

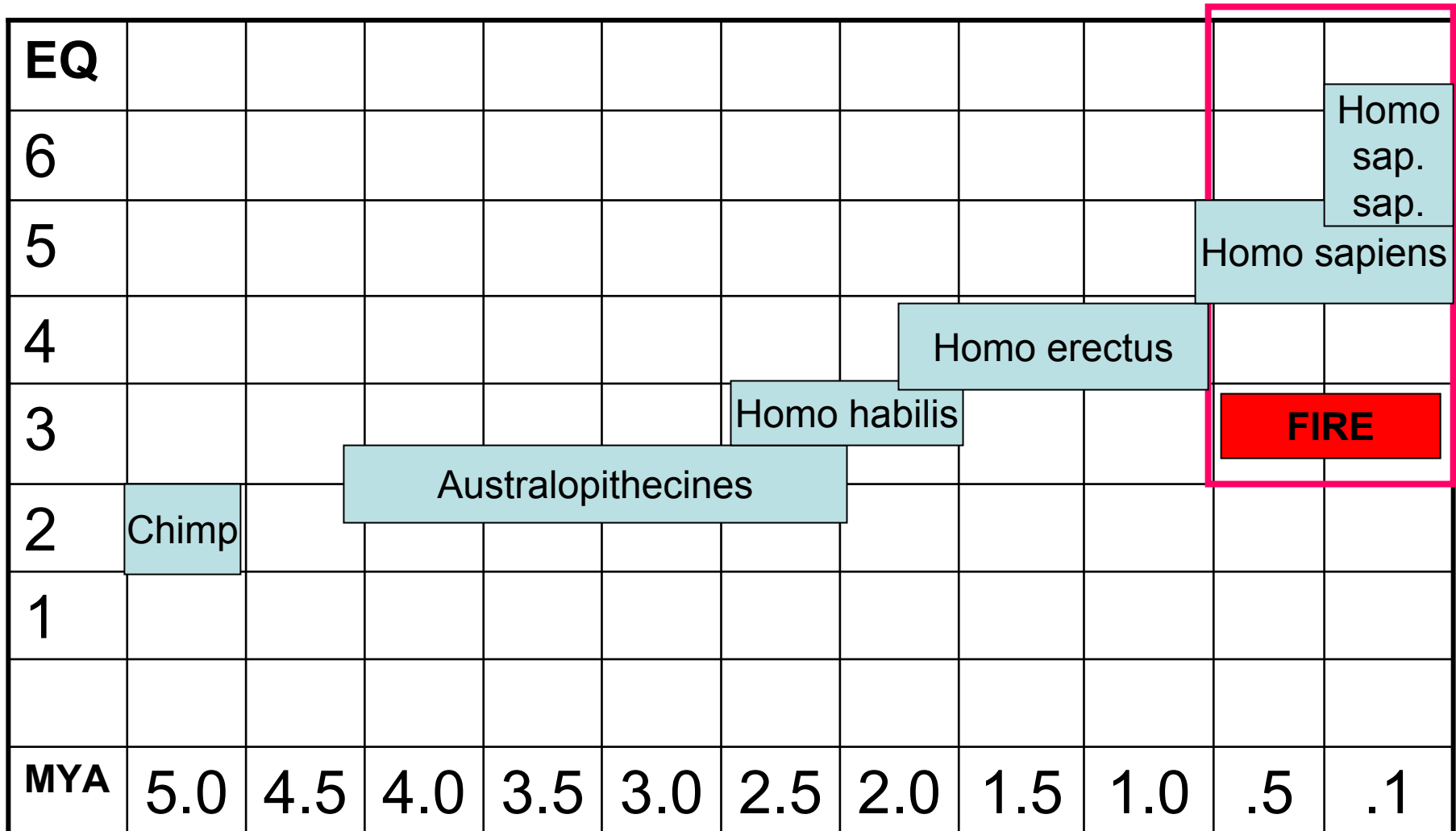
Innovation, Fatal Accidents, and the Evolution of General Intelligence

Linda S. Gottfredson
University of Delaware

International Society for Intelligence Research
Albuquerque, NM, USA
December 1, 2005

Humans' "Remarkable" Intellect

Encephalization quotient (EQ) = brain-to-body size compared to the average mammal



The Explanandum

Human “Intelligence”

- Psychometric view—*g*
 - General ability to learn & reason
 - General (cross-domain) utility
 - Instrumental (not socioemotional)

E.g., Fitness signaling & survival theories consistent with *g*

- Evo Psych views—varied, but mostly not *g*
 - Modular: Narrow, domain-specific, automated (many fast and frugal heuristics)
 - Social intelligence (not “ecological competence”)

So, most Evo Psych theories leave *g* unexplained.

What Must an Explanation of g Specify?

1. **Cross-domain value** (common cognitive demands across *different* task domains in *Homo* ecology)
2. **Differential impact on survival** (g -related differences in task performance must create g -related differences in survival/reproduction)

Need to lay out a “nitty-gritty selection walk”

3. **Ecological demands that are unique to genus *Homo***
4. **Conditions that accelerated selection for g in *Homo sapiens***

Natural Selection, or Sexual Selection?

- My focus here on natural selection
 - I.e., external, physical environment matters
- Sexual selection for g may also operate, but is not plausibly the whole answer:
 - Why would it select so strongly for g only among humans?
 - What would trigger runaway selection for g ?
 - What about all those individuals who die before reproductive age?

1. Ecological Demands—How General?

- Clues from analyzing modern jobs
 - Cognitive complexity is major distinction
 - Example: “Judgment & Reasoning Factor”
 - Deal with unexpected situations
 - Learn & recall job-related information
 - Reason & make judgments
 - Identify problem situations quickly
 - React swiftly when unexpected problems occur
 - Apply common sense to solve problems

None of these is domain-specific.

But wasn't life simpler in the early human EEA?

- Yes, but it was never *g*-proof
- Opportunity to learn & reason + within-group *variation* in *g* = opportunity for selection
- Tiny effect size + many generations = big shift in distribution

2. *g*-Related Mortality During Reproductive Years (15-44)?

Major cause of death today: Fatal injuries

- Mostly unintentional (not homicide or suicide)
 - Burns, drowning, vehicle collisions, cuts, crushing, falls, poisons, animal bites, exposure, etc.
- Many males killed in work-related activities
- True worldwide
- Accident prevention is highly cognitive process.
 - Spotting and managing hazards makes same demands as do complex jobs (e.g., dealing with the unexpected)
- Absolute risk of accidental death is low but relative risk is high for lower-*g* populations

But in the EEA too?

% Non-Warfare Deaths: USA vs. Pre-Contact Hunter-Gatherers

	USA (1986)				Ache (<1971)
Age:	15-24	25-34	35-44	45-64	15-59
Illness	22	44	72	93	49
Accident	51	31	15	4	37
Suicide	13	12	7	2	0
Homicide	14	13	6	1	14

Cause of Ache Deaths (N, <1971)

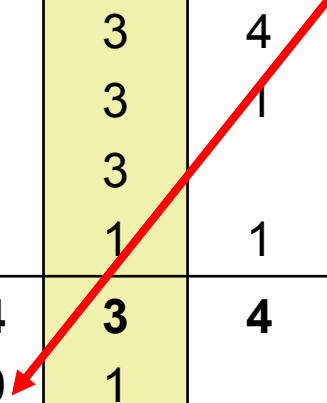
Age:	0-3		4-14		15-59		60+	
Sex:	F	M	F	M	F	M	F	M
Illness					9	26	2	3
Congenital/degenerative					1		2	4
Childbirth					3			
Accident					6	23	4	3
jaguar/snake					4	19	1	3
lightning					1	2		
lost						1	3	
drowned/falls/other					1	1		
Homicide					4	7	1	4
sacrificed with adult								
homicide/neglect								
buried alive/left behind					2		1	2
ritual club fights						6		2
non-sanctioned murder					2	1		

Cause of Ache Deaths (N, <1971)

Age:	0-3		4-14		15-59		60+	
Sex:	F	M	F	M	F	M	F	M
Illness			8	7	9	26	2	3
Congenital/degenerative					1		2	4
Childbirth					3			
Accident			1	10	6	23	4	3
jaguar/snake				3	4	19	1	3
lightning				3	1	2		
lost				3		1	3	
drowned/falls/other			1	1	1	1		
Homicide			14	3	4	7	1	4
sacrificed with adult			10	1				
homicide/neglect			3					
buried alive/left behind			1	2	2		1	2
ritual club fights						6		2
non-sanctioned murder					2	1		

Most are "mistakes"
(faulty mind's eye)
during provisioning

Mistakes
reverberate



Cause of Ache Deaths (N, <1971)

Age:	0-3		4-14		15-59		60+	
Sex:	F	M	F	M	F	M	F	M
Illness	19	17	8	7	9	26	2	3
Congenital/degenerative	8	11			1		2	4
Childbirth					3			
Accident	1	2	1	10	6	23	4	3
jaguar/snake				3	4	19	1	3
lightning		1		3	1	2		
lost				3		1	3	
drowned/falls/other	1	1	1	1	1	1		
Homicide	26	26	14	3	4	7	1	4
sacrificed with adult	7	4	10	1				
homicide/neglect	17	18	3					
buried alive/left behind	2	4	1	2	2		1	2
ritual club fights						6		2
non-sanctioned murder					2	1		

Cause of Ache Deaths (N, <1971)

Age:	0-3		4-14		15-59		60+
Sex:	F	M	F	M	F	M	
Illness	19	17	8	7	9	26	<p>NOTE:</p> <p>Many Ache died before mating age</p> <p>Many evolutionary "two-fers": child killed after parent dies</p>
Congenital/degenerative	8	11			4		
Childbirth					3		
Accident	1	2	1	10	6	23	
jaguar/snake				3	4	19	
lightning		1		3	1	2	
lost				3		1	
drowned/falls/other	1	1	1	1	1	1	
Homicide	26	26	14	3	4	7	
sacrificed with adult	7	4	10	1			
homicide/neglect	17	18	3				
buried alive/left behind	2	4	1	2	2		
ritual club fights						6	
non-sanctioned murder					2	1	

What Killed Differentially by g Level?

- **Not the obvious**
 - Not high-interest, high-probability threats to band's survival (e.g., starvation, harsh climate)
 - Because the fruits of competence are shared (e.g., meat from hunting)
- **But the “minor” side-effects of core tasks**
 - Myriad low-probability, chance-laden, oft-ignored risks in daily chores (e.g., “accidental” injury)
 - Costs of injury not shared widely

Recall Spearman-Brown Formula for test reliability:
Low- g items can yield high- g test when many items cumulated (here: across tasks, individuals, generations)

3. What Unique to Human EEA?

Not

- Tool use
- Hunting
- Being hunted
- Climate
- Social living

3. What Unique to Human EEA?

Human Innovation

- Changed physical environment or how humans interacted with it (e.g., fire, weapons)
- Improved average well-being but created novel risks (e.g., burns/scalds, inattention to snakes)
- Put a premium on independent learning and foresight,
 - especially for recognizing hazards and preventing “accidental” injury and death during core activities

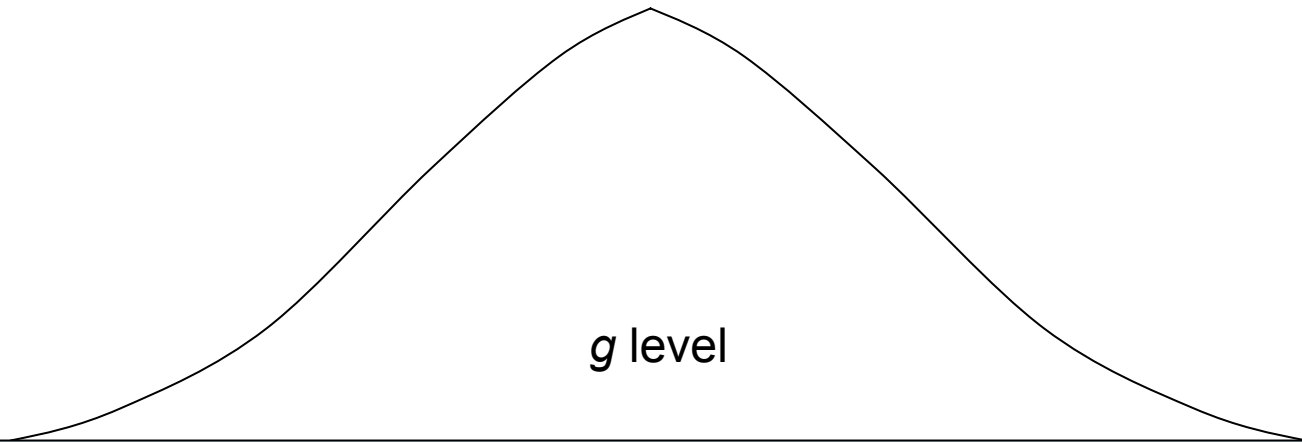
Innovation & hazards require a mind’s eye—imagination, foresight

4. How Did Innovation Accelerate Selection for g ?

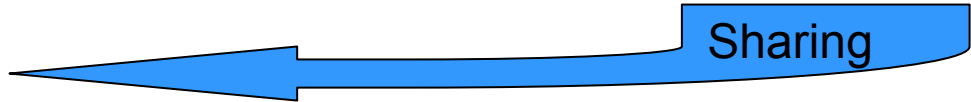
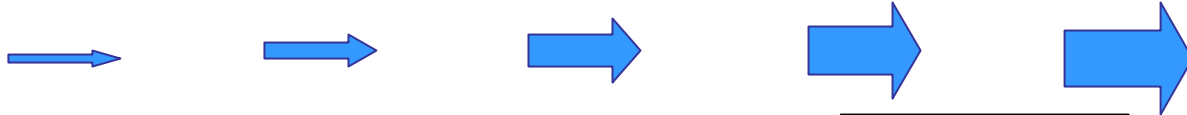
Five possible accelerators

- Double jeopardy
- Spearman-Brown pump
- Spiraling complexity
- Contagion of error
- Migration ratchet

Double Jeopardy



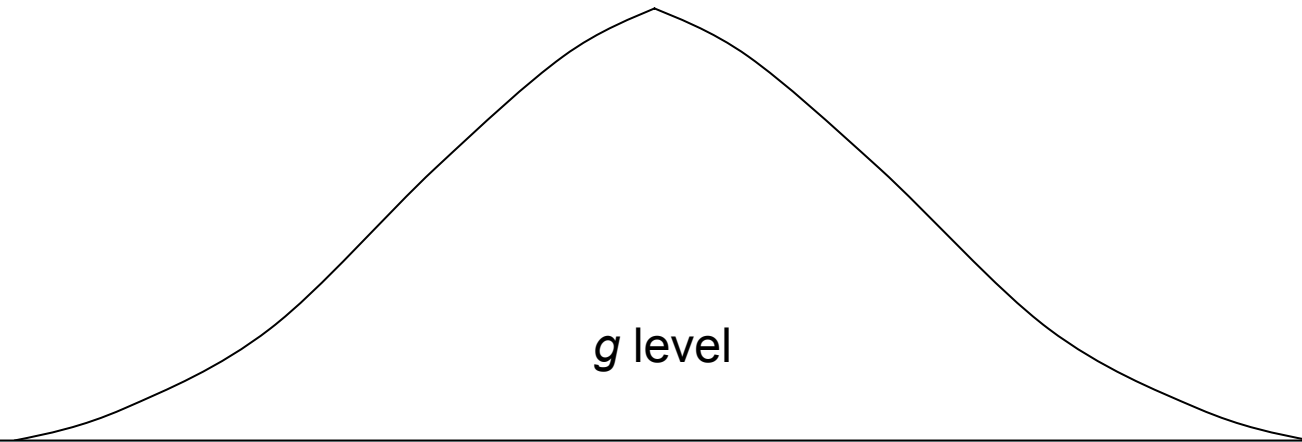
Risk of benefit



Risk of injury

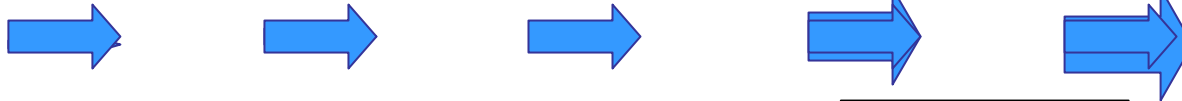


Social Intelligence View?



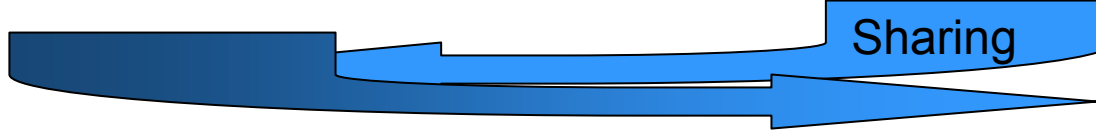
g level

Risk of benefit



Sharing

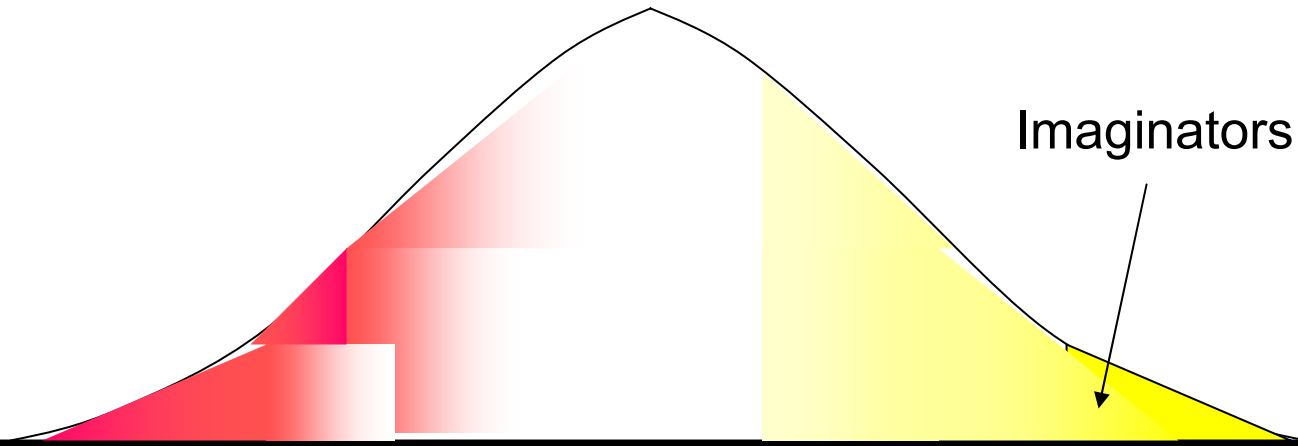
Machiavellian exploitation



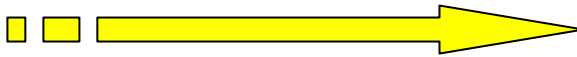
Risk of injury



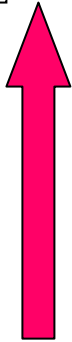
Migration Ratchet



Mean IQ rises



Relative risk steepens

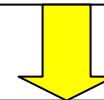


Imaginators



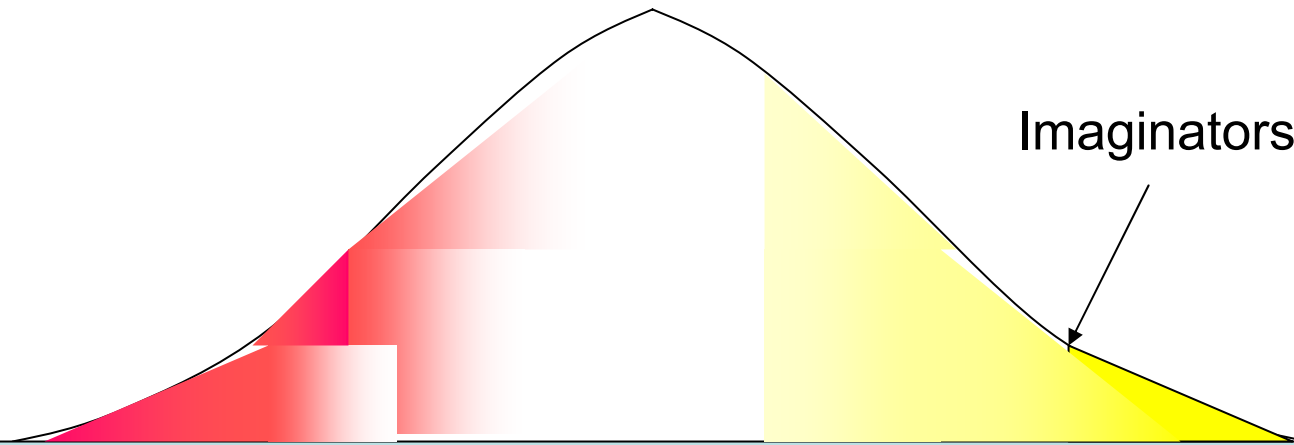
Innovate to adapt to harsher climates:

- clothing, shelter
- storage, preservation



Bigger consequences ← More hazards ← More complexity ← More innovations

Migration Ratchet

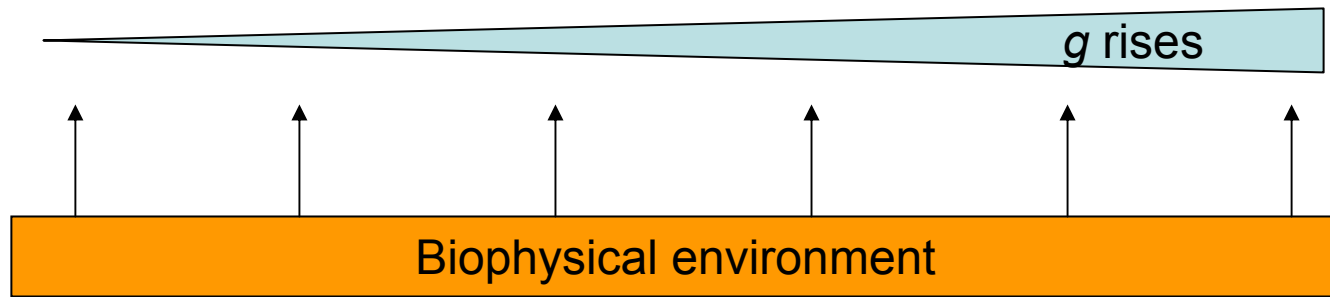


Consistent with mean differences in IQ, brain size, and skeletal robustness by race/latitude

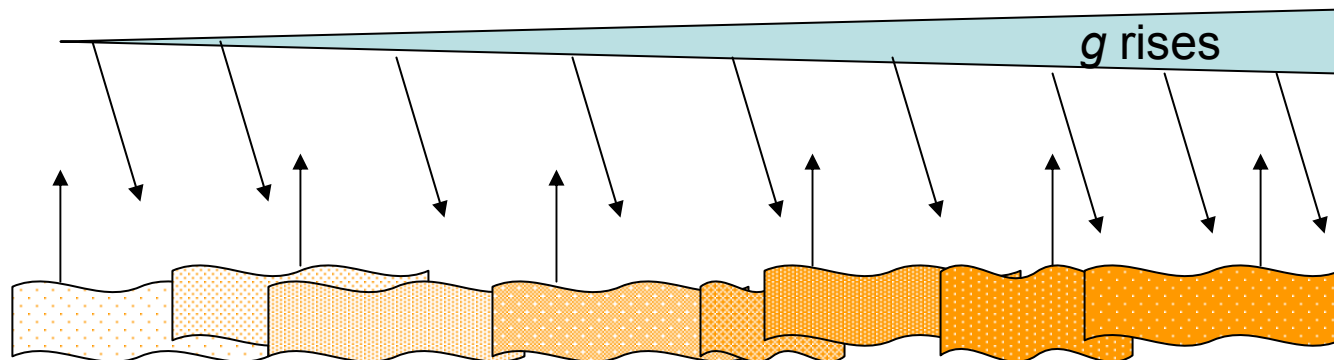
Bigger consequences ← More hazards ← More complexity ← More innovations

Gene-Culture Co-Evolution of g

Not this:



But this:



Humans modified their EEA, which modified them.

Thank you.

- In press
- Available at:

www.udel.edu/educ/gottfredson