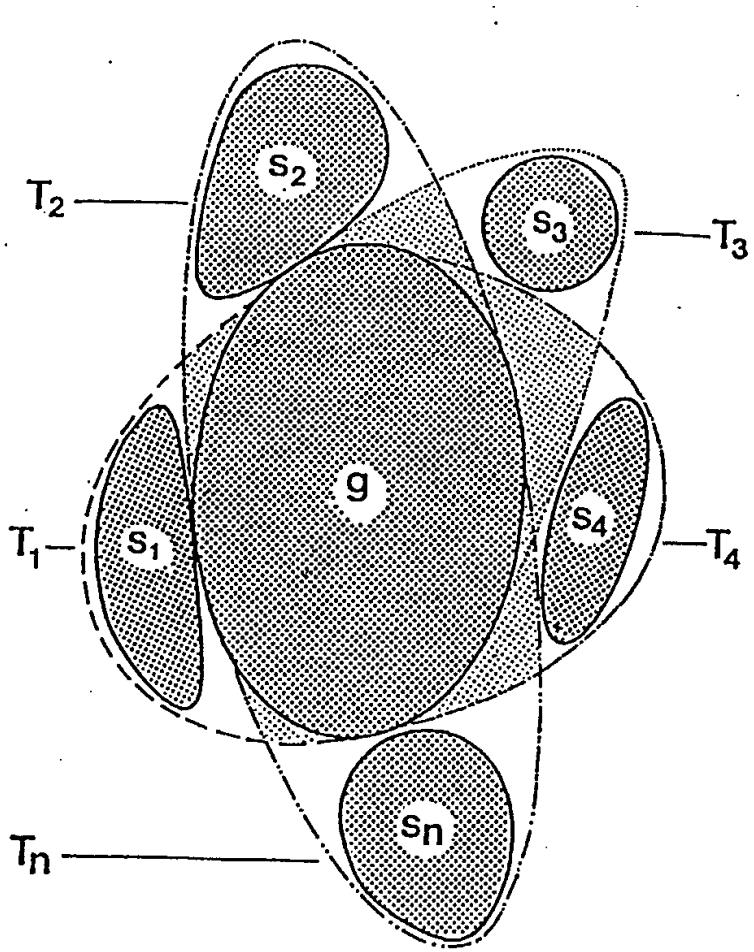
(Gottfredson, 1997, *Intelligence*; Mainstream science on intelligence: an editorial with 52 signatories, history, and bibliography*)*

Charles Spearman (1863 - 1945)
The general factor

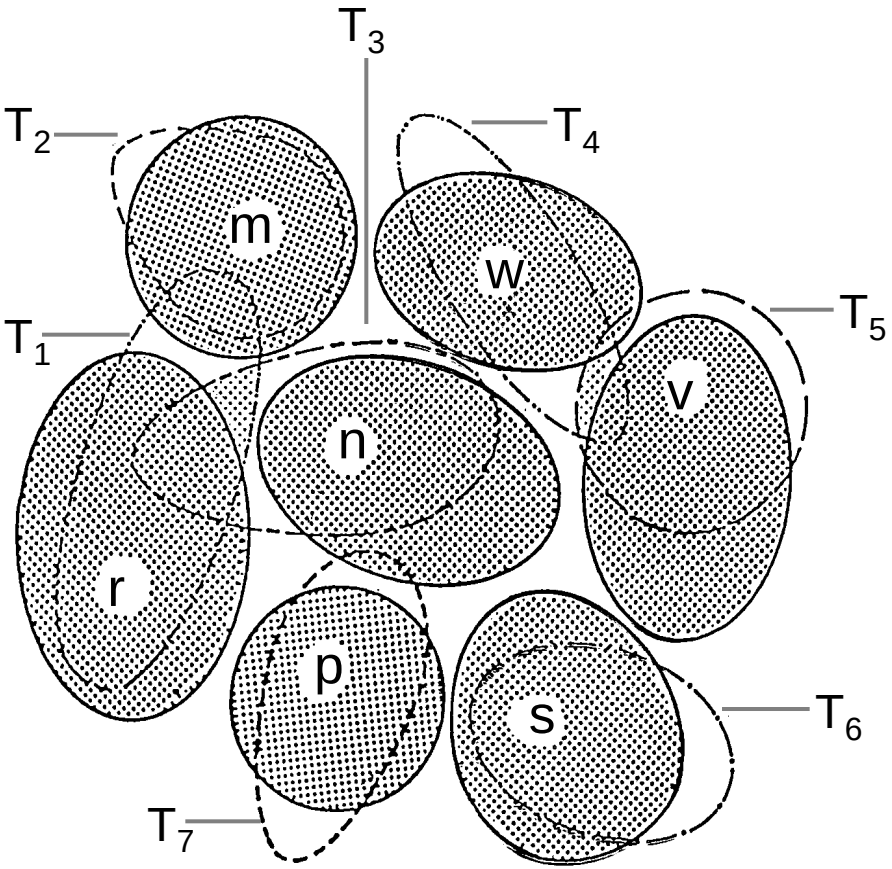


g-factor or not?

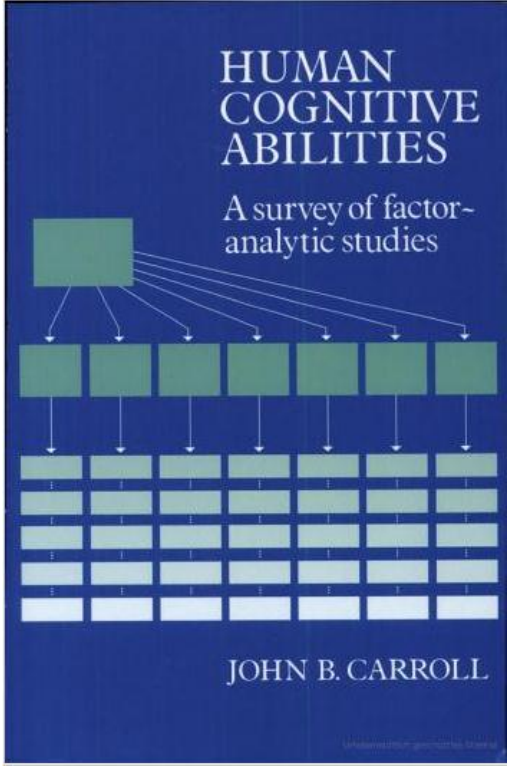
Spearman:

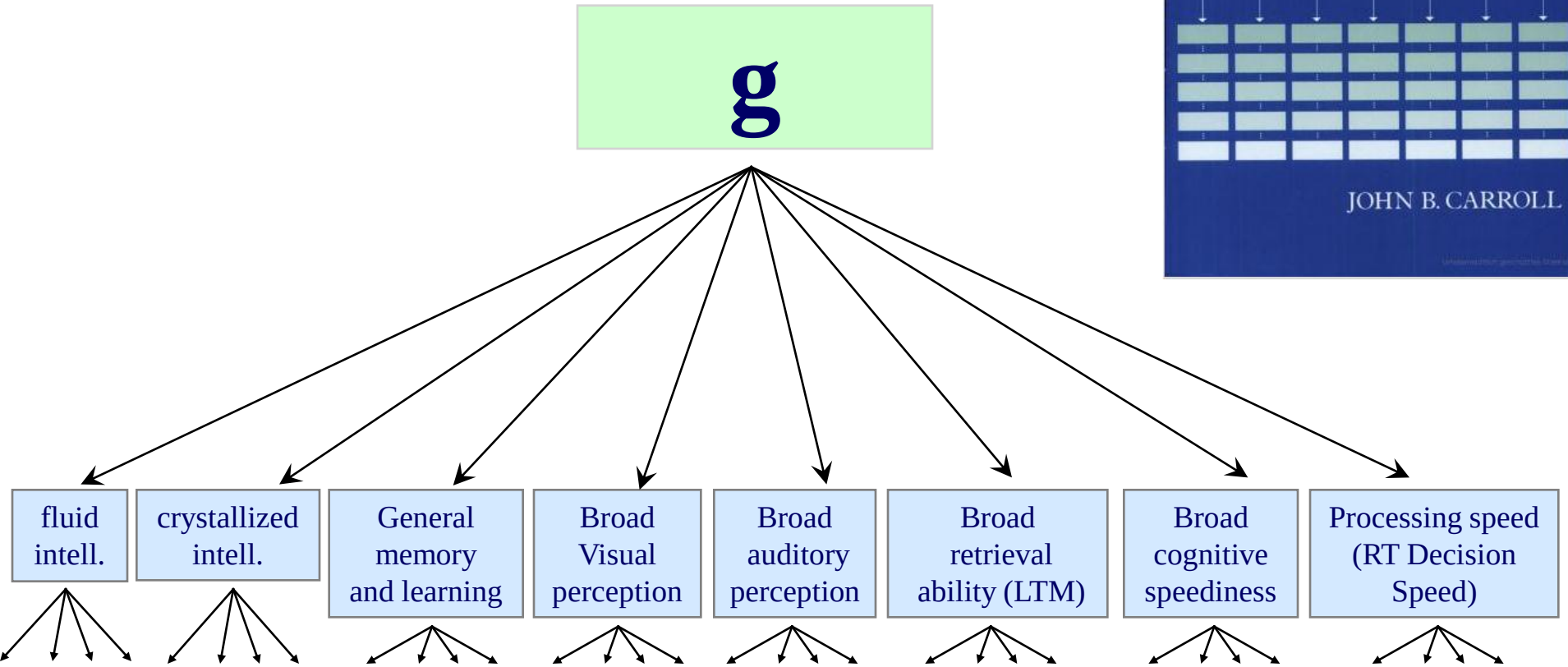


Thurstone:

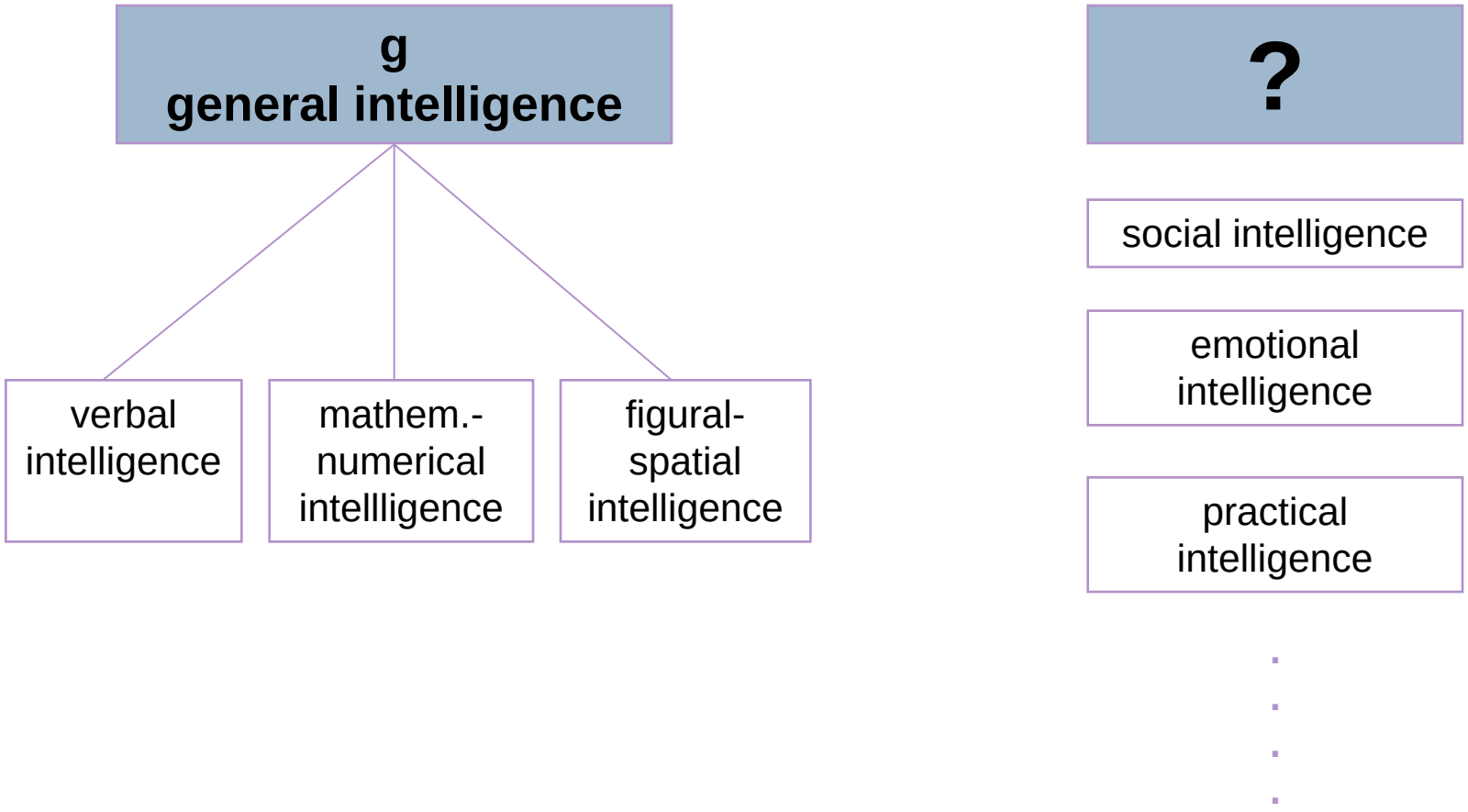


John B. Carroll‘s 3-Stratum-Model (1993)

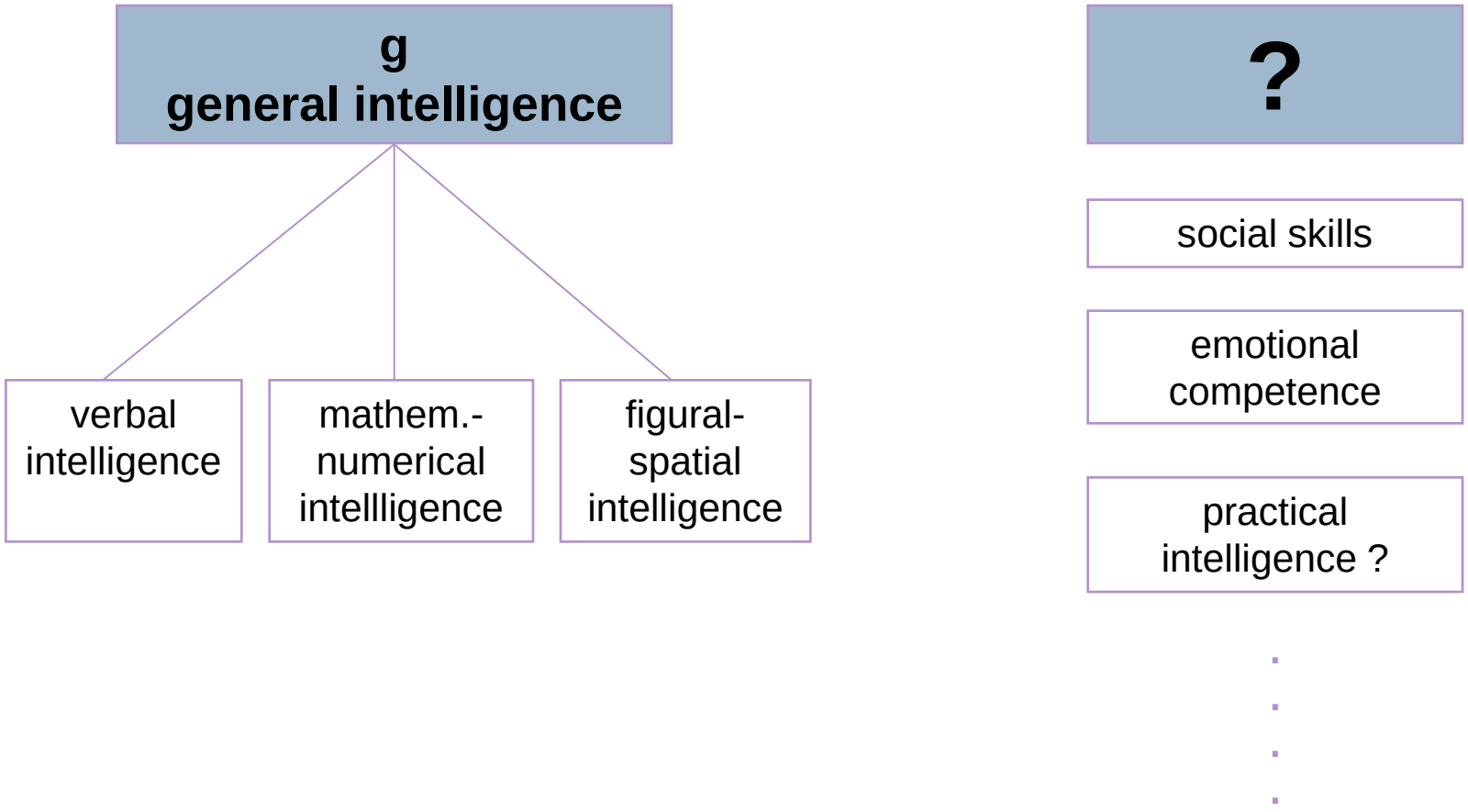




What is intelligence?



What is intelligence?



Tasks in intelligence tests

Verbal tasks, e.g.

- **Vocabulary:** *Was bedeutet anonym?*
- **Analogies:** *Gramm : Gewicht = Stunde : ?*

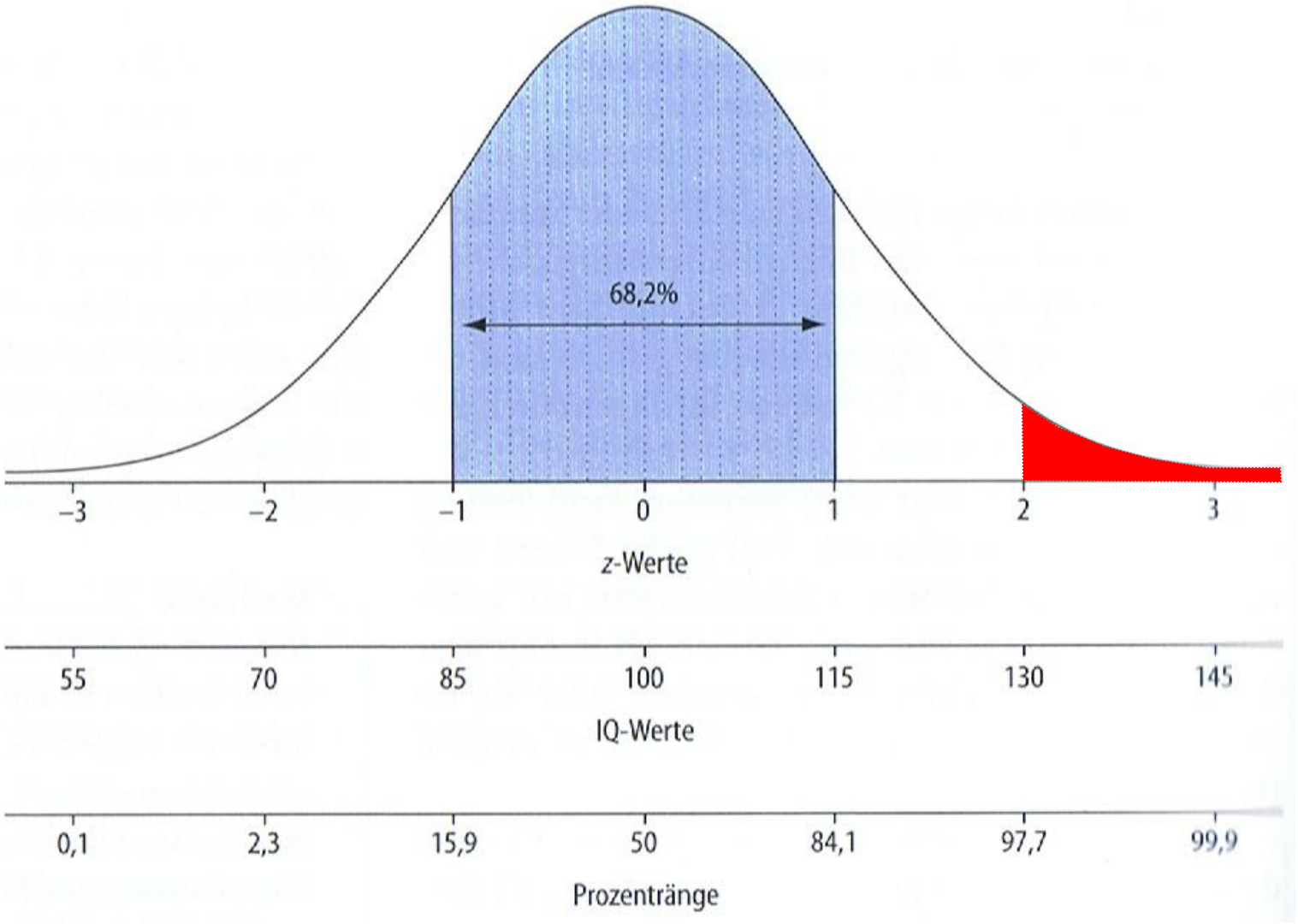
Numerical tasks, e.g.

- **number series:** *57 60 30 34 17 22 11 ?*

Figural-spatial Tests

e.g. cube rotation: find out the correct cube a to e after turning or tilting the cube

Normal distribution of the IQ = g factor



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„… and intelligence tests measure it well“.

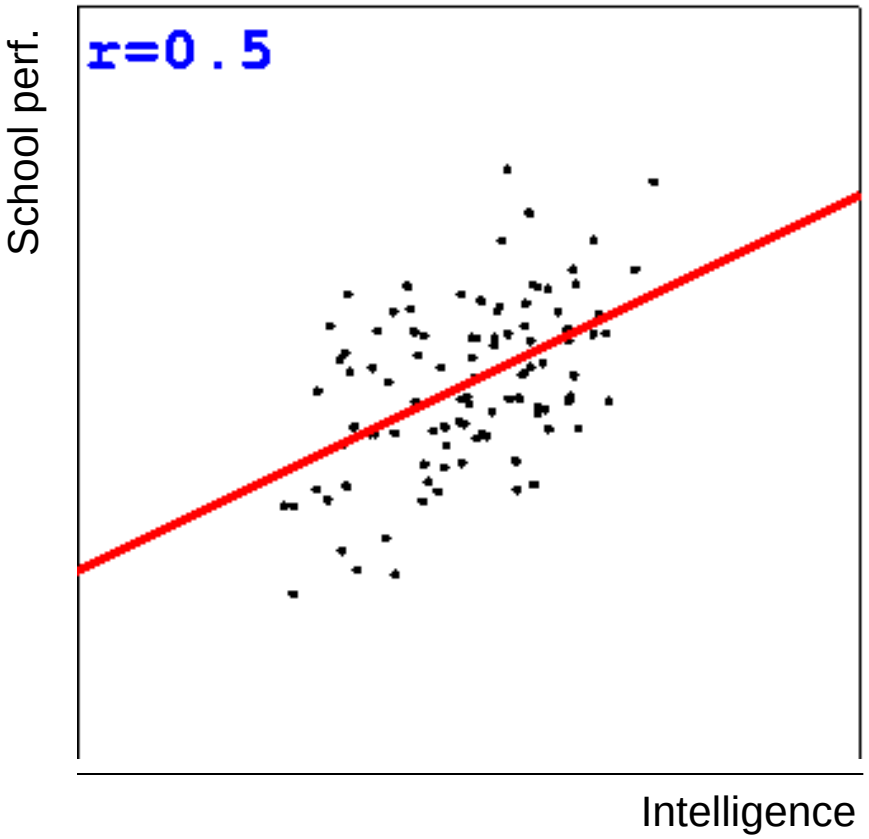
The validity of intelligence tests

- General cognitive ability * school performance / job performance:

  r = .50

(cf. Schmidt & Hunter, 1998

Deary et al., 2007)



Intelligence and school performance

- Primary school: r = 0.6 to 0.7
- High School: r = 0.5 to 0.6
- College: r = 0.4 to 0.5
- Graduate school: r = 0.3 to 0.4
  (Jensen, 1980)
- Rather weak (incremental) validity of other constructs:
  - Interests
  - (achievement) motivation

But: self-discipline (Duckworth & Seligman, 2006)

Meta-analysis by Kuncel & Hazlett, 2007: Cognitive tests as predictors of performance in graduate schools, universities etc.

Are intelligence*school performance relationships due to SES?

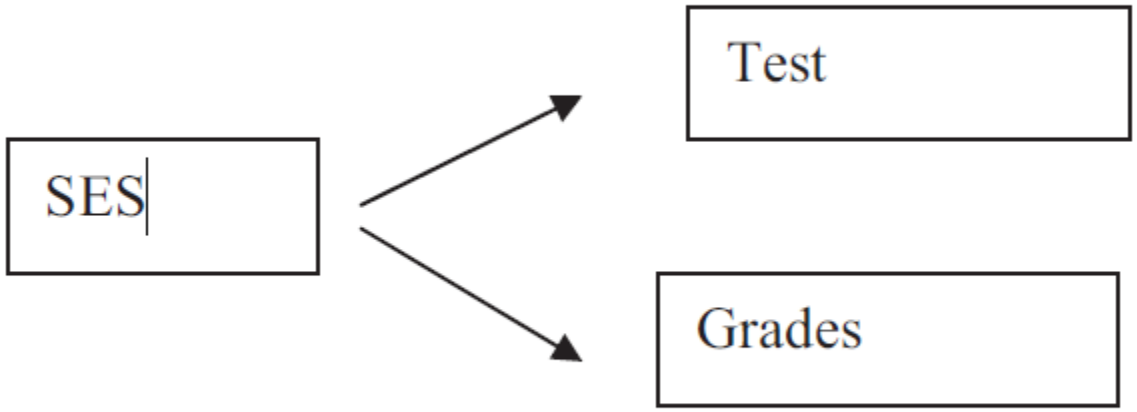


Figure 1. Model 1. SES = socioeconomic status.

Sackett et al. (2009): meta *re*-analysis

- SES * SAT = .42
- SAT * success in grad school = .47
- SAT * success in grad school (SES controlled) = .44

Intelligence and job performance (I)

- Schmidt & Hunter (1998): meta-analysis of 32.000 persons from 515 jobs:

  - Average r = 0.5

  - Several confirmations in subsequent meta-analyses

- Salgado & Anderson (2003): meta-analysis of 128 primary studies with 12.228 Ss in Europe:

  - Average r 0.6 to 0.7

Do age at testing, at success or date of study influence validities?

(Strenze, 2007)

Moderators	Correlation with education (r)	Correlation with occupation (r)	Correlation with income (r)
Age at testing			
3-10	.37	.37	.19
11-15	.49	.41	.23
16-18	.51	.40	.17
19-23	.51	.37	.25

r = average correlation, Strenze (2007)

Do age at testing, at success or date of study influence validities?

(Strenze, 2007)

Moderators	Correlation with education (r)	Correlation with occupation (r)	Correlation with income (r)
Age at success			
20-24	.47	.31	.06
25-29	.48	.40	.16
30-34	.48	.40	.21
35-39	.47	.39	.25
40-44	.48	.38	.25
45-49	.43	.39	.21
50-78	.50	.44	.24

r - average correlation, Strenze (2007)

Do age at testing, at success or date of study influence validities?

(Strenze, 2007)

Moderators	Correlation with education (r)	Correlation with occupation (r)	Correlation with income (r)
Year of success			
1929-1959	.53	.48	.16
1960-1969	.51	.44	.22
1970-1979	.49	.39	.19
1980-1989	.41	.31	.20
1990-2003	.41	.32	.18

r - average correlation, Strenze (2007)

Does intelligence get irrelevant with increasing level of job experience?

Years of experience	IQ with performance correlation	Experience with performance correlation
0-3	.35	.49
3-6	.37	.32
6-9	.44	.25
9-12	.44	.19
12+	.59	.15

Schmidt & Hunter (2004)

Is intelligence important for all levels of job complexity?

Complexity level of job	Performance measures	
	On the job	In training
1	.58	.59
2	.56	.65
3	.51	.57
4	.40	.54
5	.23	-

Complexity levels: 1 = professional, scientific and upper management jobs,
2 = complex technical jobs such as computer-systems trouble-shooting or complex manufacturing set-up jobs,
3 = skilled workers, technicians, mid-level administrators, paraprofessionals and similar jobs,
4 = semiskilled work,
5 = feeding/ off-bearing jobs

Schmidt & Hunter (2004)

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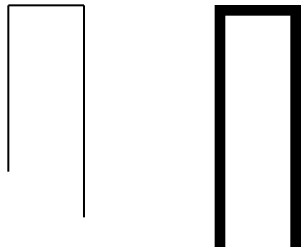
Elementary cognitive processes and intelligence

⇨ Short RTs in speeded Elementary Cognitive Tasks (ECTs) correlate with high IQ (meta analysis by Sheppard and Vernon, 2008)



The IT-task with two lines
a Target stimulus, b Mask

Mental rotation task

⇨ High working memory capacity associated with high *g*: (meta analysis by Ackerman et al., 2005)

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Where in the brain is intelligence:
Neuroscience correlates of ***g***

- Neuro-*structural* (anatomical) correlates of g
  - brain size, cortical thickness (neuropil)
  - grey matter (MRI)
  - white matter (MRI)

EEG

- Neuro-functional correlates of g
  - Speed (ERPs in EEG)
  - Regional brain activation (PET, fMRI, EEG)
  - Functional connectivity (EEG,MEG)

(f)MRI

Parieto-Frontal Integration Theory

Jung & Haier (2007)

Functions of the *prefrontal cortex*: action planning, decision making, selective attention, **working memory, central executive**

Functions of the *parietal cortex*: storage/recall of knowledge, symbolic processing, abstraction, elaboration

Brodmann areas (BA) associated with measures of intelligence and reasoning
Numbers = BAs; dark circles = predominant left hemisphere associations; light circles = predominant bilateral associations; white arrow = arcuate fasciculus.

More intelligent individuals

- have more grey matter (neurons, dendrites, synapses?), mostly in
- prefrontal, temporal and parietal areas

and

- more white matter (stronger/better myelination of axons)

Functional correlates of intelligence – The neural efficiency hypothesis

Haier et al. (1988): RAPM * glucose metabolism (PET)

$r_{(RAPM\ x\ GMR)}$ = **-.44 bis -.84**

NEURAL EFFICIENCY

„Intelligence is not a function of how hard the brain works but rather how efficiently it works. ... This efficiency may derive from the disuse of many brain areas irrelevant for good task performance as well as the more focused use of specific task-relevant areas.“

(Haier et al., 1992)

IQ low **IQ high**

Intelligence and Neural Efficiency: A review

(Neubauer & Fink, 2009, Neuroscience & Biobehav. Rev.)

Pro: ***Negative*** g * brain activation relationships in k = 29 (out of 54) studies, i.e. higher g -> less brain activation = higher neural efficiency

e.g. confirmed with

- **PET**: *Haier et al. (1988, 1992, 1995, etc.)*
- **rCBF:** *Charlot et al. (1992)*
- **fMRI**: *Reichle et al. (2000); Ruff et al. (2003); Rypma et al. (2002)*
- **EEG**: *Jausovec (1998, 2000 etc.); Lamm et al. (1999); Neubauer et al. (1995, 2002 etc.)*

More intelligent individuals

- display less brain activation,
- mostly in prefrontal areas and
- during tasks of low to medium cognitive demand

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The Actiotope Model of Giftedness
(Ziegler, 2005)

- Consequences from biographies of persons demonstrating excellence:
- Development of excellence takes 10 years (Ericsson)
- through executing a large number of actions in specific domain (Ziegler)

Learning and neural plasticity

- Changes in GM after training of juggling (Draganski et al., 2004, Nature)

- Increased posterior right hippocampal (GM) volumes in taxi drivers with enhanced navigation skills (Maguire et al., 2000, PNAS)

- GM increases in posterior cortex areas and hippocampus in medical students preparing for state examination from t1 (3 mo before) to t2 (after exam), and partially (only hippocampus) to t3 (3 mo after exam) (Draganski et al., 2006)

Brain usage:

Effects of expertise vs. intelligence

	Lower Intelligence	Higher Intelligence
Experts	*n* = 15	*n* = 16

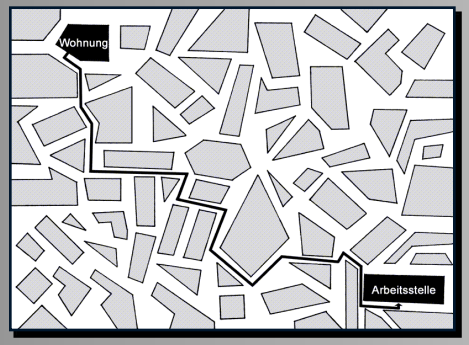
Expertise Task

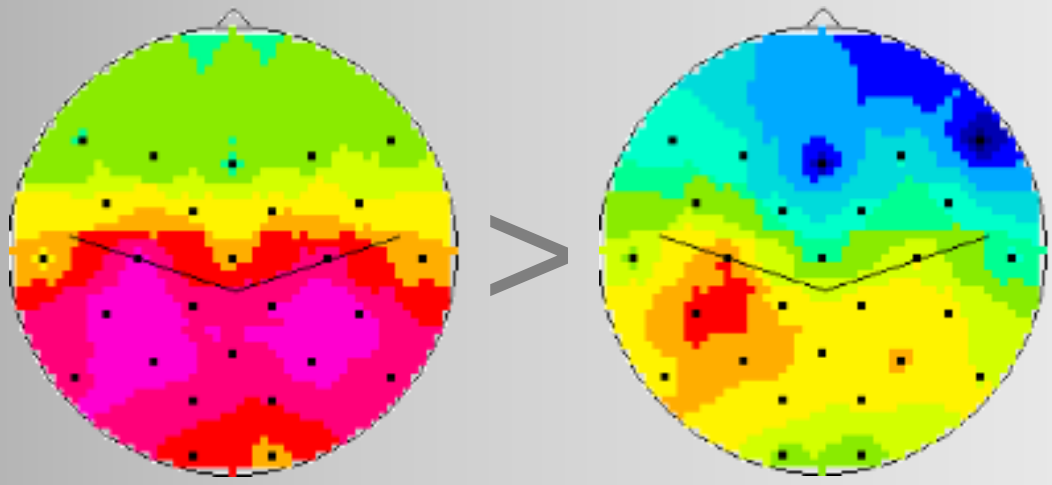
Intelligence Task

Grabner, Stern & Neubauer, 2003

Results

Intelligence Task

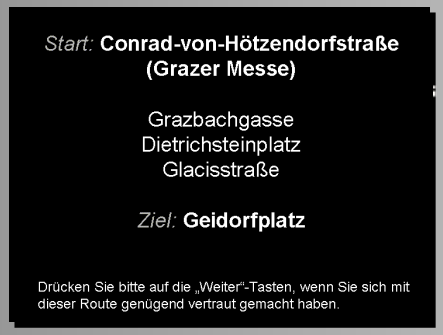


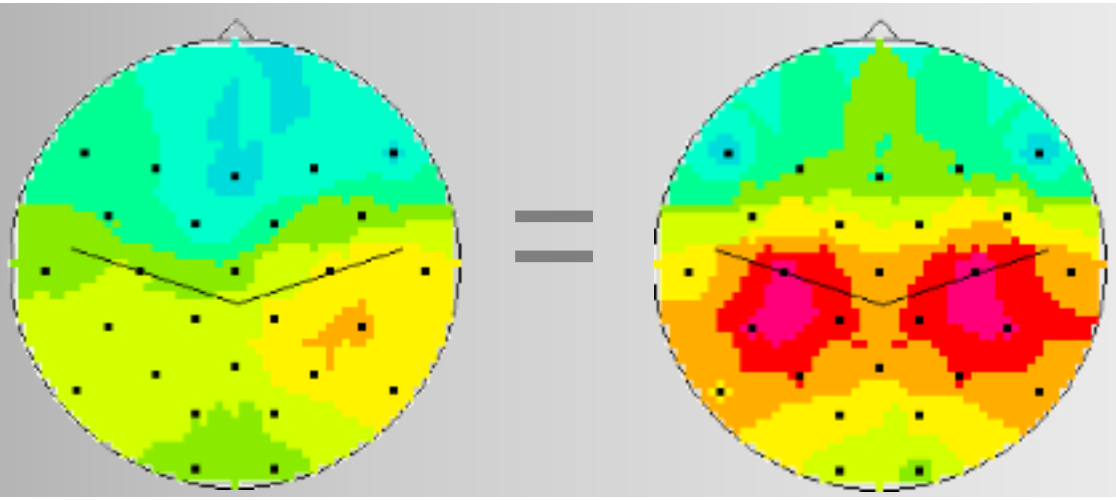


r with IQ = .50**

IQ lower **IQ higher**

Expertise Task





r with IQ = .10

Grabner, et al., 2003, Int. J. Psychophysiol

Conclusio

- Development of expertise makes the brain more efficient
- Still, when confronted with novel demands the ‚more intelligent brain‘ is more efficient right from scratch
- Intelligence is a very general capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, **learn quickly, and learn from experience…**

(Gottfredson, 1997*)*

Some (questionable?) assumptions of the AMG:

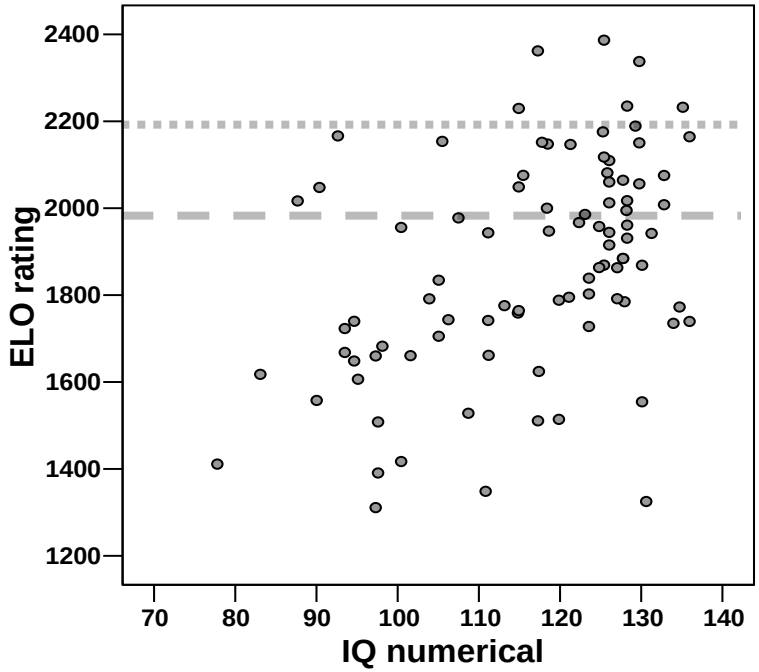
- ‚The focus of analysis should be on actions and their determinants, rather than on persons and their characteristics‘ (Ziegler, 2005, p. 9)

- The focus is no longer on personal attributes, but on actions and their development within a complex system (p.10)

  - Neubauer: People (self-)select their actions and their environments to match their abilities and personality traits!

- Example of chess: ‚one must be able to mentally foresee a relatively long series of moves and have the capability to compare and evaluate moves with the consequences with which they are associated‘ (Ziegler, 2005, p. 11f.)
- But:
  Ability to ‚foresee‘ is intelligence-dependent!

ELO and IQ

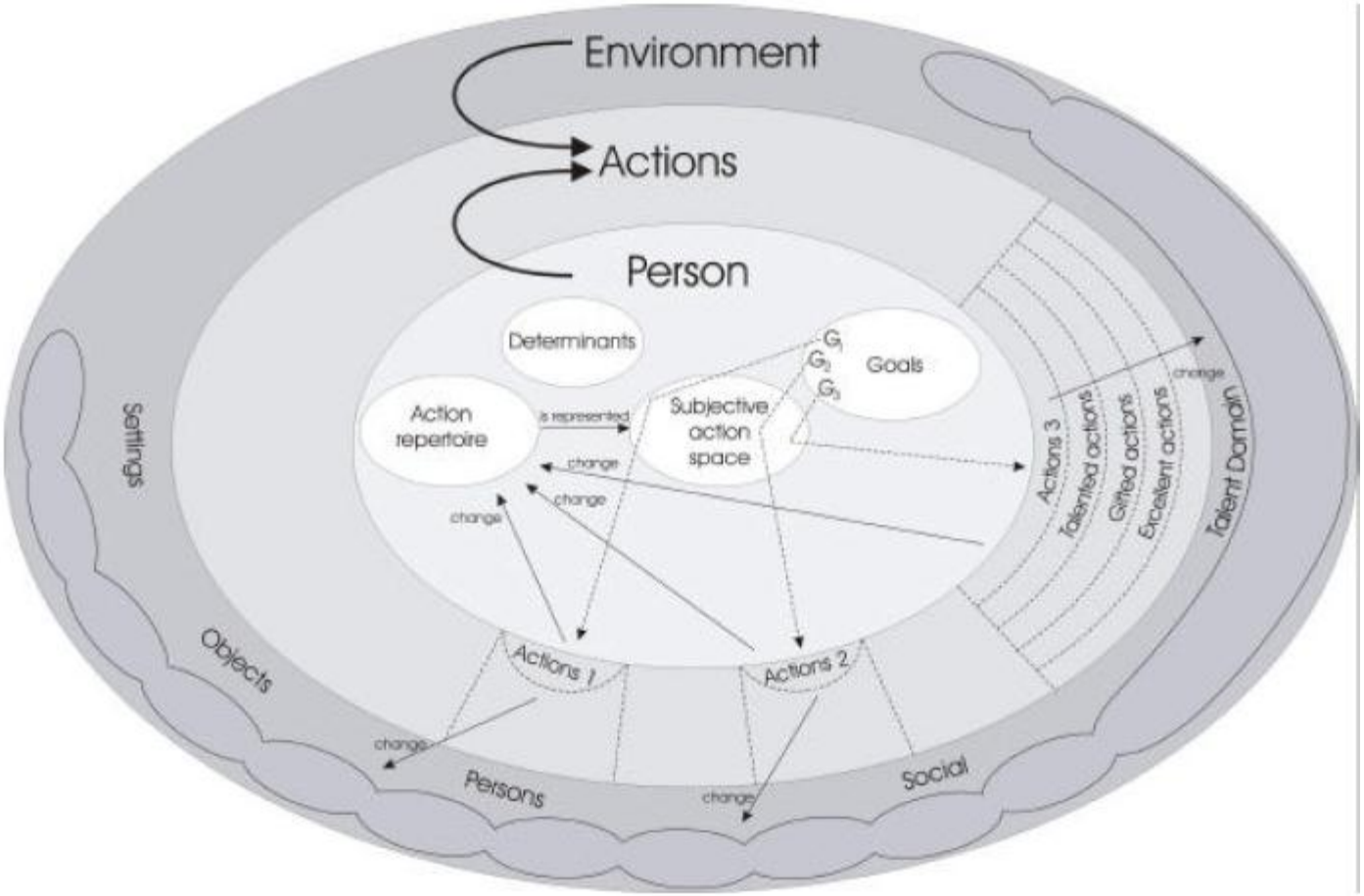


advanced (expert) players
(ELO 2,200)

playing strength of strong intermediate players
(ELO 2,000)

Grabner, Stern, Neubauer, 2007, Acta Psychologica

The AMG


Environment
Actions
Person
Determinants
Goals
Action repertoire
is represented
Subjective action space
change
change
change
Actions 3
Talented actions
Gifted actions
Excellent actions
change
Talent Domain
Settings
Objects
Actions 1
Actions 2
change
Persons
change
Social

How can we make sure that each (potentially) gifted person finds the right = fostering environment?

- Environment is important: School attendance fosters intelligence (Ceci: each year of school = 5 IQ points)

‚…the system interacts with the Actiotope of an individual: this means the action repertoire, the subjective action space, the goals and finally the actions in the domain.‘ (p.15)

- ‚the rapid alteration of domains is another reason why the analysis of the objective structure of a talent domain and postulation of characteristics of efficient action are so important‘

- Intelligence is a very general capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, **learn quickly, and learn from experience…**

  (Gottfredson, 1997*)*

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Intelligence in China / East Asia

- Only few studies with special focus
- Three main topics:

- Mean IQ in China, Hong Kong, Taiwan; outcome: higher av. IQ in Eastern Asia:
- Correlations of exposure to environmental poisons (environm. lead, dental lead,serum fluoride, sodium fluoride): supposed negative effects
- (presumably positive) effects of iodine on intelligence

IQ in 81 Nations (a selection)

	Country	IQ	Country	IQ	Country	IQ
Europe	Austria	102	Denmark	98	Bulgaria	93
	Italy	102	Hungary	99	Ireland	93
North America and Australia	New Zealand	100	Australia	98	Canada	97
			United States	98		
East Asia	**Hong Kong**	**107**	**Japan**	**105**	**China**	**100**
	South Korea	**106**	**Taiwan**	**104**		
South and Southwest Asia	Singapore	103	Thailand	91	Nepal	78
Southeast Asia and Pacific Islands	Indonesia	89	Philippines	86	Fiji	84
Latin America and the Caribbean	Argentina	96	Guatemala	79	Jamaica	72
Africa	Morocco	85	South Africa	72	Equatorial Guinea	59

Lynn & Vanhanen, 2002

And the role of creativity?...

- Hongli (2004): why no Nobel prize winner from China? -> do we need special strategies for nurturing creativity of Chinese primary and middle school students?
- Huang et al. (2005): implicit theories of creativity held by Chinese teachers influence creative behaviors in students
- Chan & Chan (1999): Chinese teachers regard high creativity socially undesirable (similar to findings outside China)

- Forrester & Hui (2007): relating creativity measures to classroom measures (teachers fostering c., classroom climate, creative personality): explains environmental factors influence on student creativity and motivation (Hong Kong)

- Dineen & Niu (2008): explored effectiveness of Western creative teaching methods in China (undergraduate graphics design) in quasi-experimental design (pre-post design w control group): creative methods developed in UK proved highly effective in fostering creativity and intrinsic motivation

Problem:

- Focus on high-stakes educational testing might lead to de-emphasis of creative behavior in favor of assessment of reading, writing, arithmetic.
- Niu & Sternberg (2003): high stakes testing in China coupled with societal values and school pedagogic approaches has for some time impaired creativity of Chinese students
- Required is more focus on creativity boosting teaching techniques (Hennessey & Amabile, 2010)

Conclusions I

- A ‚conceptual reboot' like Ziegler's AMG seems attractive. It's systemic and… aspects are important but without considering individual traits we run into danger of violating Carnap's ‚Total Evidence Rule' (Carnap, 1950)
- Practically, through focussing on observed actions/behavior we might lose ‚underachievers', whose potentials might be uncovered only by assessing their intellectual potentials through IQ tests

Conclusions II

- Ziegler: ‚gifts are not personal attributes‘
- Neubauer: gifts ***are*** personal attributes and need to be identified and developed;
- For their development the AMG seems to be a attractive approach, which in the future should be implemented and empirically tested
- Special focus should be given on creativity

Thank you for your attention