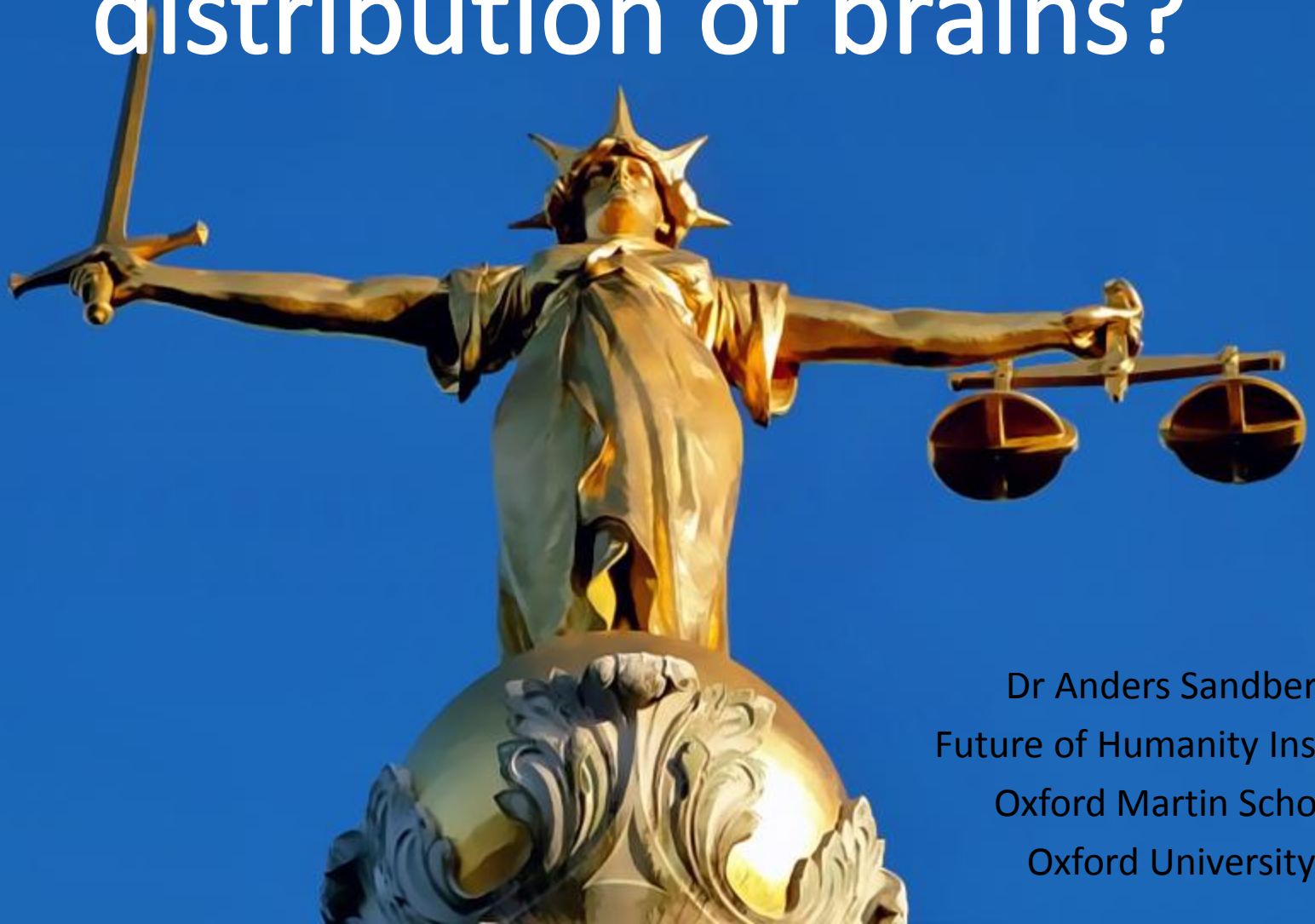
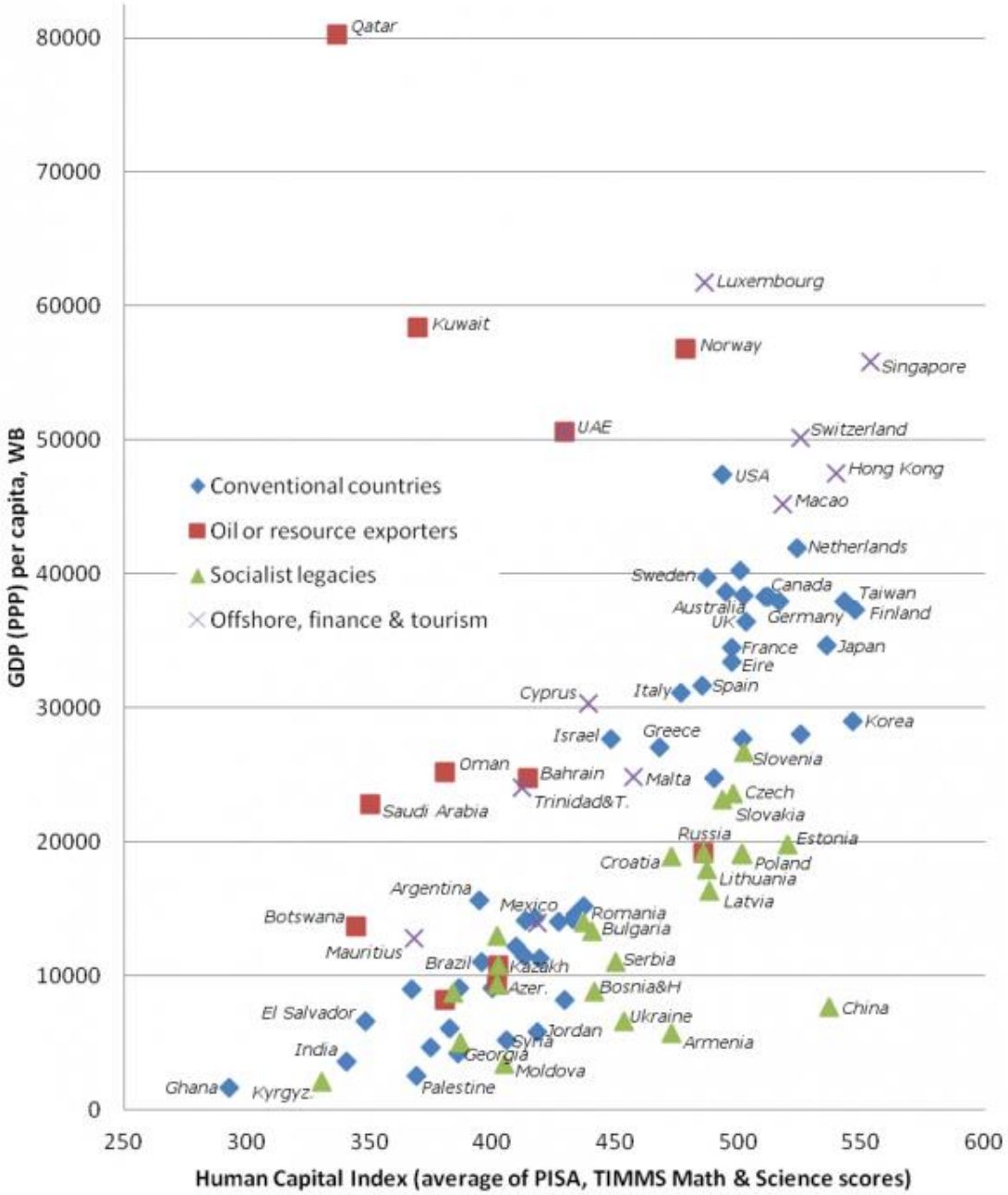
What is a fair distribution of brains?

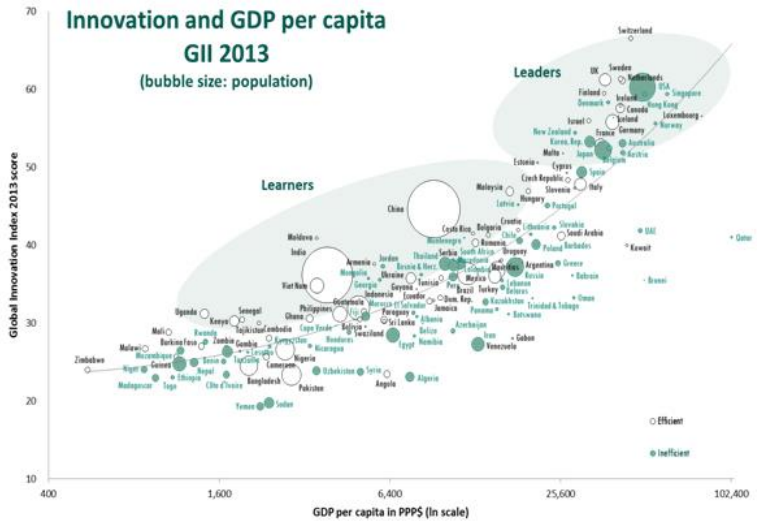


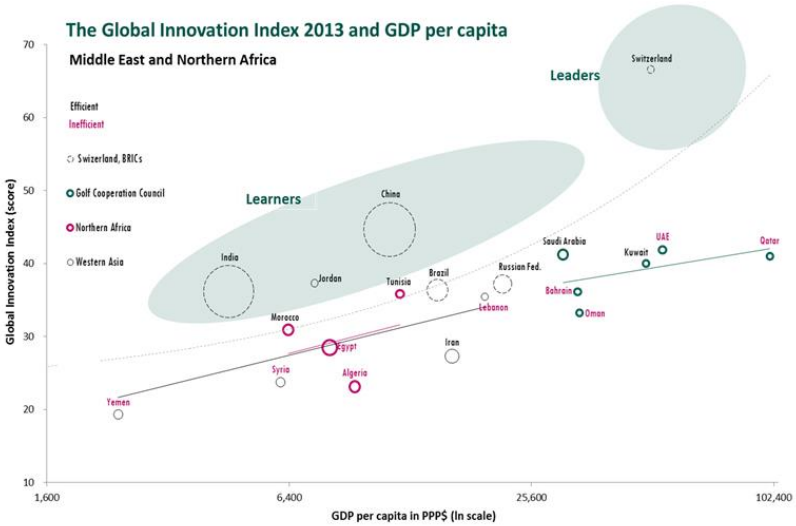
Dr Anders Sandberg
Future of Humanity Institute
Oxford Martin School
Oxford University

Distributing brains?

Education And Economic Growth, Part II

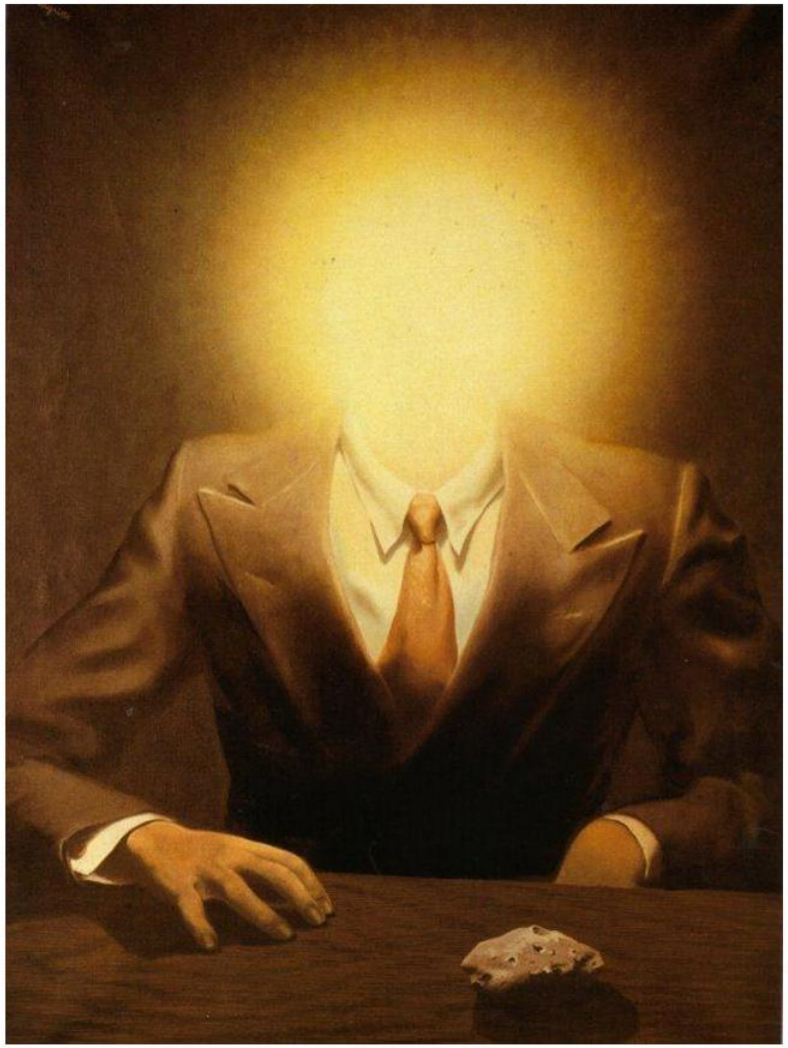






Intelligence, what is it good for?

- Standardized academic achievement
- Job performance (more on complex jobs)
- Years of education
- Occupational level
- Income
- Predicts health
- Predicts longevity
- Accident risk
- Delinquency rate
- Risk of being murder victim
- Economic rationality
- Discount rate
- Cooperation
- Preventing unhappiness
- GDP and GDP growth



Life Chances	High Risk	Uphill Battle	Keeping Up	Out Ahead	Yours to Lose
Training Style	Slow, simple, supervised	Very explicit, hands-on	Mastery learning, hands-on; Written materials, plus experience	College format	Gathers, infers own information
Career Potential		Assembler, food service, nurse's aide	Clerk, teller, police officer, machinist, sales	Manager, teacher, accountant	Attorney, chemist, executive
IQ	70	80 90	100	110	120 130
	Population Percentages				
Total population distribution	5	20	50	20	5
Out of labor force more than 1 month out of year (men)	22	19	15	14	10
Unemployed more than 1 month out of year (men)	12	10	7	7	2
Divorced in 5 years	21	22	23	15	9
Had illegitimate children (women)	32	17	8	4	2
Lives in poverty	30	16	6	3	2
Ever incarcerated (men)	7	7	3	1	0
Chronic welfare recipient (mothers)	31	17	8	2	0
High school dropout	55	35	6	0.4	0

IQ effects

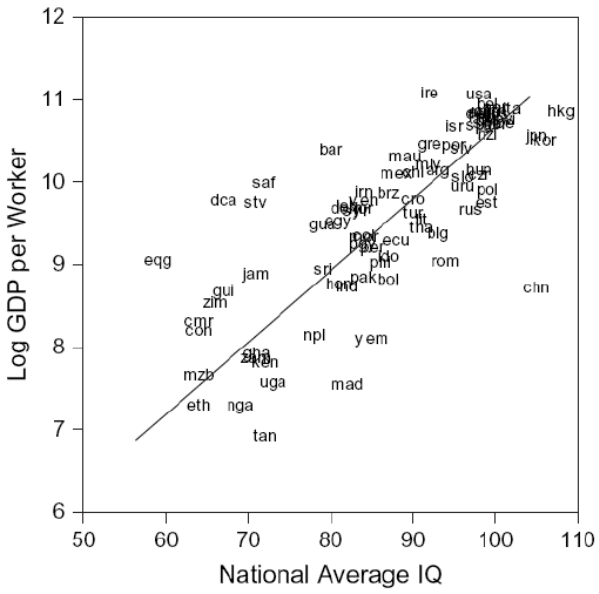
Cognition important protection for good life

Environmental toxin models: +1 IQ point = +1.763% income (Schwartz), +2.094/3.631% (Salkever, m/f)

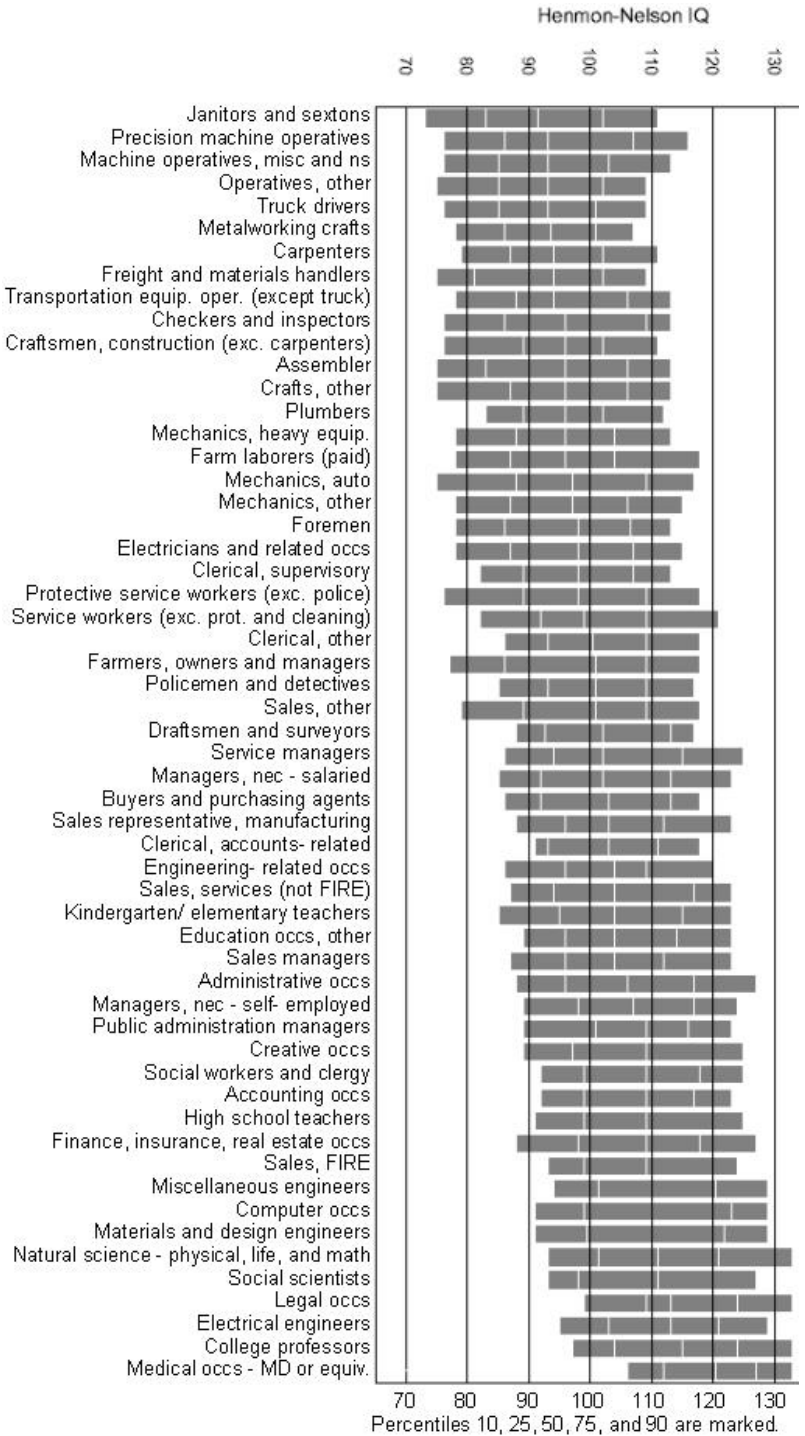
Annual gain / IQ point US $55-65 billion
0.4-0.5% GDP

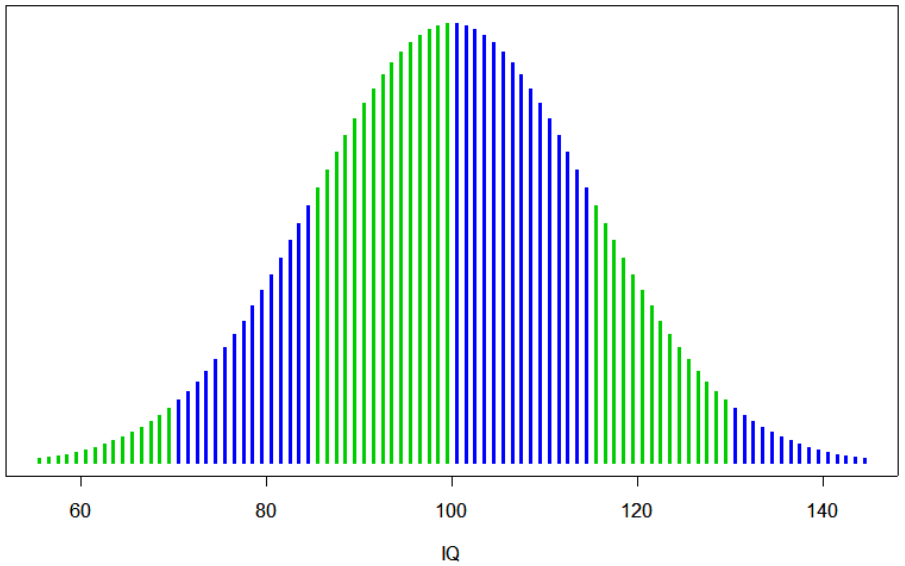
The top ¼% SAT scorers produce twice as many patents per person as the next lower percentile.

Jones & Schneider (+1 IQ ≈ +8.2% GDP)

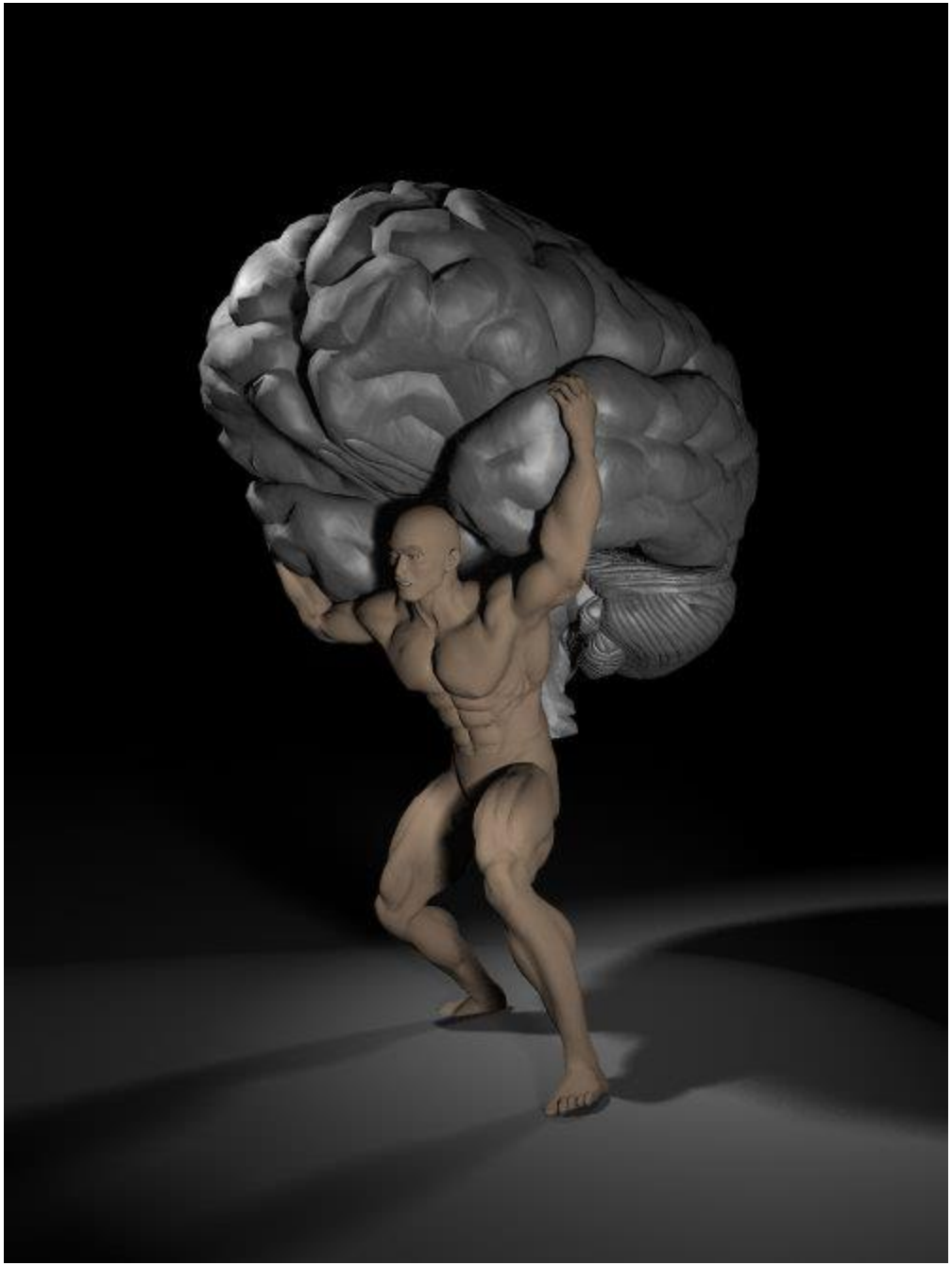


Gottfredson 2002





Hauser, Robert M. 2002. "Meritocracy, cognitive ability, and the sources of occupational success." CDE Working Paper 98-07 (rev). Center for Demography and Ecology, The University of Wisconsin-Madison, Madison, Wisconsin. Figure 12: "Wisconsin Men's Henmon-Nelson IQ Distributions for 1992-94 Occupation Groups with 30 Cases or More" http://www.ssc.wisc.edu/cde/cdewp/98-07.pdf.



Regression Coefficients					Test That Each Coefficient = 0	
	B	SE(B)	Beta	SE(Beta)	T-statistic	Probability
AGE	-.001	.001	-.027	.023	-1.172	.242
SEX	-.033	.024	-.027	.020	-1.363	.174
RACE	.033	.022	.030	.020	1.484	.138
EDUC	-.008	.005	-.037	.023	-1.619	.106
INCOME	-.015	.006	-.056	.021	-2.676	.008
MARITAL	.072	.008	.191	.022	8.873	.000
ATTEND	-.016	.005	-.070	.020	-3.443	.001
HEALTH	.203	.016	.266	.021	12.693	.000
VOTE96	-.005	.022	-.005	.022	-.232	.817
WORDSUM	.014	.007	.046	.022	2.055	.040
Constant	1.524	.131			11.616	.000

Color coding:	<-2.0	<-1.0	<0.0	>0.0	>1.0	>2.0	T
Effect of each variable:	Negative			Positive			

Multiple R =	.380	R-Squared =	.145	Std Error of Estimate =	.568

Frequency Distribution

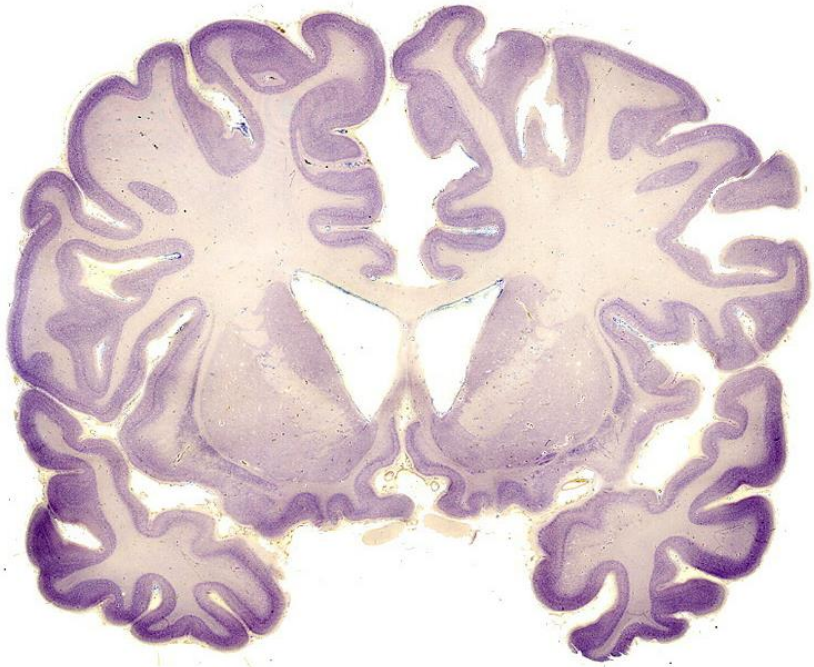
Cells contain:
-Column percent
-N of cases

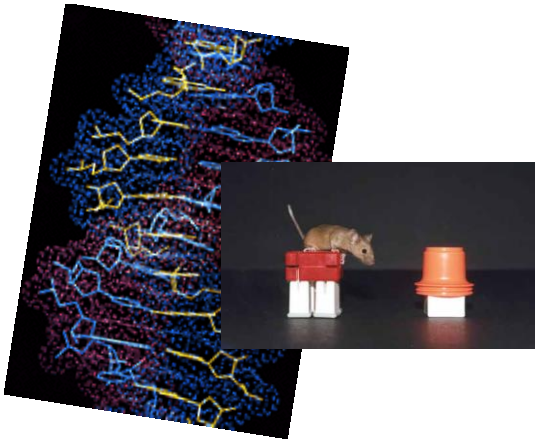
		HAPPY			
		1 VERY HAPPY	2 PRETTY HAPPY	3 NOT TOO HAPPY	*ROW TOTAL*
WORDSUM	0	.8 50	.7 80	1.5 35	***.8*** *165*
	1	2.0 131	1.5 166	3.5 79	***1.9*** *376*
	2	3.5 227	3.2 362	4.8 109	***3.5*** *698*
	3	5.9 379	6.0 684	10.4 237	***6.5*** *1,300*
	4	9.7 627	10.5 1,188	13.4 305	***10.6*** *2,120*
	5	15.8 1,017	16.1 1,833	18.5 420	***16.3*** *3,270*
	6	20.7 1,335	22.2 2,521	18.7 424	***21.3*** *4,280*
	7	16.1 1,040	15.6 1,778	10.8 245	***15.2*** *3,063*
	8	11.1 714	10.0 1,142	7.8 178	***10.1*** *2,034*
	9	8.1 524	8.1 918	6.1 138	***7.9*** *1,580*
	10	6.3 405	6.1 695	4.5 103	***6.0*** *1,203*
	COL TOTAL	***100.0*** *6,449*	***100.0*** *11,367*	***100.0*** *2,273*	***100.0*** *20,089*

Color coding:	<-2.0	<-1.0	<0.0	>0.0	>1.0	>2.0	Z
N in each cell:	Smaller than expected			Larger than expected			

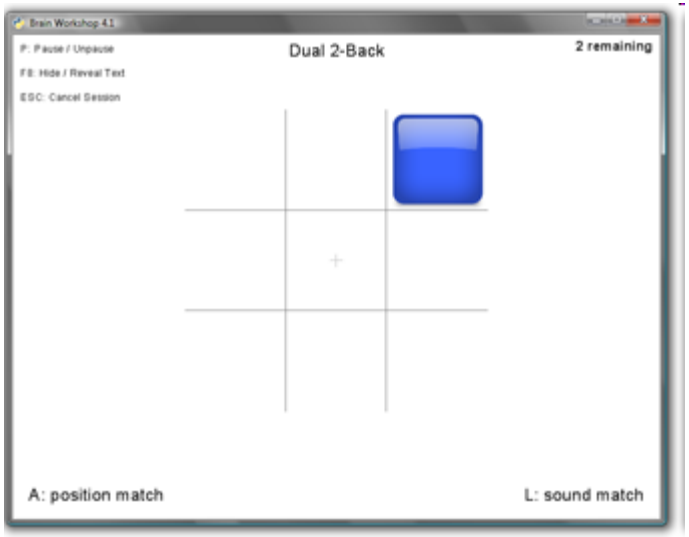
Analysis from General Social Surveys, 1972-2004. WORDSUM is a vocabulary test with about 0.83 correlation with IQ (Sigelman 1981). Table A is regression of stated happiness (HAPPY) against several different factors. Table B shows the distribution of HAPPY and WORDSUM scores. Note the strong unhappiness among the lower than average vocabulary scorers.

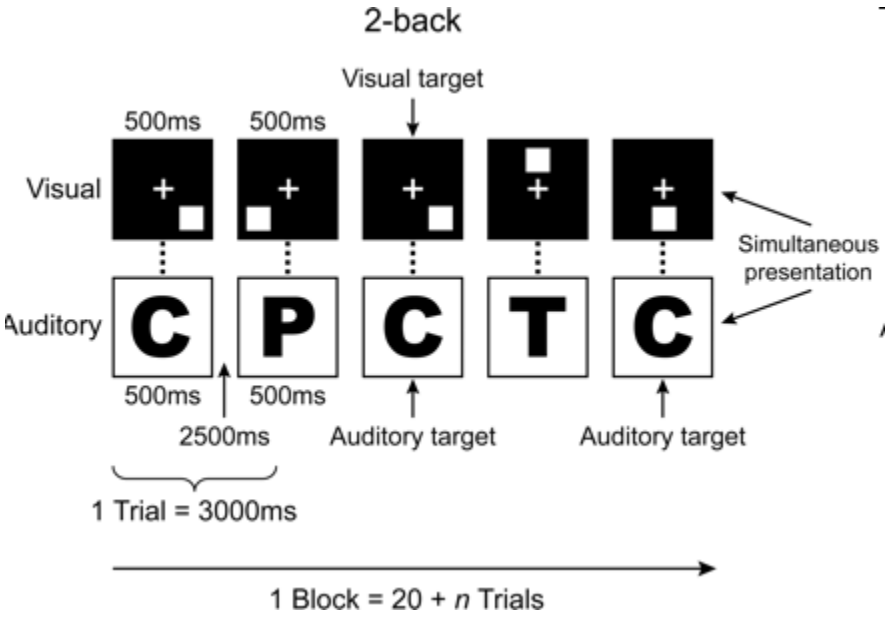

peerReview
Educating for Citizenship

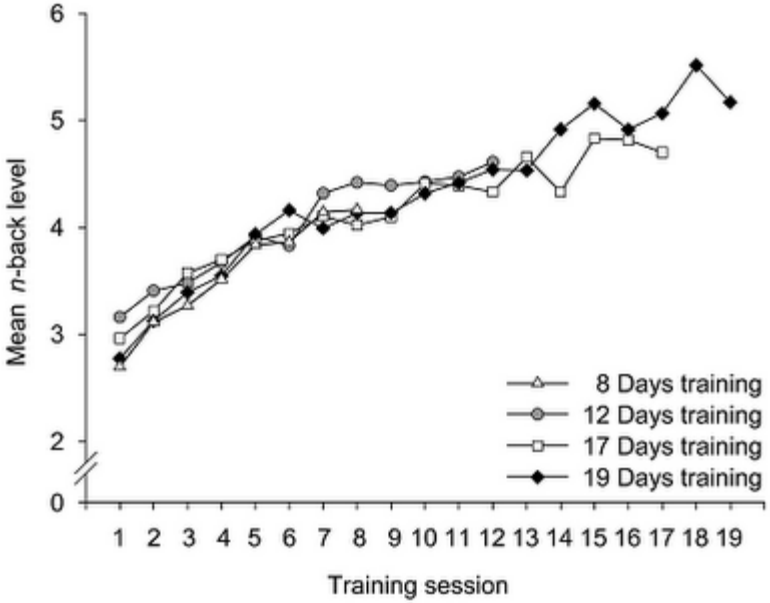


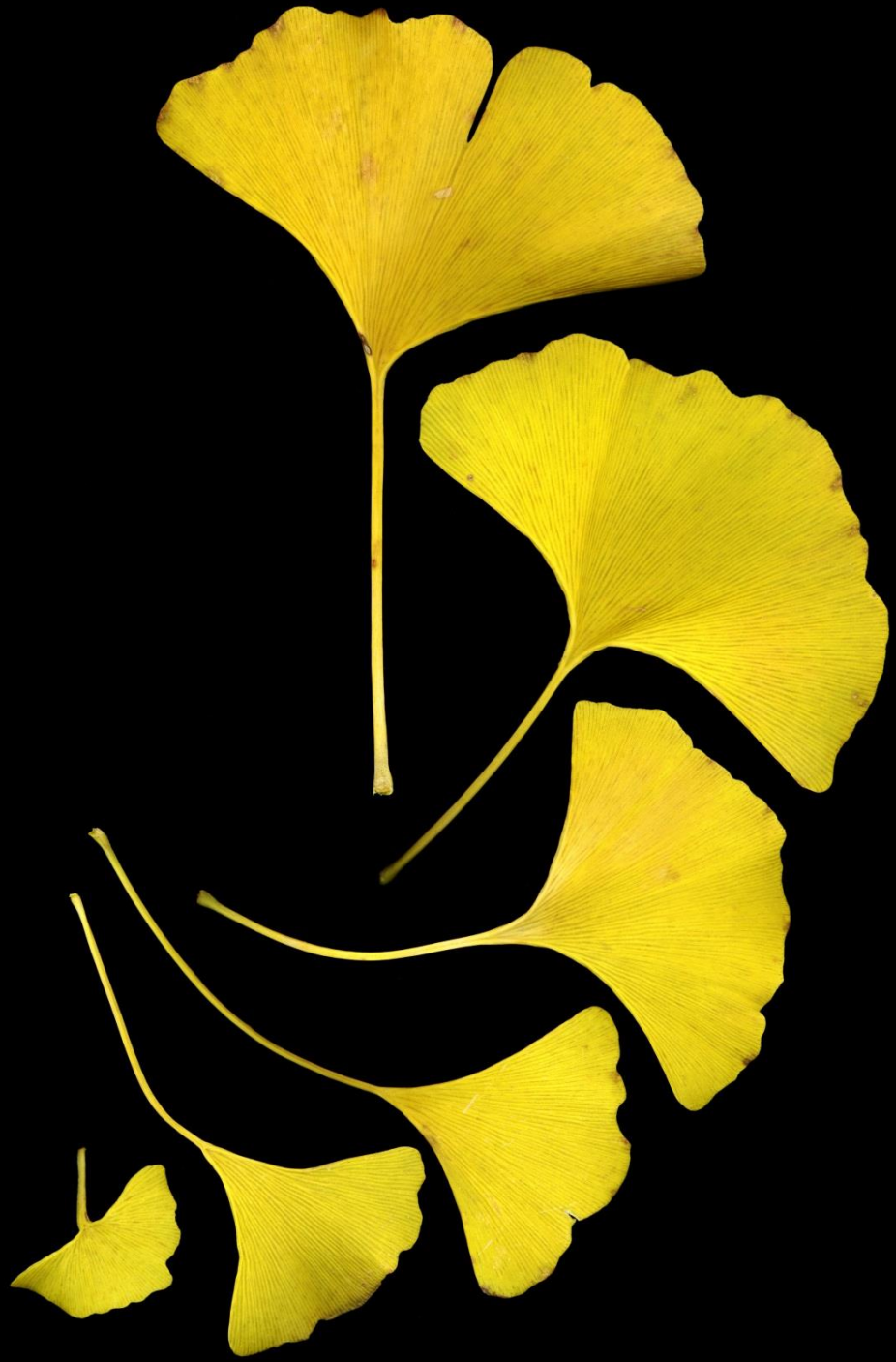



Google


Brain Workshop 4.1
P: Pause / Unpause
F8: Hide / Reveal Text
ESC: Cancel Session
Dual 2-Back
2 remaining
A: position match
L: sound match

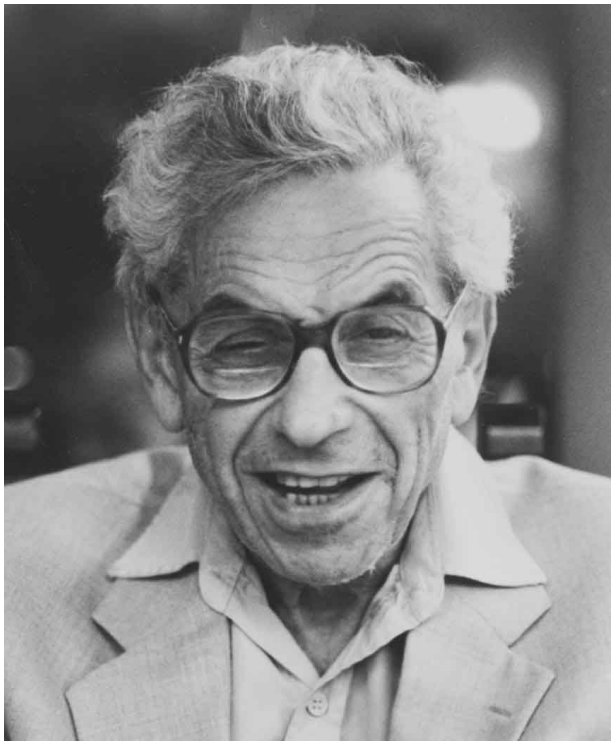

2-back
Visual target
500ms
500ms
Visual
Auditory
C
P
C
T
C
Simultaneous presentation
500ms
500ms
2500ms
Auditory target
Auditory target
1 Trial = 3000ms
1 Block = 20 + n Trials

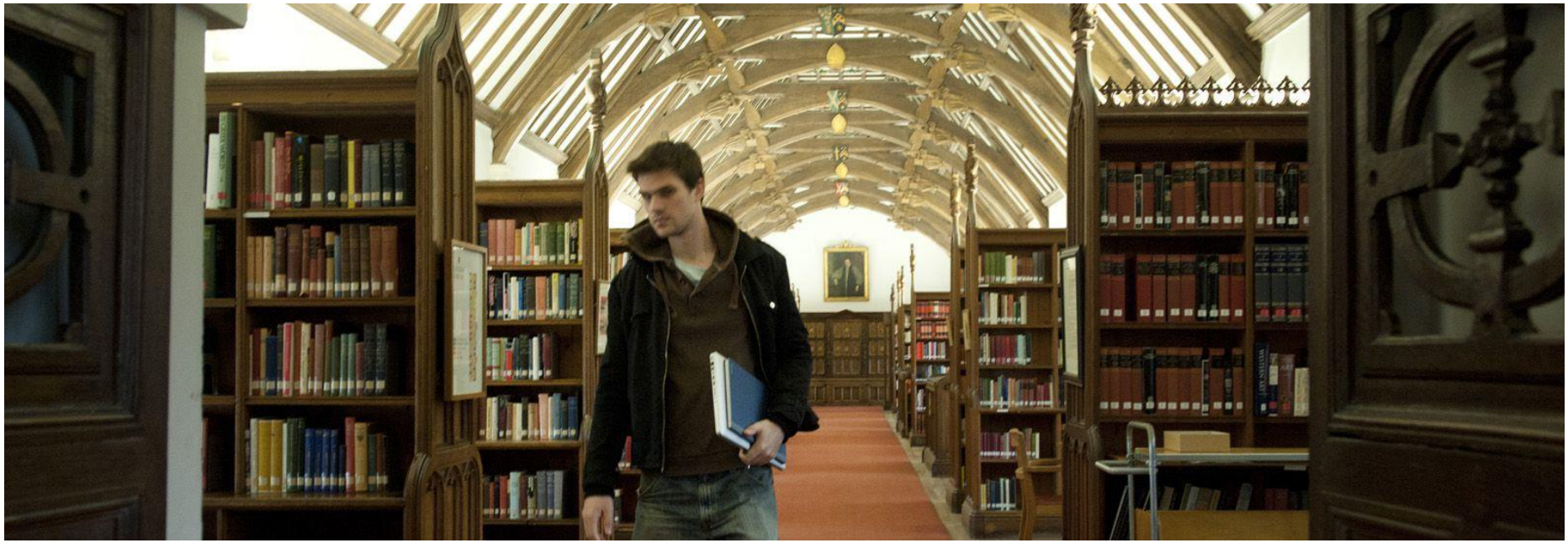

Mean n-back level
Training session
8 Days training
12 Days training
17 Days training
19 Days training




COR
13.1


325






13 1:34PM


DROWSY DRIVERS
USE NEXT EXIT
FATIGUED DRIVING

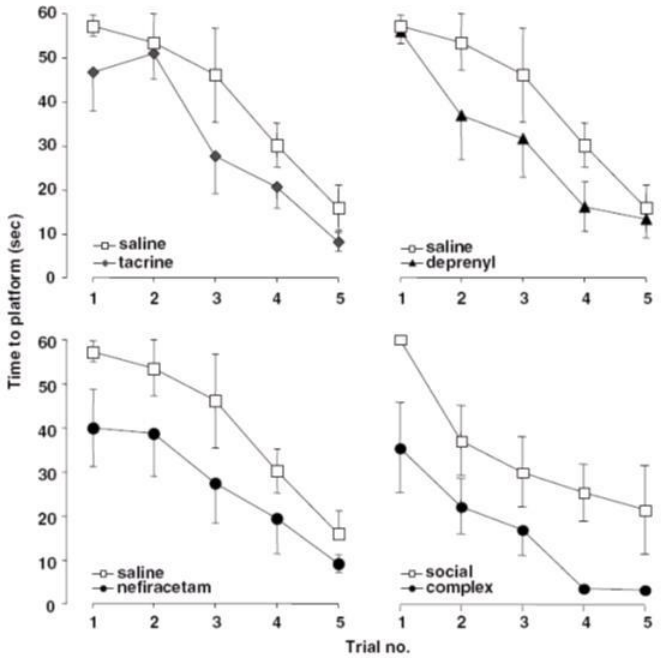


Figure 5 The consequence of chronic drug treatment and complex environment rearing on the spatial learning ability of rats. The figure shows the acquisition of water maze learning over five trials. Tacrine (1 mg/kg/day), deprenyl (5 mg/kg/day), nefiracetam (15 mg/kg/day), and complex rearing significantly improved acquisition of platform location (saline *vs* nefiracetam, tacrine, and deprenyl-treated, two-way ANOVA: $F[1,40] = 8.78$, $p = 0.005$; $F[1,40] = 5.73$, $p = 0.022$; and $F[1,40] = 5.78$, $p = 0.026$, respectively; social *vs* complex environment, two-way ANOVA: $F[1,40] = 19.08$, $p < 0.0001$). The data are the mean ± SEM time to reach the platform in seconds ($n = 5$). NB: the last drug injection was administered 24 h prior to training to eliminate acute drug effects and animals reared in the complex environment were removed to social housing conditions 24 h prior to training.

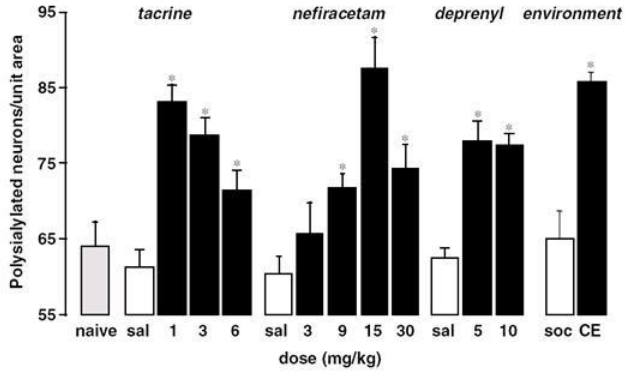


Figure 2 Influence of chronic treatment with nefiracetam, tacrine, deprenyl, or complex environment rearing on basal expression of polysialylated neurons in the hippocampal dentate infragranular zone. All data are the mean ± SEM number of cells/0.15 mm^2 of the granule cell layer ($4 \leqslant n \leqslant 7$). Values significantly different ($p < 0.05$; Student's *t*-test) from naïve are indicated with an asterisk. sal: saline-treated (0.9% w/v); soc: social housing; CE: complex environment.

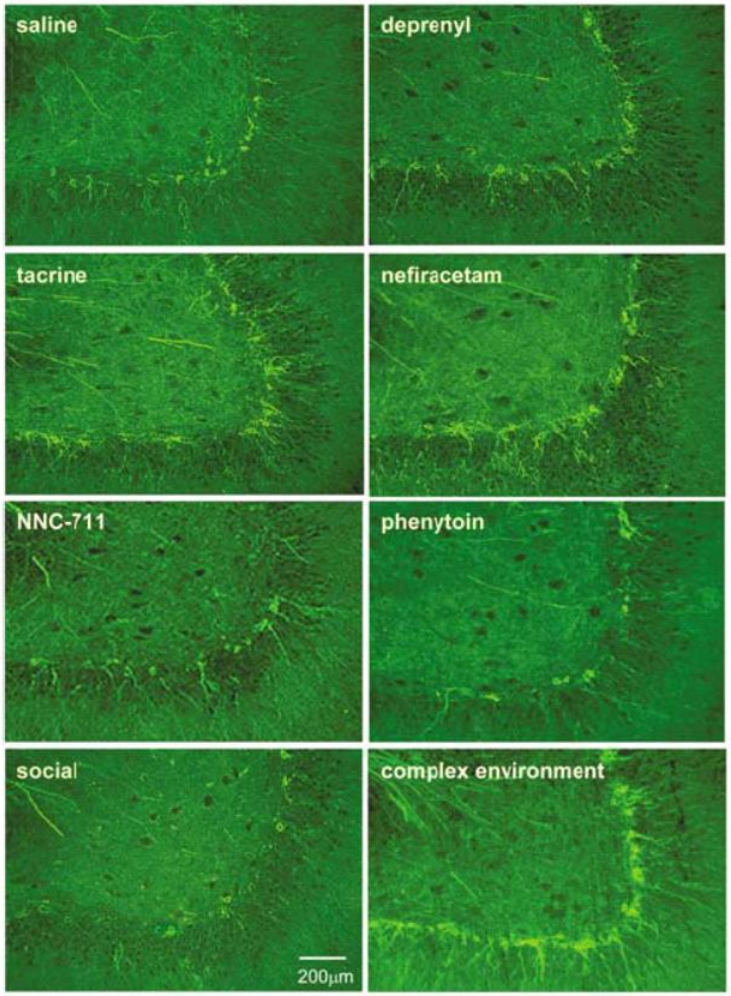
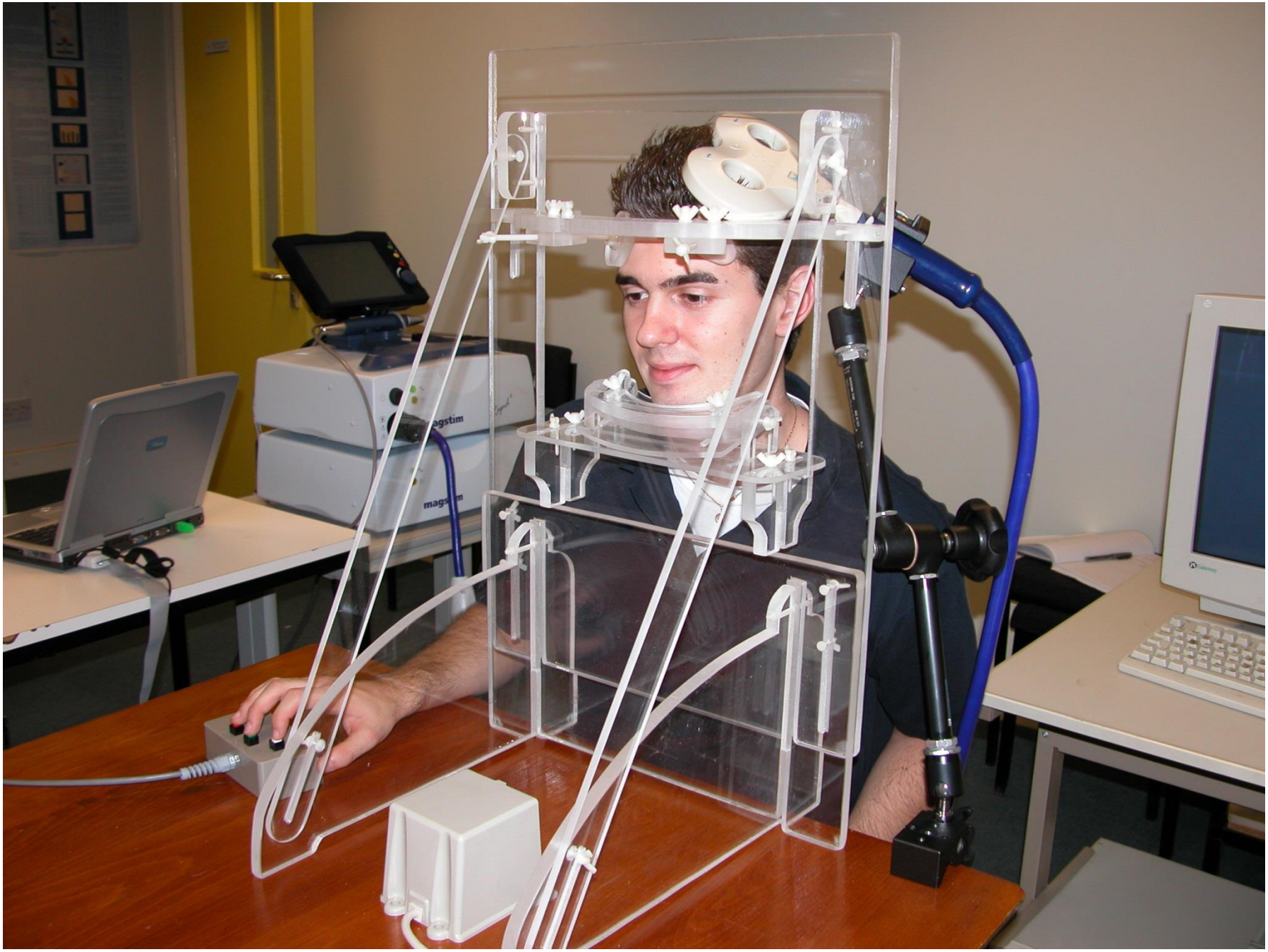


Figure 3 Photomicrographs illustrating the effect of chronic treatment with saline (0.9% w/v), deprenyl (5 mg/kg/day), tacrine (1 mg/kg/day), nefiracetam (15 mg/kg/day), NNC-711 (1 mg/kg/day), phenytoin (8 mg/kg/day) and rearing in a social or complex environment on the frequency of polysialylated hippocampal infragranular neurons in the postnatal day 80 male Wistar rat.

Murphy, K. J., Foley, A. G., O'Connell, A. W. and Regan, C. M. (2006). Chronic Exposure of Rats to Cognition Enhancing Drugs Produces a Neuroplastic Response Identical to That Obtained by Complex Environment Rearing. *Neuropsychopharmacology*, 31(1), 90-100



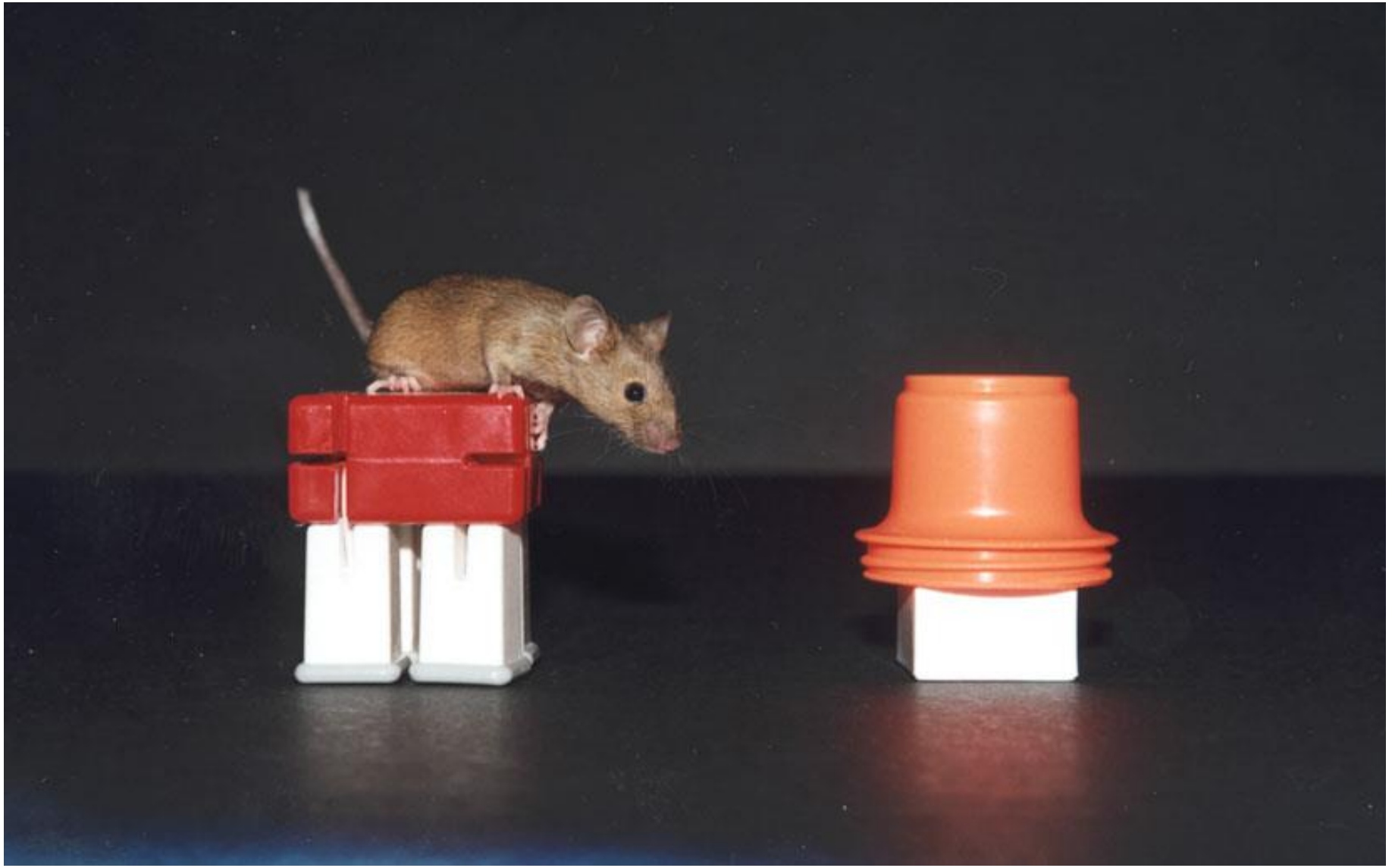


Table 1. How the maximum amount of IQ gain (assuming a Gaussian distribution of predicted IQs among the embryos with a standard deviation of 7.5 points[3]) might depend on the number of embryos used in selection

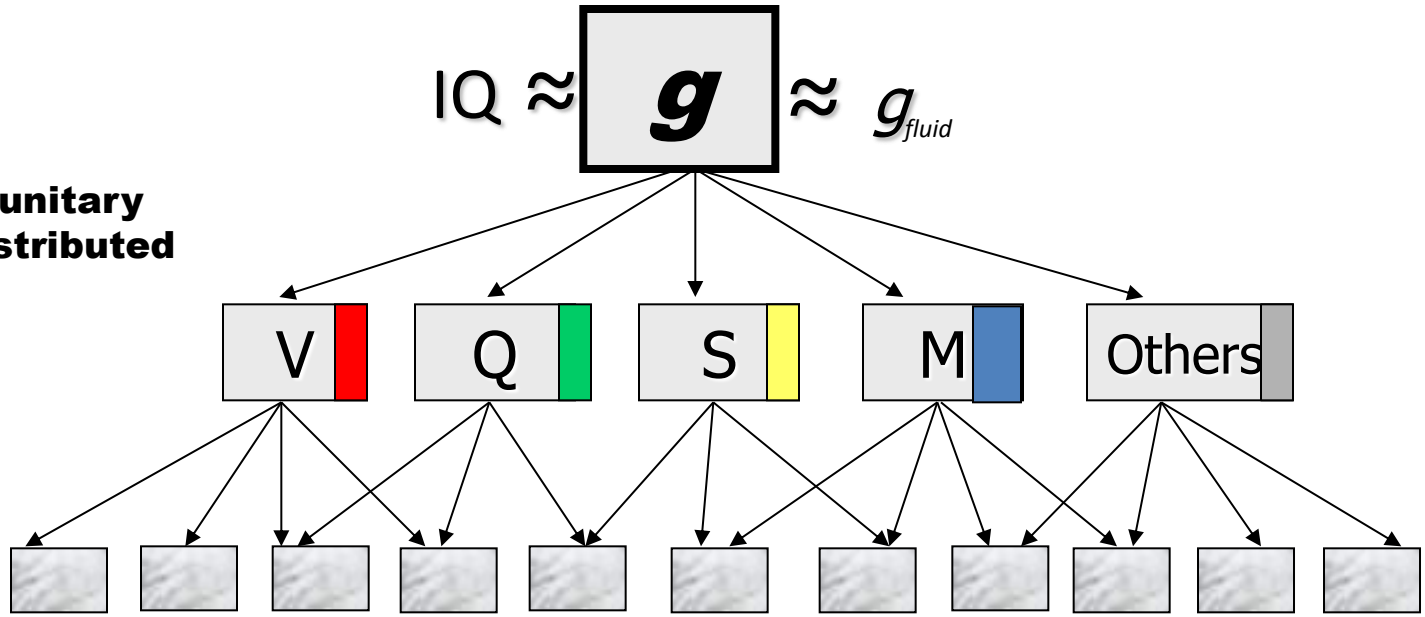
Selection	IQ points gained
1 in 2	4.2
1 in 10	11.5
1 in 100	18.8
1 in 1000	24.3
5 generations of 1-in-10	< 65 [b/c diminishing returns]
10 generations of 1-in-10	< 130 [b/c diminishing returns]
Cumulative limits (additive variants optimized for cognition)	100 + (< 300 [b/c diminishing returns])

Carl Shulman and Nick Bostrom. Embryo Selection for Cognitive Enhancement: Curiosity or Game-changer? *Global Policy*, Vol. 5, No. 1 (2014): 85-92

MOST GENERAL

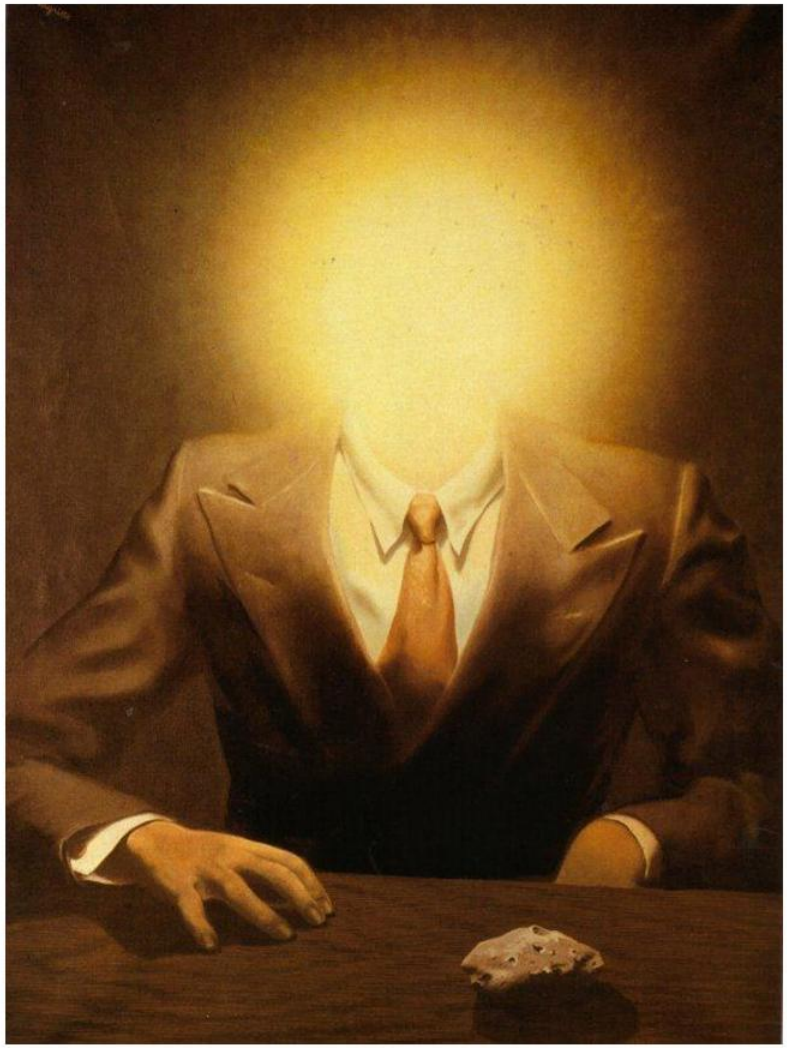
- **Domain general**
- **More heritable**
- ***Psychometrically*** **unitary**
- ***Physiologically*** **distributed**

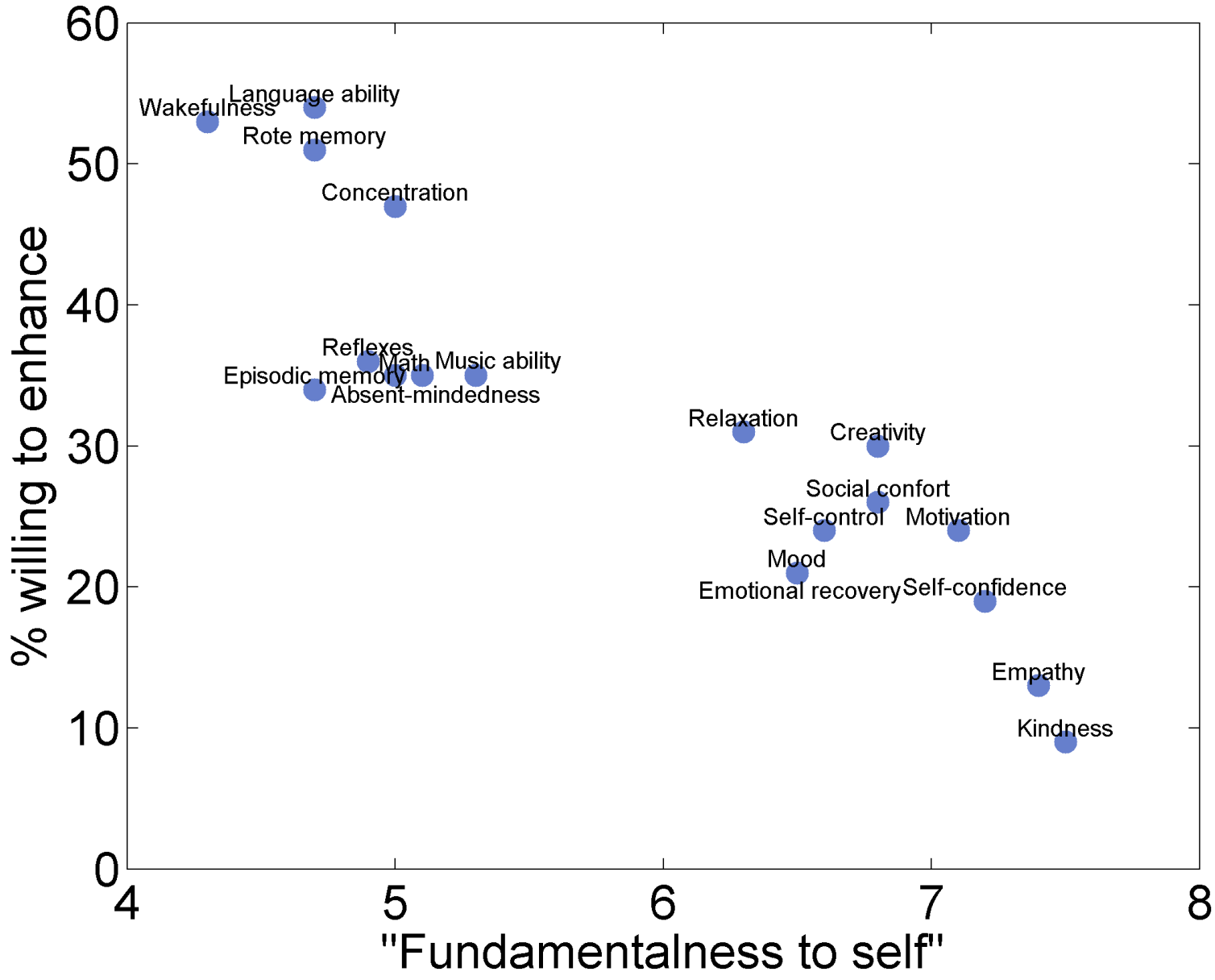
NARROW



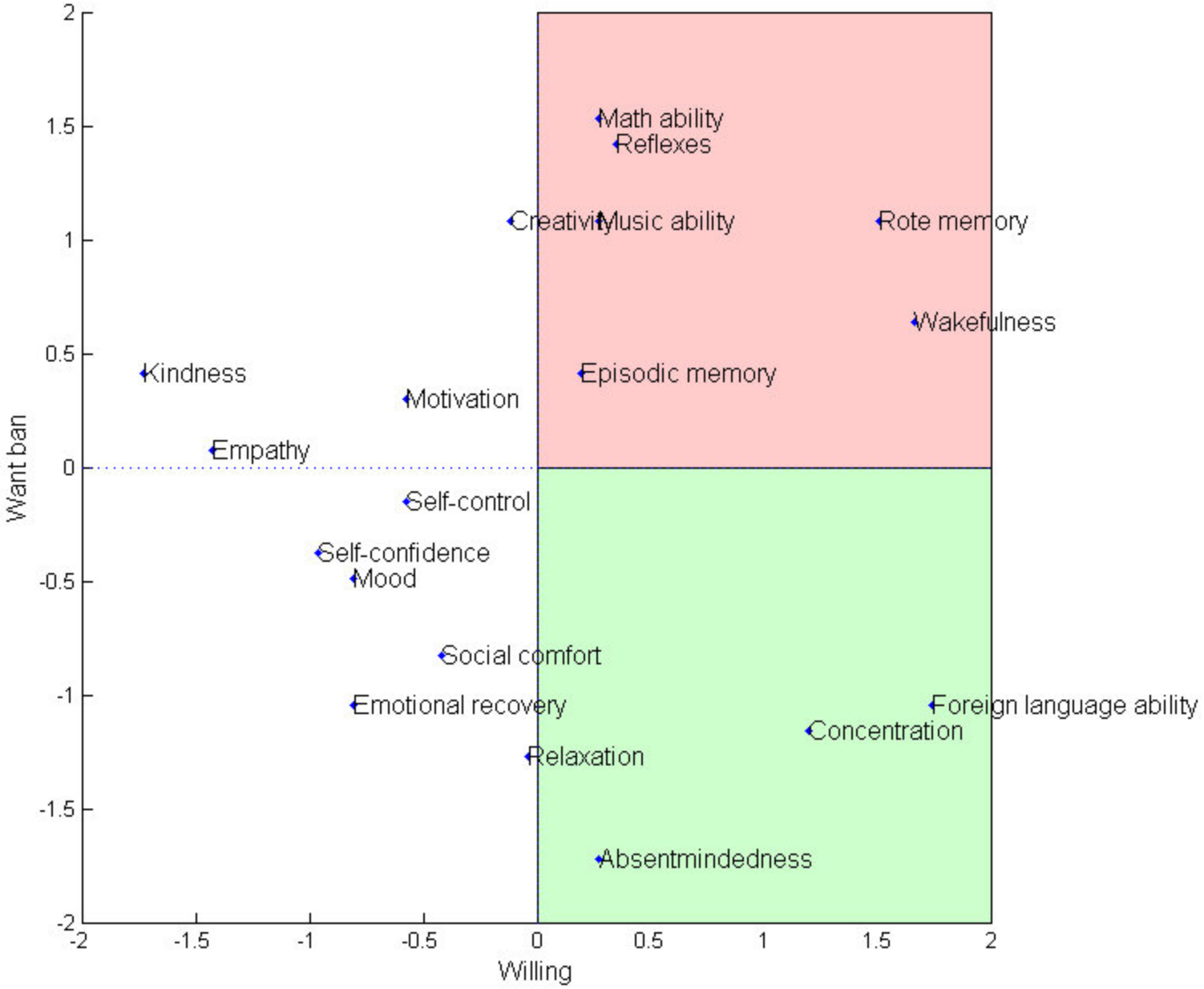
What are the limits?

- Biological/physical limits
- Identity limits
- Ethical limits
- Limits of desire





Jason Riis, Joseph P. Simmons, Geoffrey P. Goodwin, Preferences for enhancement pharmaceuticals: the reluctance to enhance fundamental traits, *Journal of Consumer* Research, 35, 495-508, 2008


Math ability
Reflexes
Creativity
Music ability
Rote memory
Wakefulness
Kindness
Episodic memory
Motivation
Empathy
Self-control
Self-confidence
Mood
Social comfort
Emotional recovery
Foreign language ability
Concentration
Relaxation
Absentmindedness
Want ban
Willing
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2

What is fairness?

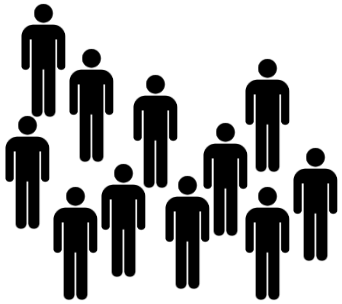
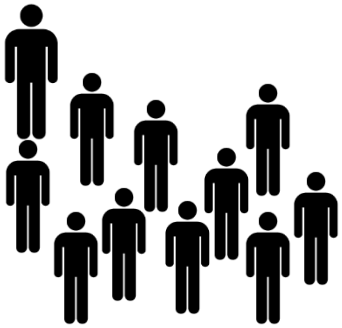
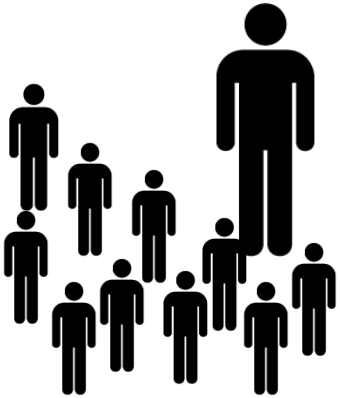
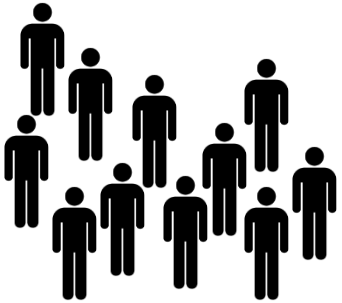
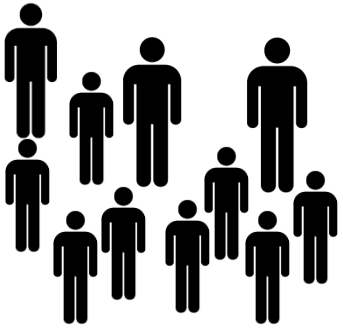
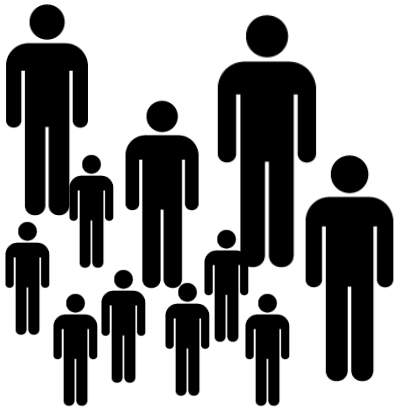
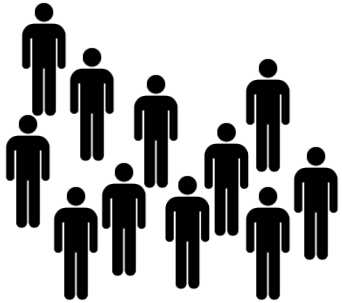
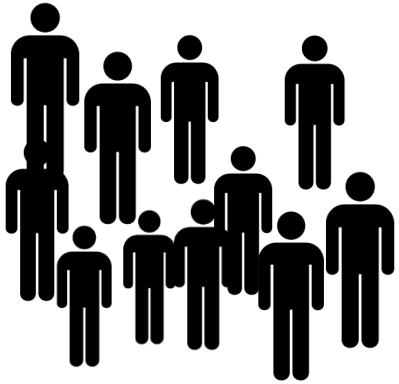
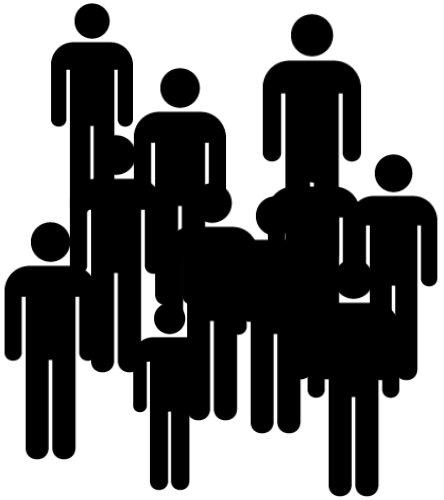
- Distributive justice:
  - What should be distributed? Among who? In what way?

	Enhancement positive for individual	Enhancement neutral or negative for individual
Enhancement positive for society	Win-win situation.	Free rider problem
Enhancement neutral or negative for society	Social trap	Positional goods arms race


ONE HUNDRED DOLLARS
INDEPENDENCE HALL
100

Table 3. Some possible impacts from genetic selection with different technologies and rates of adoption for cognitive enhancement[6]

adoption / technology	'IVF+' Selection of 1 of 2 embryos [4 points]	'aggressive IVF' Selection of 1 of 10 embryos [12 points]	'*in vitro* egg' Selection of 1 of 100 embryos [19 points]	'IES' [100 + points]
~ 0.25 per cent adoption 'marginal fertility practice'	Socially negligible over one generation. Effects of social controversy more important than direct impacts.	Socially negligible over one generation. Effects of social controversy more important than direct impacts.	Enhanced contingent forms noticeable minority in highly cognitively selective positions.	Selected dominate ranks of elite scientists, attorneys, physicians, engineers. Intellectual Renaissance?
10 per cent adoption 'elite advantage'	Slight cognitive impact in first generation, combines with selection for noncognitive traits to perceptibly advantage a minority.	Large fraction of Harvard undergraduates enhanced. 2nd generation dominate cognitively demanding professions.	Selected dominate ranks of scientists, attorneys, physicians, engineers in first generation.	'Posthumanity' (Bostrom, 2009)
> 90 per cent adoption 'new normal'	Learning disability much less frequent among children. In second generation, population above high IQ thresholds more than doubled.	Substantial growth in educational attainment, income. Second generation manyfold increase at right tail.	Raw IQs typical for eminent scientists 10 + times as common in first generation. Thousands of times in second generation.	'Posthumanity'

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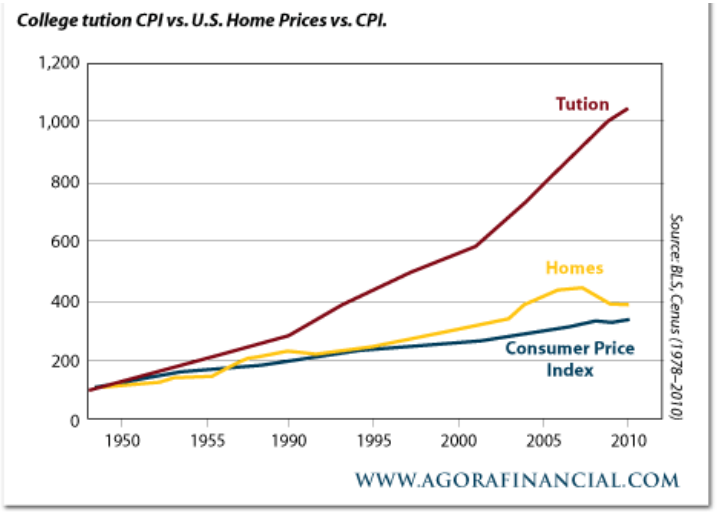
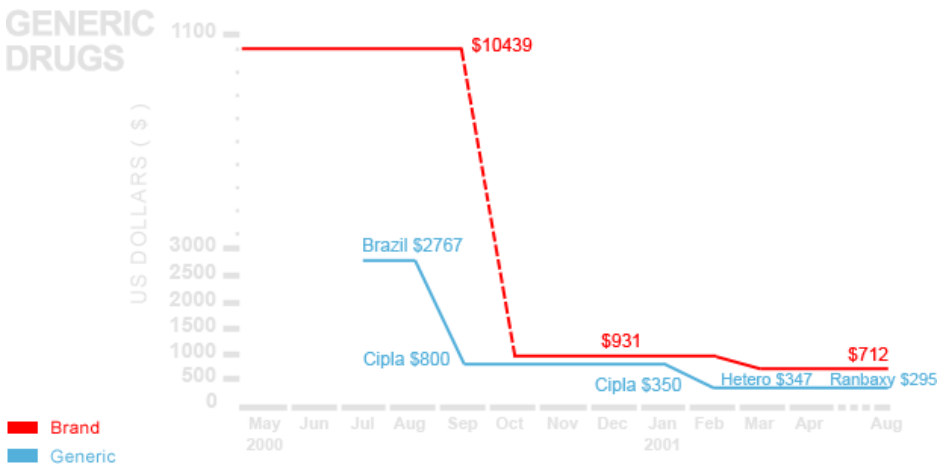
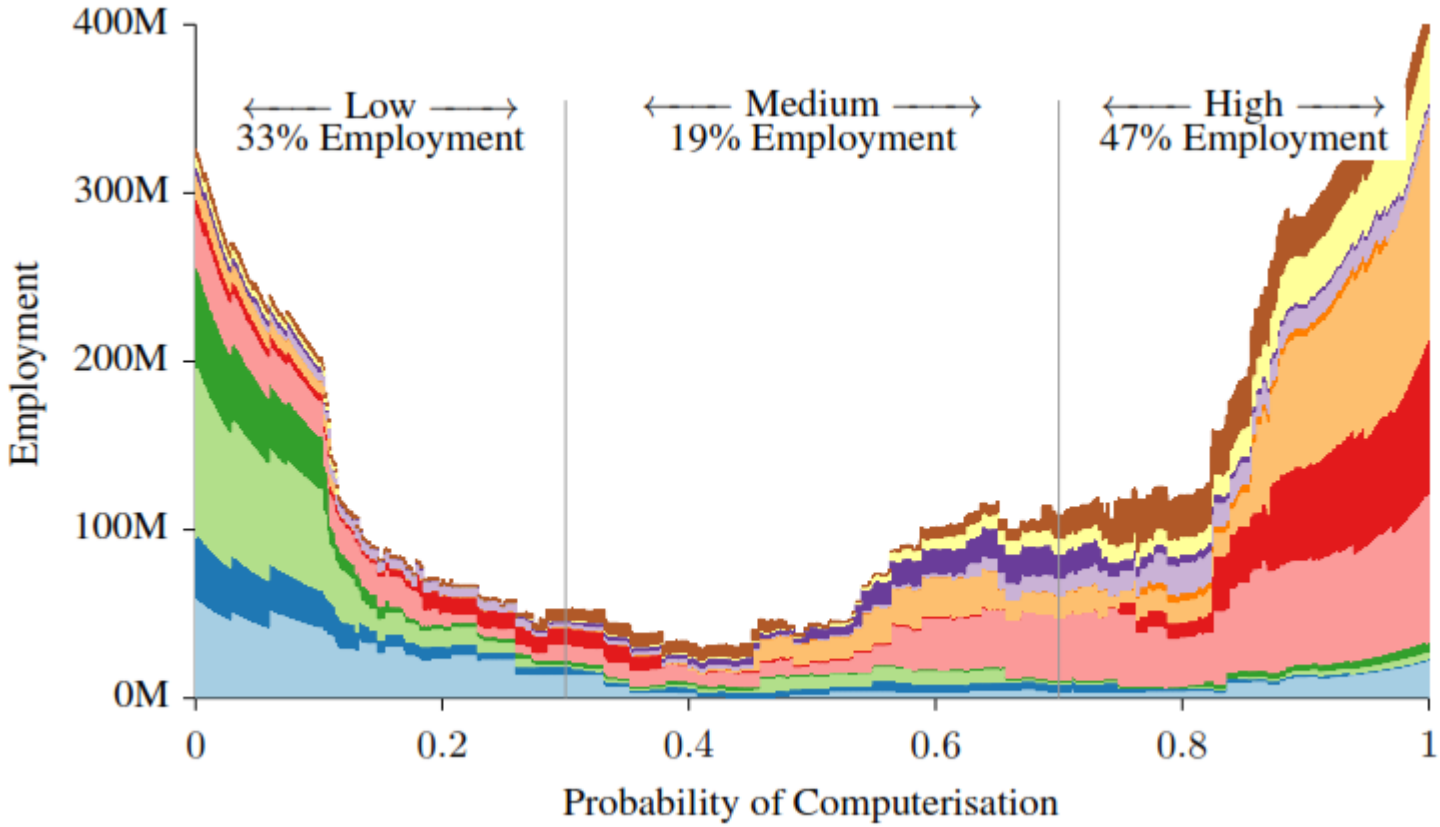
I. LANGMUIR M. PLANCK Mme CURIE H.A. LORENTZ A. EINSTEIN P. LANGEVIN Ch.E. GUYE C.T.R. WILSON O.W. RICHARDSON


VUZIX


College tution CPI vs. U.S. Home Prices vs. CPI.
1,200
1,000
800
600
400
200
0
1950
1955
1990
1995
2000
2005
2010
Tution
Homes
Consumer Price Index
Source: BLS, Census (1978–2010)
WWW.AGORAFINANCIAL.COM


GENERIC DRUGS
US DOLLARS ($)
1100
3000
2500
2000
1500
1000
500
0
$10439
Brazil $2767
$931
$712
Cipla $800
Cipla $350
Hetero $347
Ranbaxy $295
May 2000
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan 2001
Feb
Mar
Apr
Aug
Brand
Generic



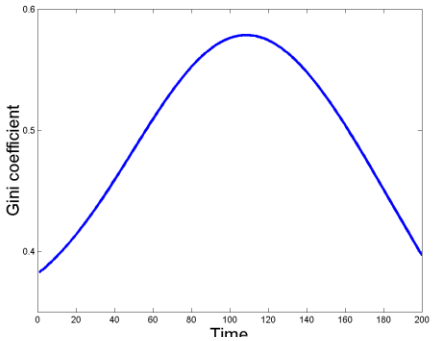
- Management, Business, and Financial
- Computer, Engineering, and Science
- Education, Legal, Community Service, Arts, and Media
- Healthcare Practitioners and Technical
- Service
- Sales and Related
- Office and Administrative Support
- Farming, Fishing, and Forestry
- Construction and Extraction
- Installation, Maintenance, and Repair
- Production
- Transportation and Material Moving

Variable	Probability of Computerisation		
	Low	Medium	High
Assisting and caring for others	48±20	41±17	34±10
Persuasion	48±7.1	35±9.8	32±7.8
Negotiation	44±7.6	33±9.3	30±8.9
Social perceptiveness	51±7.9	41±7.4	37±5.5
Fine arts	12±20	3.5±12	1.3±5.5
Originality	51±6.5	35±12	32±5.6
Manual dexterity	22±18	34±15	36±14
Finger dexterity	36±10	39±10	40±10
Cramped work space	19±15	37±26	31±20

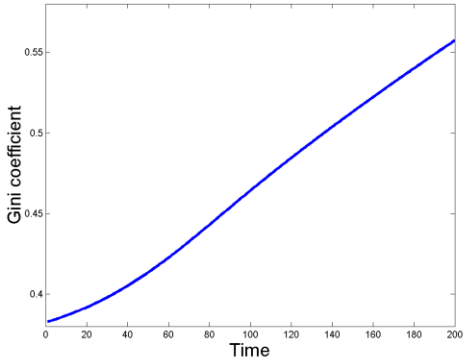
The future of employment: how susceptible are jobs to computerisation? Carl Benedikt Frey, Michael A. Osborne, 2013

Simulation

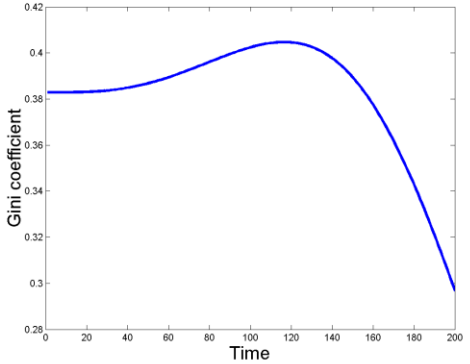
- Enhancements that increase earning ability constant factor, decreasing to a low price

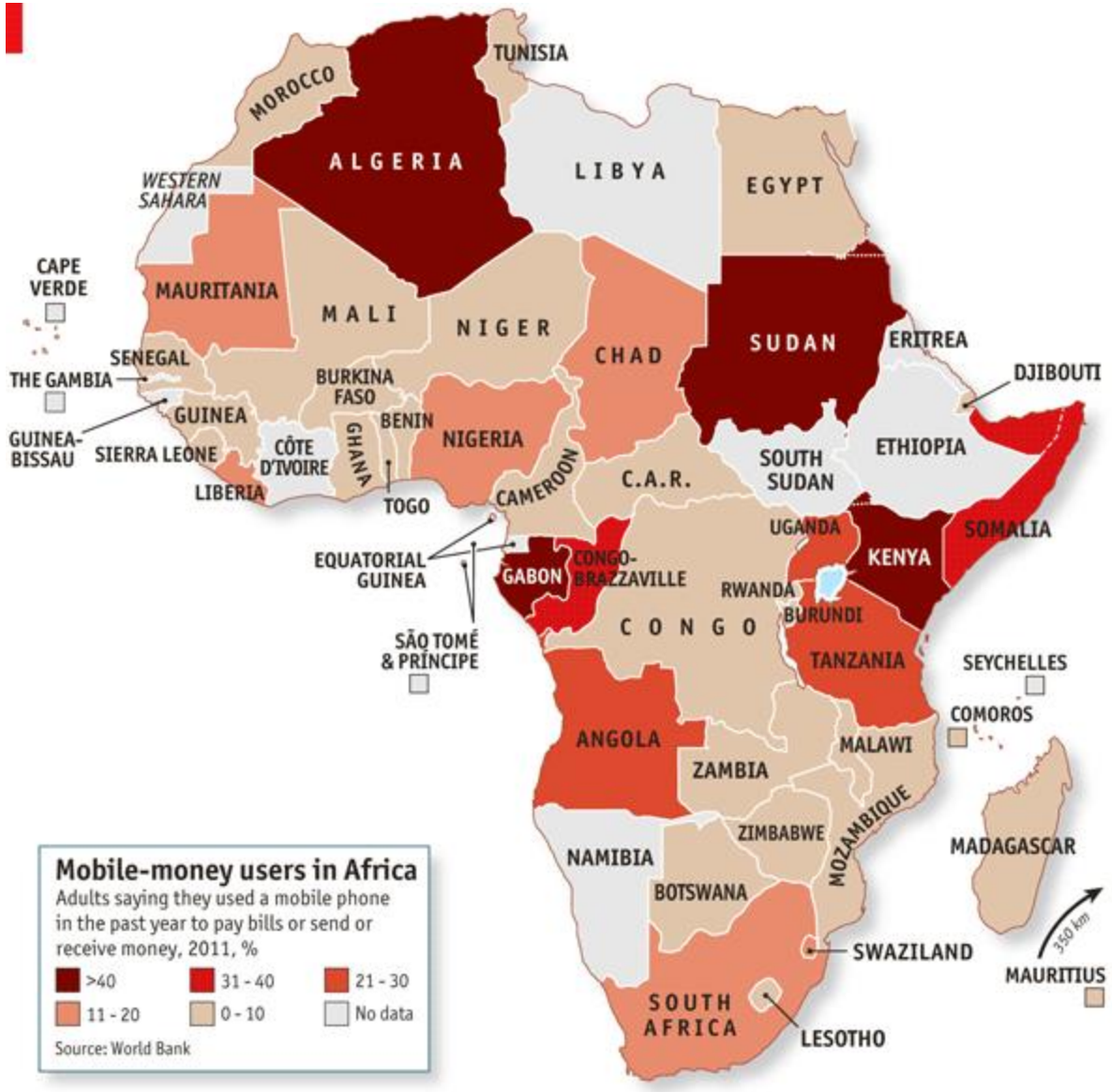


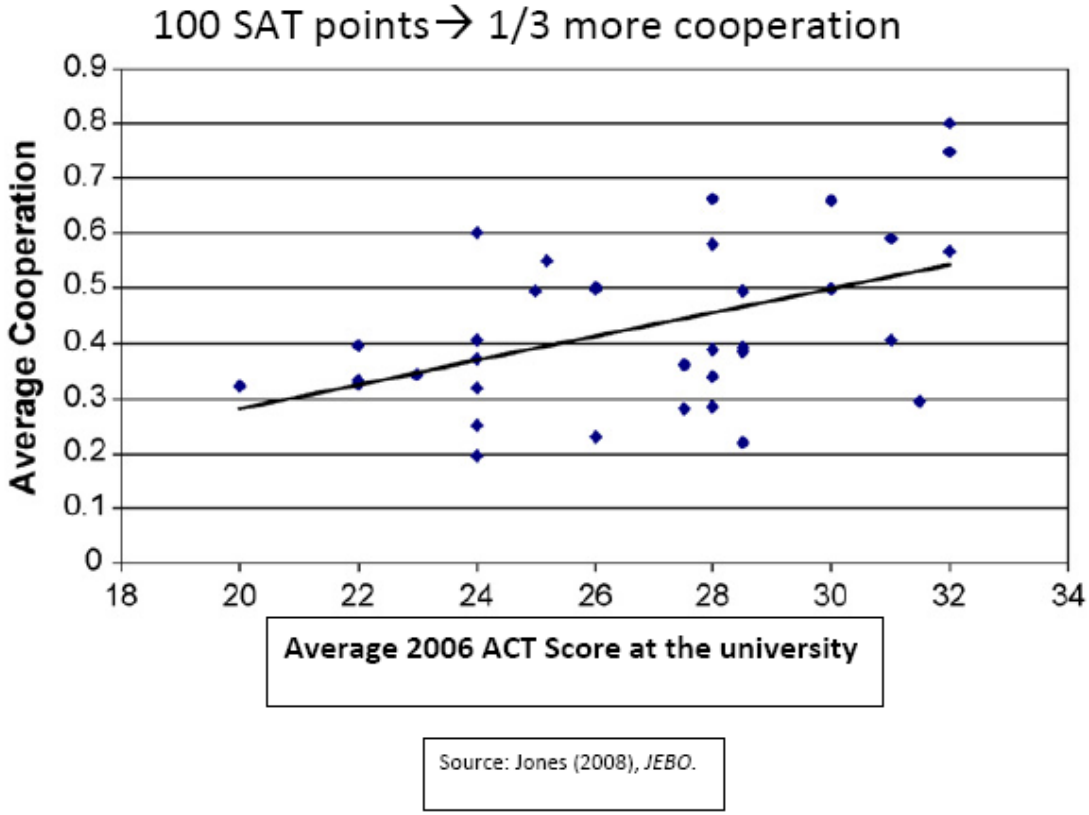
- Enhancement proportional to income



- Decreasing margins




TUNISIA
MOROCCO
ALGERIA
LIBYA
EGYPT
WESTERN SAHARA
CAPE VERDE
MAURITANIA
MALI
NIGER
CHAD
SUDAN
ERITREA
DJIBOUTI
SENEGAL
THE GAMBIA
BURKINA FASO
GUINEA
GUINEA-BISSAU
SIERRA LEONE
CÔTE D'IVOIRE
GHANA
BENIN
NIGERIA
CAMEROON
C.A.R.
SOUTH SUDAN
ETHIOPIA
LIBERIA
TOGO
UGANDA
KENYA
SOMALIA
EQUATORIAL GUINEA
GABON
CONGO-BRAZZAVILLE
RWANDA
BURUNDI
CONGO
SÃO TOMÉ & PRÍNCIPE
TANZANIA
SEYCHELLES
COMOROS
ANGOLA
MALAWI
ZAMBIA
ZIMBABWE
MOZAMBIQUE
MADAGASCAR
NAMIBIA
BOTSWANA
SWAZILAND
350 km
MAURITIUS
SOUTH AFRICA
LESOTHO
Mobile-money users in Africa
Adults saying they used a mobile phone in the past year to pay bills or send or receive money, 2011, %
>40
31 - 40
21 - 30
11 - 20
0 - 10
No data
Source: World Bank



Source: Jones (2008), *JEBO*.

Conclusions

- Cognition has a major effect on equality of opportunity.
- Enhancing cognition can make society more or less unequal. Whether this is *unjust* depends both on the technology, one's theory of justice, and what policies instituted.
- CE likely to individually help worst off, but make the best off compete harder.
- Strengthening the "dominant cooperative framework" of society is a good idea in any case.
- Individual morphological freedom must be safeguarded.
- Speeding up progress and diffusion is likely to reduce inequality over time – and promote diversity.
- Different parts of the world likely to approach CE differently

Setting priorities worth taking seriously

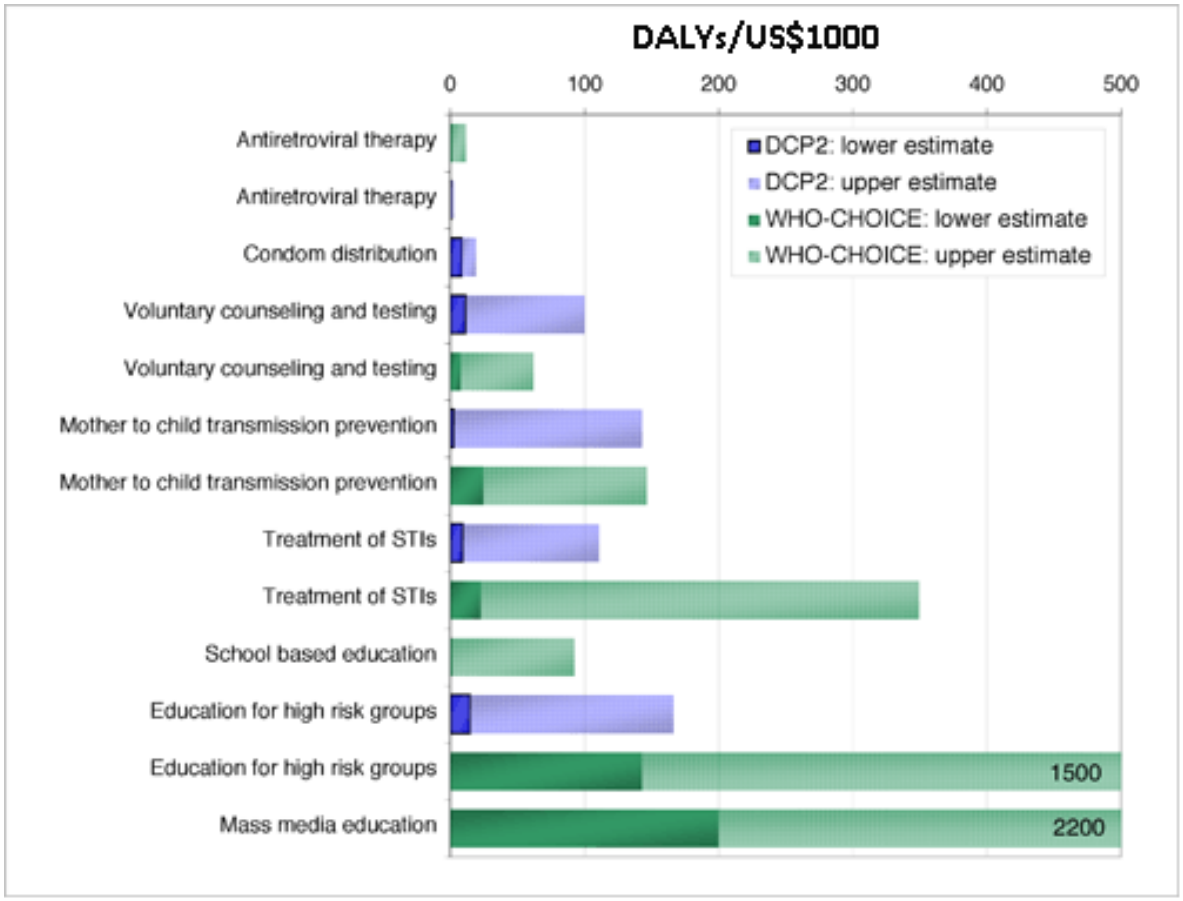
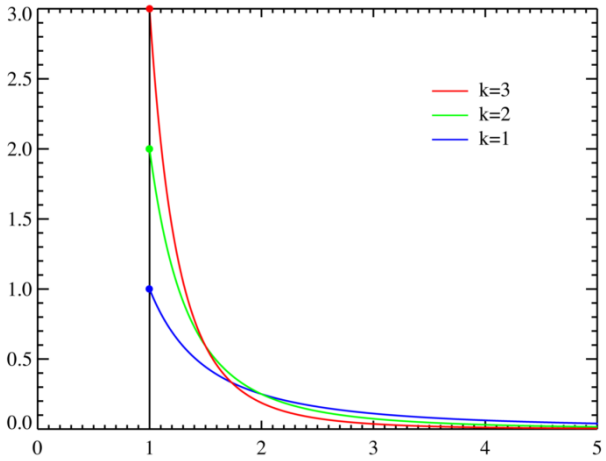
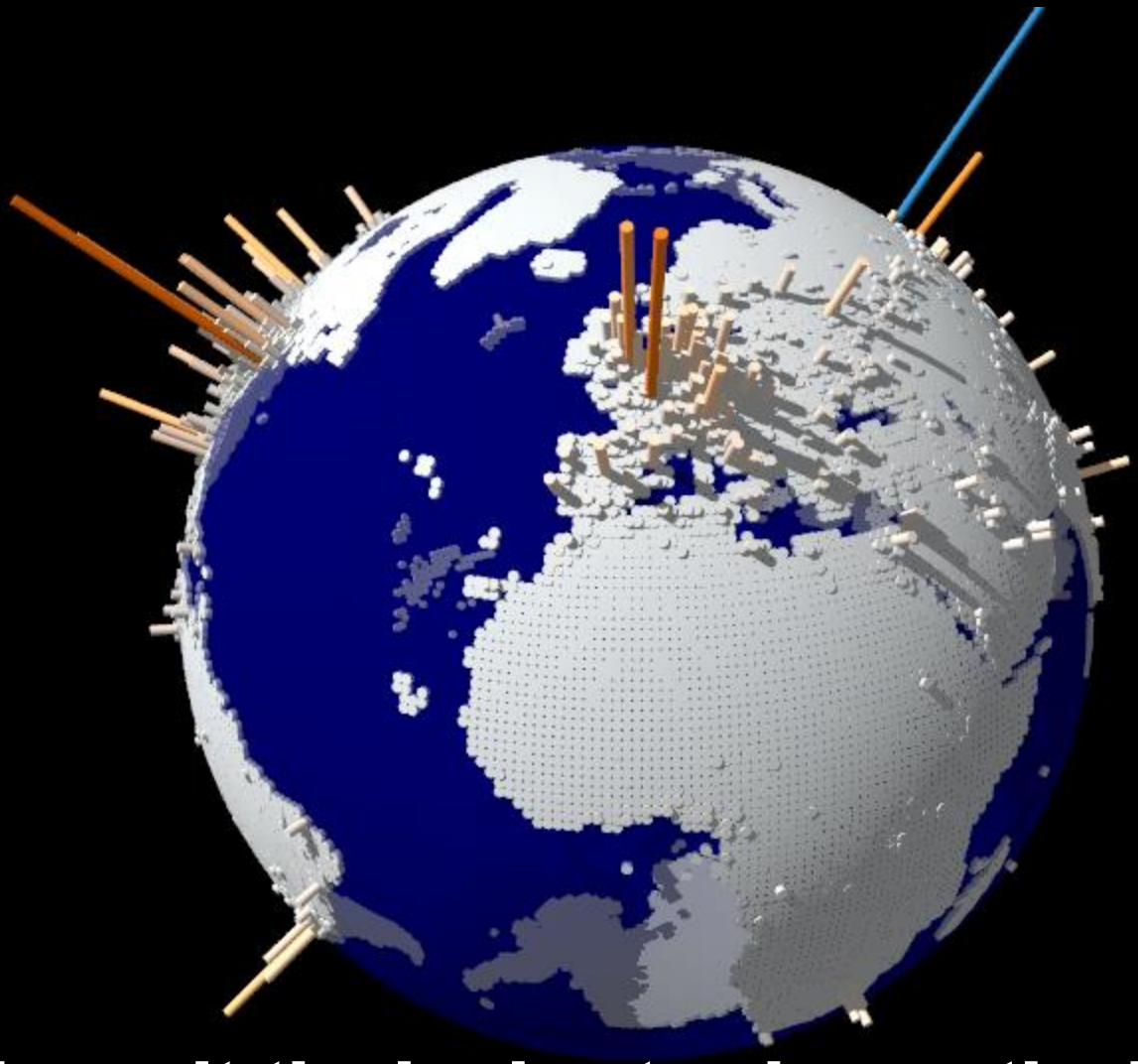


Figure 1: Cost-effectiveness (DALYs/US$1000) in fighting HIV/AIDS, http://www.givingwhatwecan.org



Optimal meta-level problem solving can at most give savings equal to half the expected utility difference between two alternatives – but if the alternatives matter *enormously*, spending effort is hugely valuable.



If we haven't the brains to choose the best track we should choose the track to better brains.

Bradley Felton