Cognitive Skills and Critical Thinking

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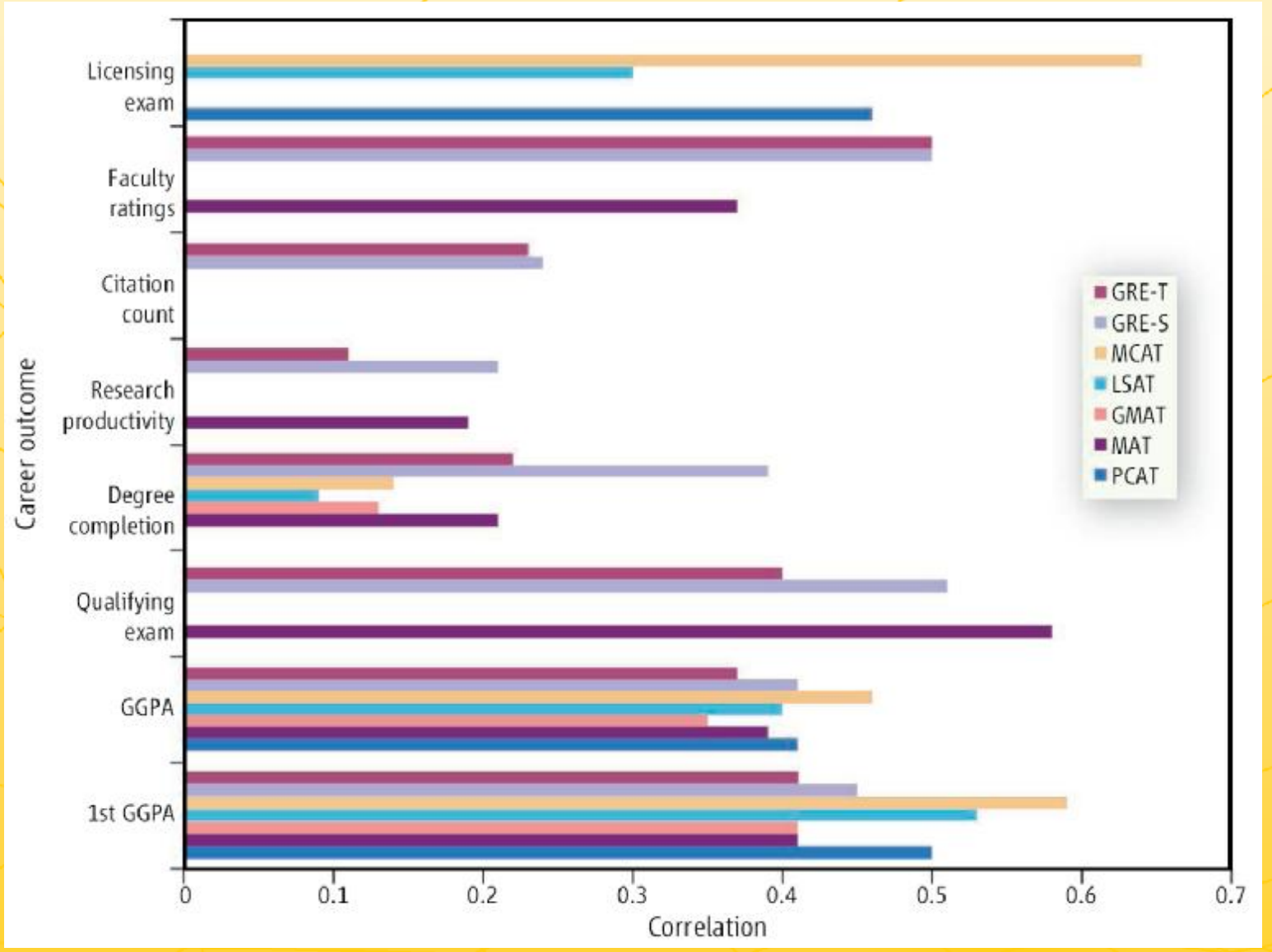
My Position

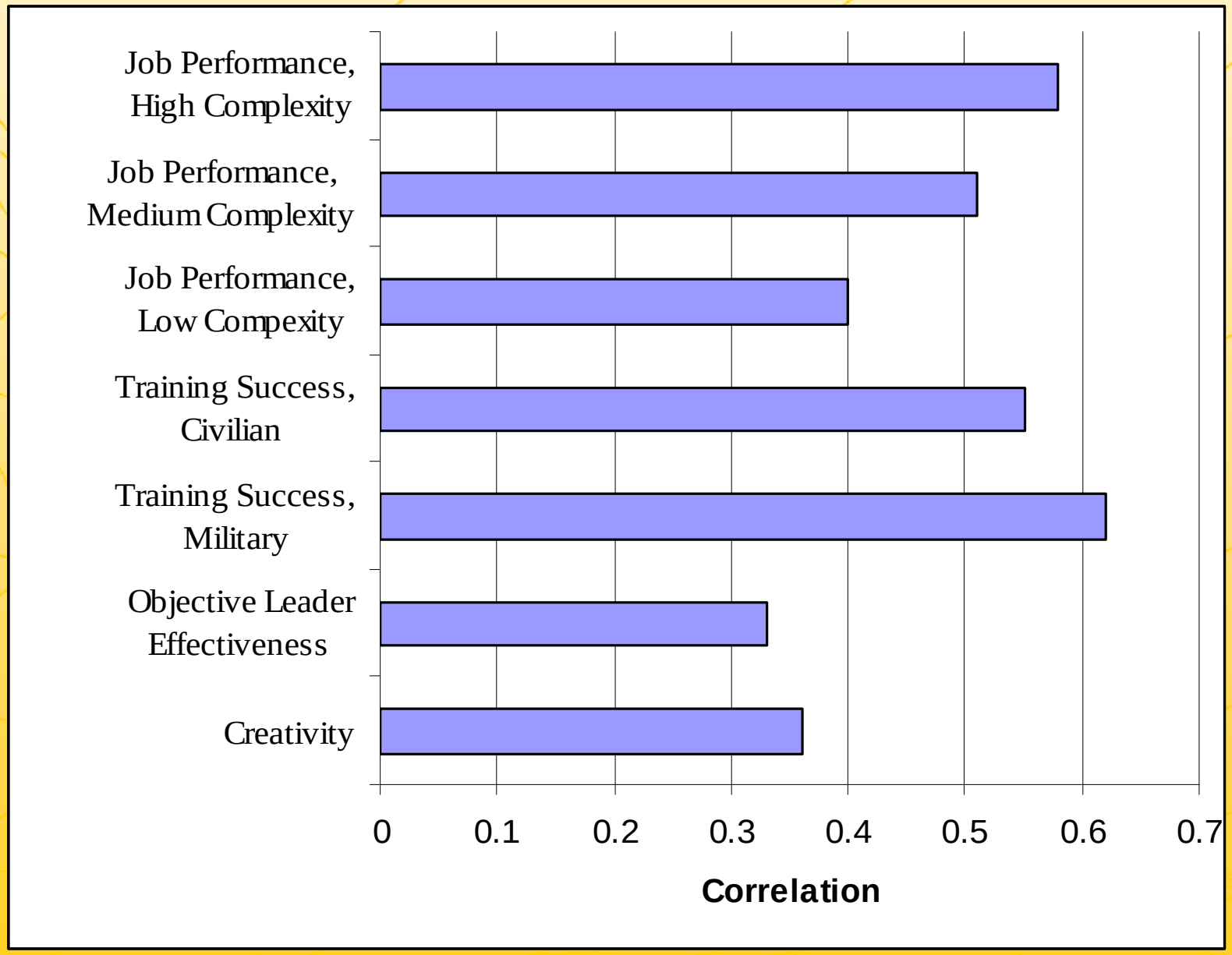
- Foundational cognitive skills (math, reading, writing) are of central importance to both subsequent skill development, academic performance, and occupational performance.
- Other broad “abilities” like critical thinking are not well defined, have not been properly validated, and are nearly indistinguishable from foundational abilities.
- What is often labeled critical thinking is often a mix of general cognitive ability, job specific expertise, or very specific skills.
- Critical thinking should be focused on those specific skills that are most relevant.
- These specific skills must be balanced against other relevant skills and knowledge domains.

Traditional Cognitive Skills

- We know a lot about foundational cognitive abilities:
  - Verbal comprehension and reasoning
  - Mathematical knowledge and skill
  - Writing skill
- These are very important for success at all levels of academic achievement and for occupational performance, as well.



Kuncel & Hezlett (2007). *Science, 315,* 1080-1081.



Kuncel & Hezlett (2010) *Current Directions in Psychological Science*

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Critical Thinking Definitions

- “Critical thinking is reflective and reasonable thinking that is focused on deciding what to believe or do” – Ennis (1985)
- “Critical thinking refers to the use of cognitive skills or strategies that increase the probability of a desirable outcome” – Halpern (1999)
- “Critical thinking, the ability and willingness to test the validity of propositions” – Bangert-Drowns & Bankert (1990)

Often Mentioned Critical Thinking Skills

- Law of large numbers
- Affirming the consequent
- Sample bias
- Control groups
- Type I versus Type II errors

Discriminant Validity

Cognitive Ability Measures					
	N	k	r_{obs}	SD_{obs}	SD_r
Critical Thinking Skills	6,461	19	**.48**	.14	.13
Critical Thinking Disp.	1,425	5	**.21**	.05	.00

Discriminant Validity

Openness to Experience					
	N	k	r_{obs}	SD_{obs}	SD_r
Critical Thinking Skills	647	3	**.24**	.11	.08
Critical Thinking Disp.	582	3	**.23**	.12	.09
Cognitive Ability			**.30**		

Predictive Validity

Grade Point Average					
	N	k	r_{obs}	SD_{obs}	SD_r
Critical Thinking Skills	2,876	12	**.27**	.10	.07
Critical Thinking Disp.	2,250	7	**.24**	.12	.10
Cognitive Ability			**.35**		

Predictive Validity

	Job Performance				
	N	k	r_{obs}	SD_{obs}	SD_r
Critical Thinking Skills	293	3	**.32**	.04	.00

Fong and Nisbett Results

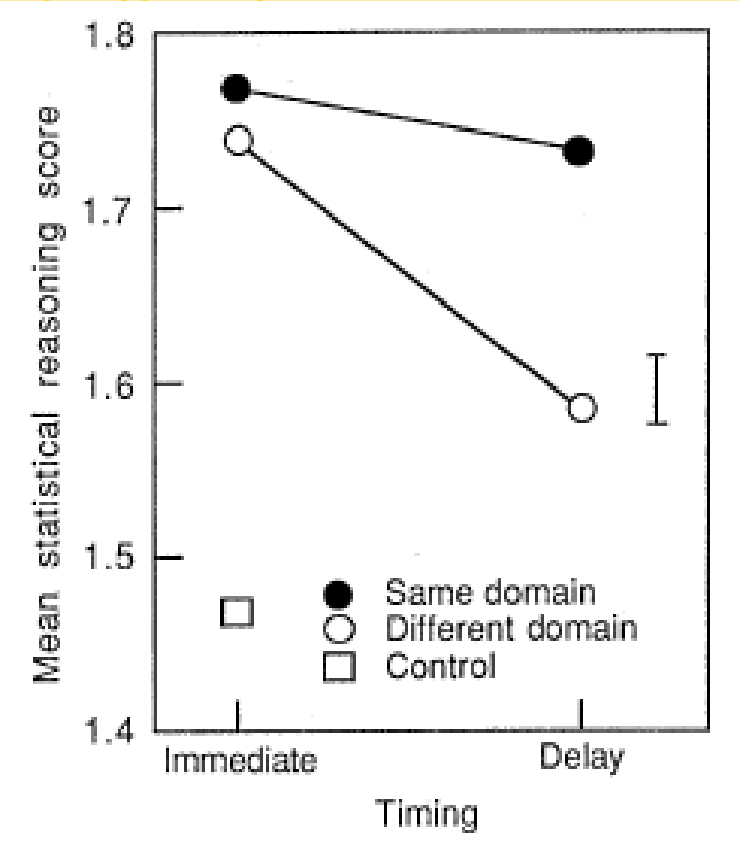

Fig. 1. Mean statistical reasoning score as a function of training and problem domain. Vertical bar represents one standard error of the mean ($N = 231$).

- Subjects trained on law of large numbers
- Given examples to help transfer of training
- Post tested to examine gains
- Note that the Figure reads "statistical reasoning"

Are these generic thinking skills?

Organized
Walk in Closet

Decked
Garage Attic
Storage

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Critical Thinking Skills NOT Used

- Law of large numbers

or

- Affirming the consequent
- Sample bias
- Control groups
- Type I versus Type II errors

2 Years Graduate Training Effect

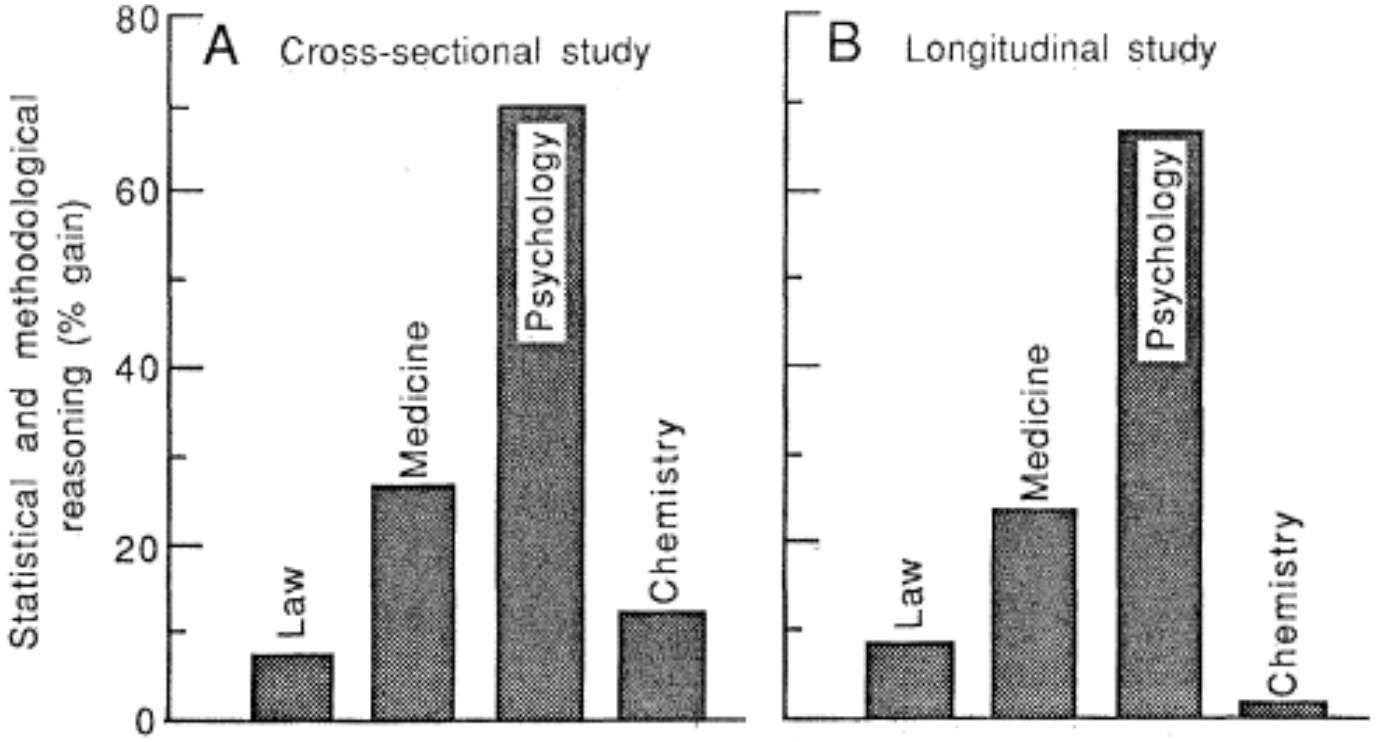


Fig. 2. Percentage of change in statistical and methodological reasoning score after 2 years of study as a function of graduate discipline. (**A**) The cross-sectional study examined first-year students and simultaneously enrolled third-year students. Sample sizes for first-year students were law, 213; medicine, 127; psychology, 25; and chemistry, 31. The sample sizes for third-year students were 50, 48, 33, and 26, respectively. (**B**) The longitudinal study examined the same students at the beginning of their first year and at the beginning of their third year. Sample sizes were law, 77; medicine, 87; psychology, 24; and chemistry, 18.

Lehman, Lempert, & Nisbett

Do we really believe that Chemistry PhDs don’t learn critical thinking?

What's going on?

Nisbett paper quote:

Test included "methodological reasoning dealing with different types of confounded variable problems, for example, self-selection problems (26), sample bias problems…" (p. 630)

What are self-selection and sample bias problems in chemistry?

Critical Thinking for Chemists is *Not the Same as* Critical Thinking for Social Scientists!

Critical Thinking for Engineers, Chemists, and Physical Scientists

- Zeroth Law of Thermodynamics: Thermodynamic equilibrium and temperature
- First Law of Thermodynamics: Work, heat, and energy
- Second Law of Thermodynamics: Entropy

Alternative Perspective

- Some people:
  - Effectively evaluate information
  - Know what information is lack or uninformative
  - Can readily decide on the best course of action
  - Make superior decisions
  - Can trouble shoot complex problems
- They are called experts and they do this by practice
- Deliberate practice is willful effort put toward trying to improve performance. It is hard work and takes time (10,000 hours)

So a Professor, Navy Seal, and Secret Service Agent Walk into a Firing Range…

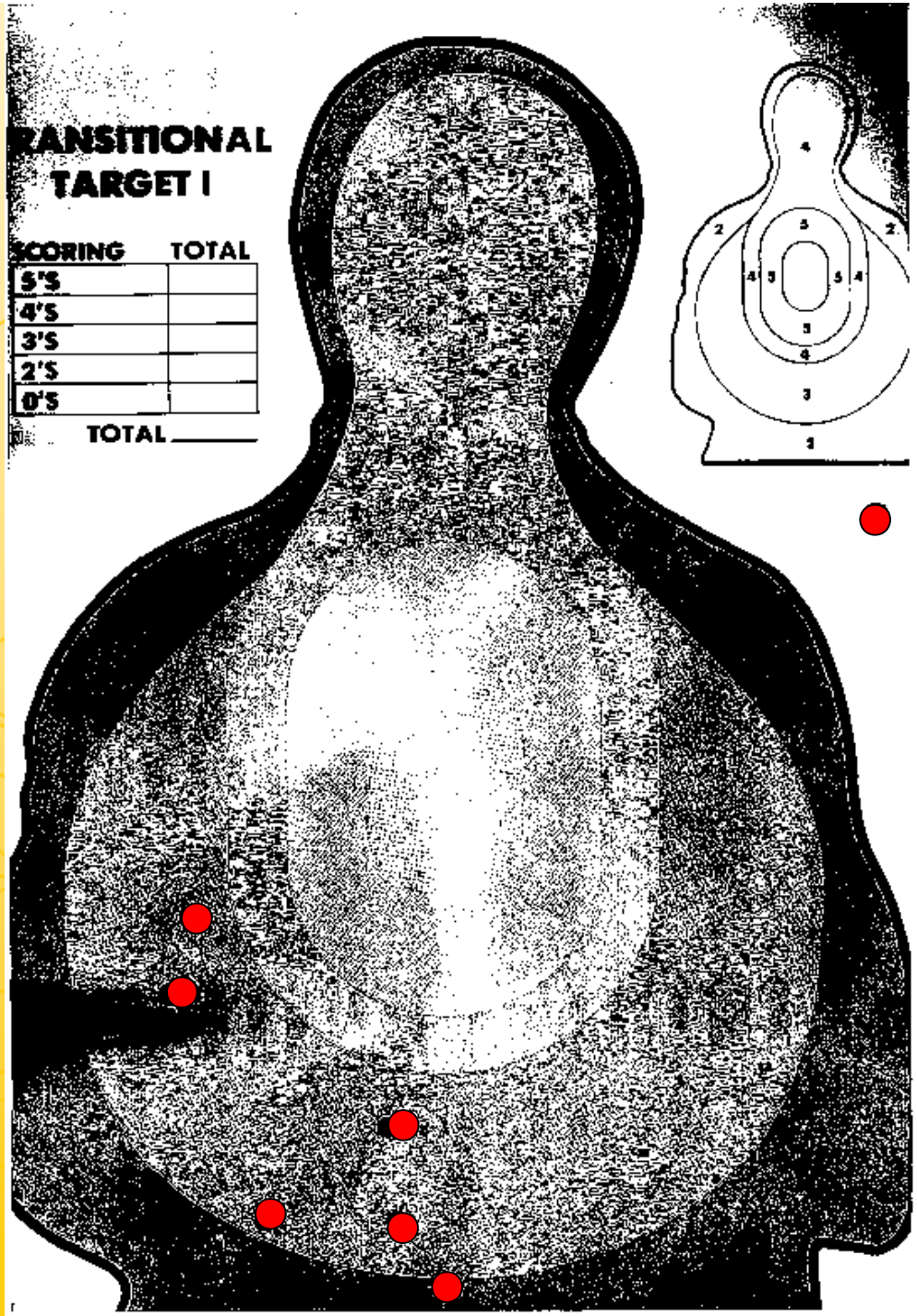
- Each fired 10 rounds with a short barreled .40 pistol at paper targets at a range of approx 48 feet.
  - Professor of Psychology
  - Lieutenant-Commander US Navy Seals
  - Special Agent with the US Secret Service

Professor of Psychology

Note: 4 complete misses, 3 were off the target entirely

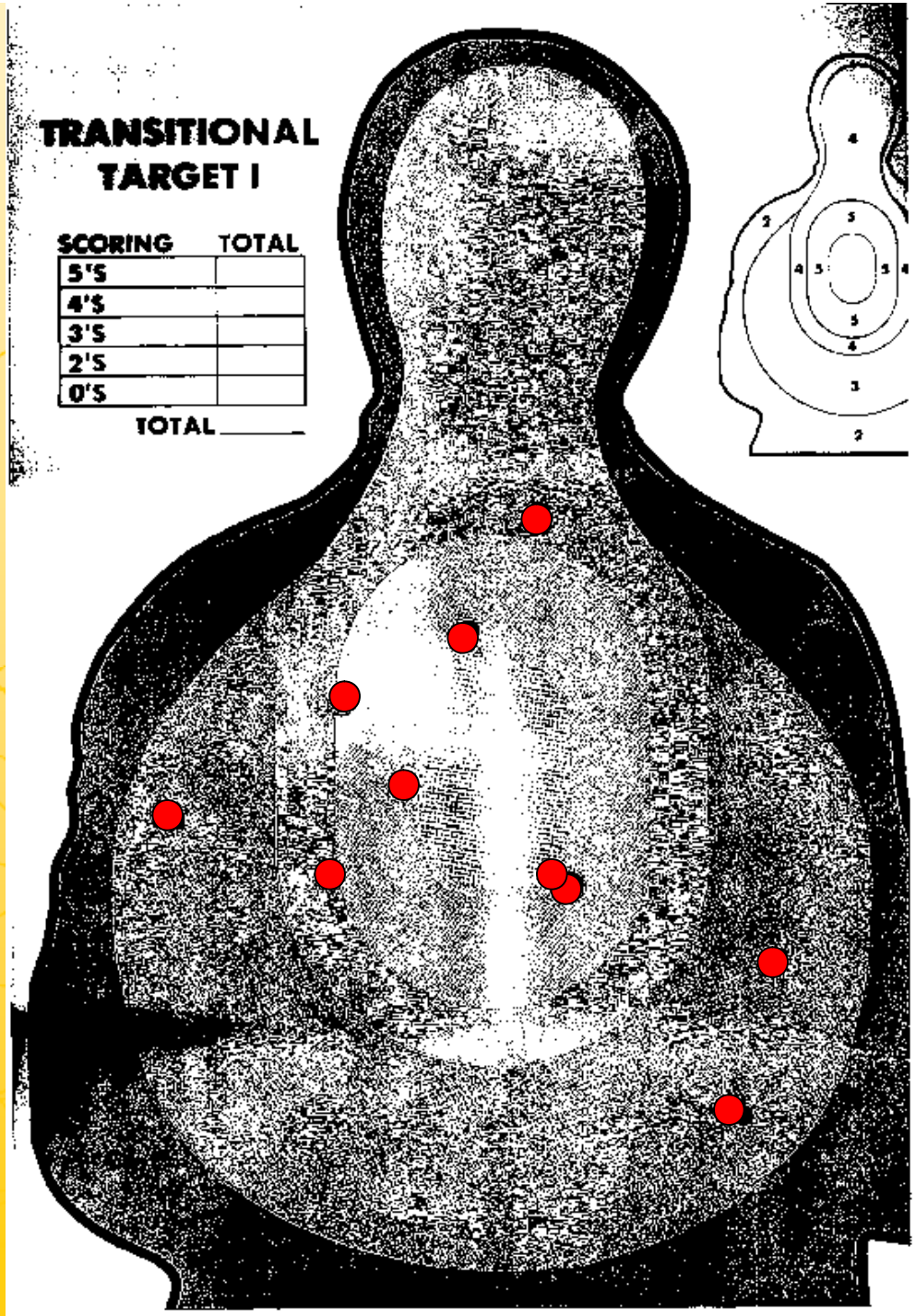
Note: Shots tend to fall to the bottom left of the target, a novice error

?



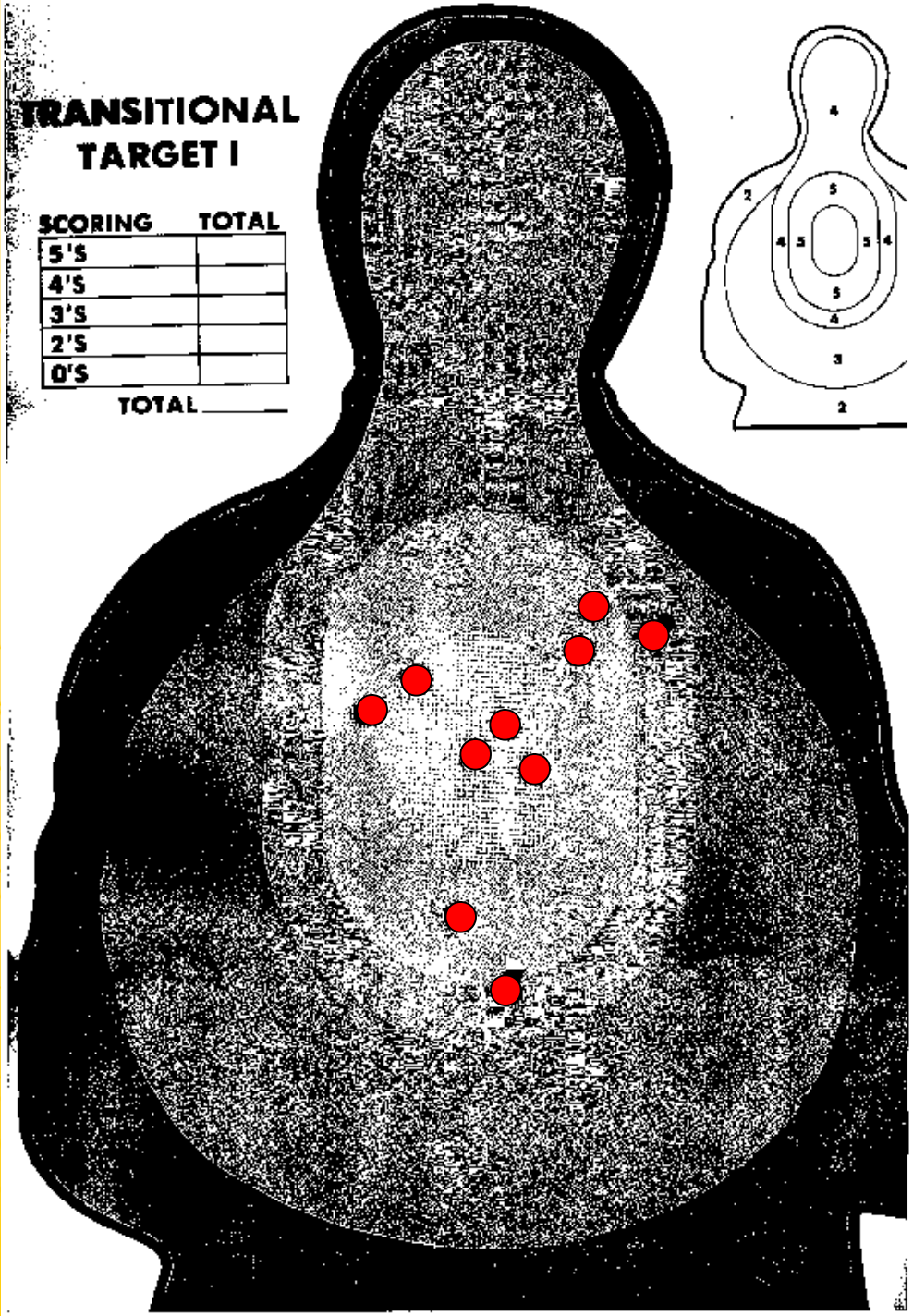
Lieutenant Commander US Navy Seals

Note: All 10 shots are on target, even at this range, and 7 are nicely in the center of mass.



Special Agent US Secret Service

Note: Wow.



Conclusion

- There is a finite set of critical thinking type skills that are specific but useful for a range of somewhat common tasks
- The decision to emphasize these skills will come at the expense of training other skills
- Additional research is needed before we know that training CT is more important for the economic health of the nation than training: reading, writing, math, civics, science, mechanical reasoning, and language skills.

Thank You

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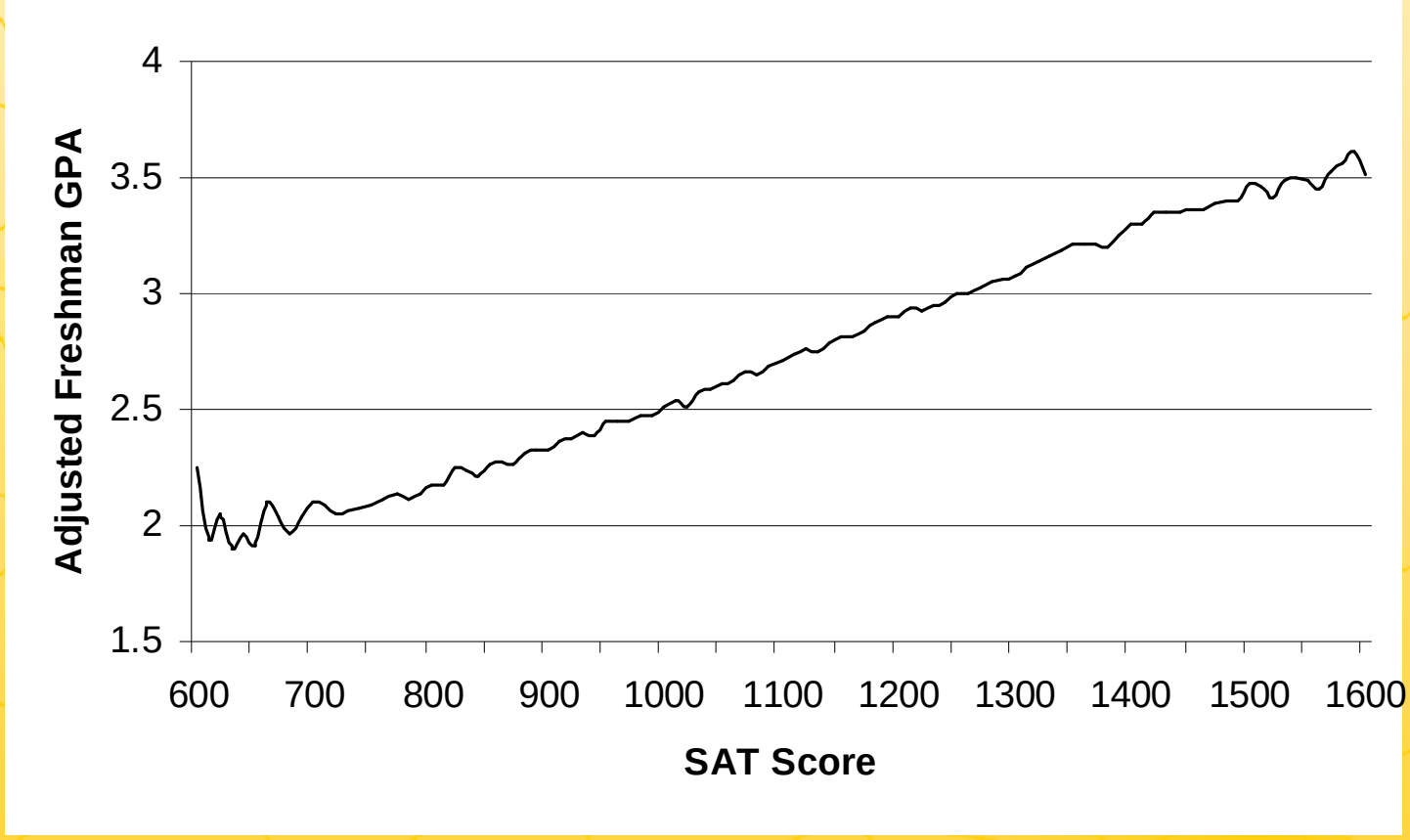
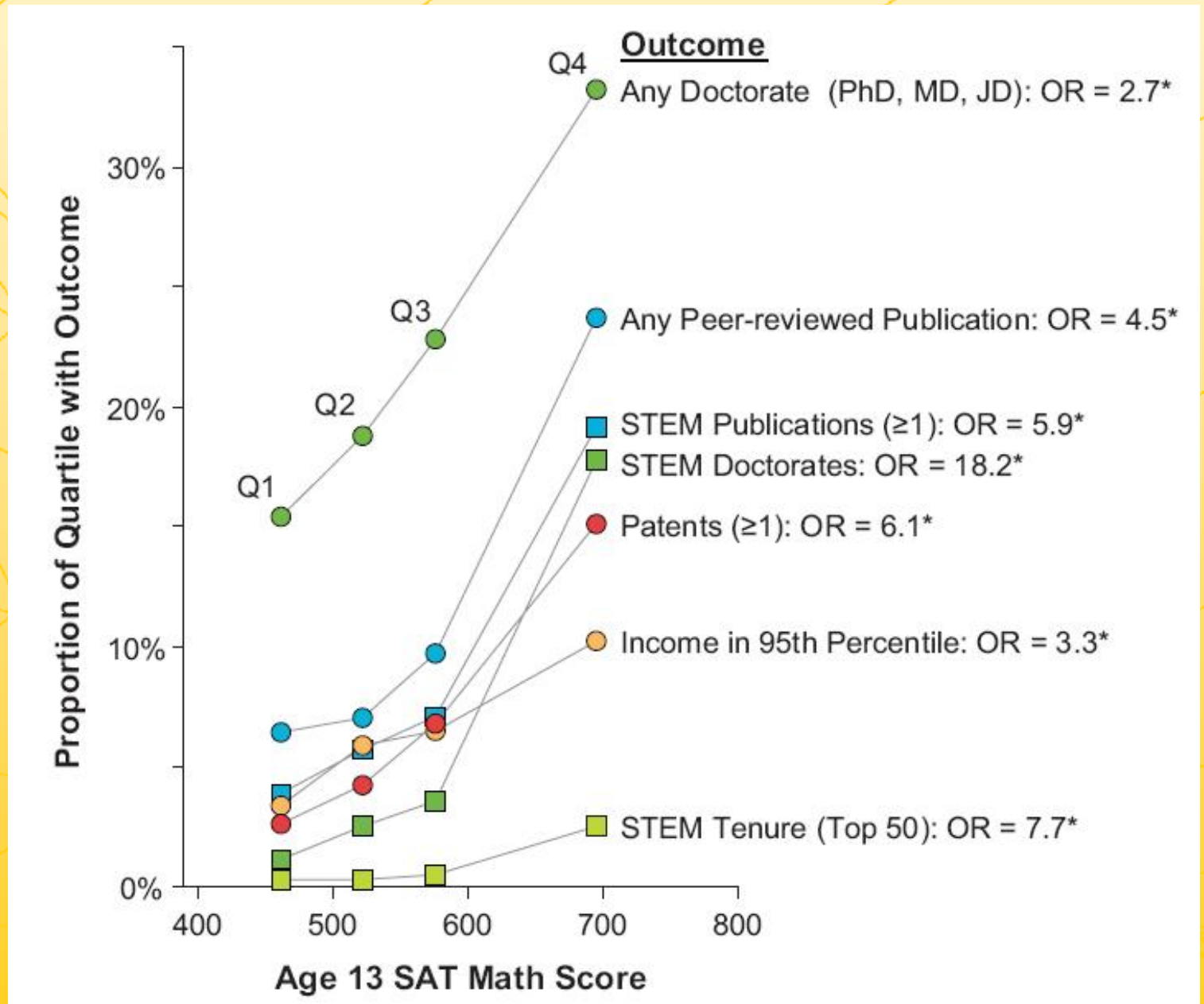
More is also better at school



- Arneson and Sackett (2009)



Lubinski (2009)