Measurement and Meaning of Critical Thinking

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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

Critical Thinking

- Typically presented as a broad, domain general skill that is used without domain specific skill or knowledge.
- This definition is incorrect and counterproductive.
- Critical thinking is best considered as a set of specific and isolated skills that are useful for some tasks that may or may not be useful for some jobs.

What kinds of basic evidence do we need?

- CT measures should strongly correlate with each other.
- CT measures should have appropriate correlations with other individual difference variables.
- CT measures should predict important outcomes ideally incrementally over existing constructs

This is a Large Hurdle

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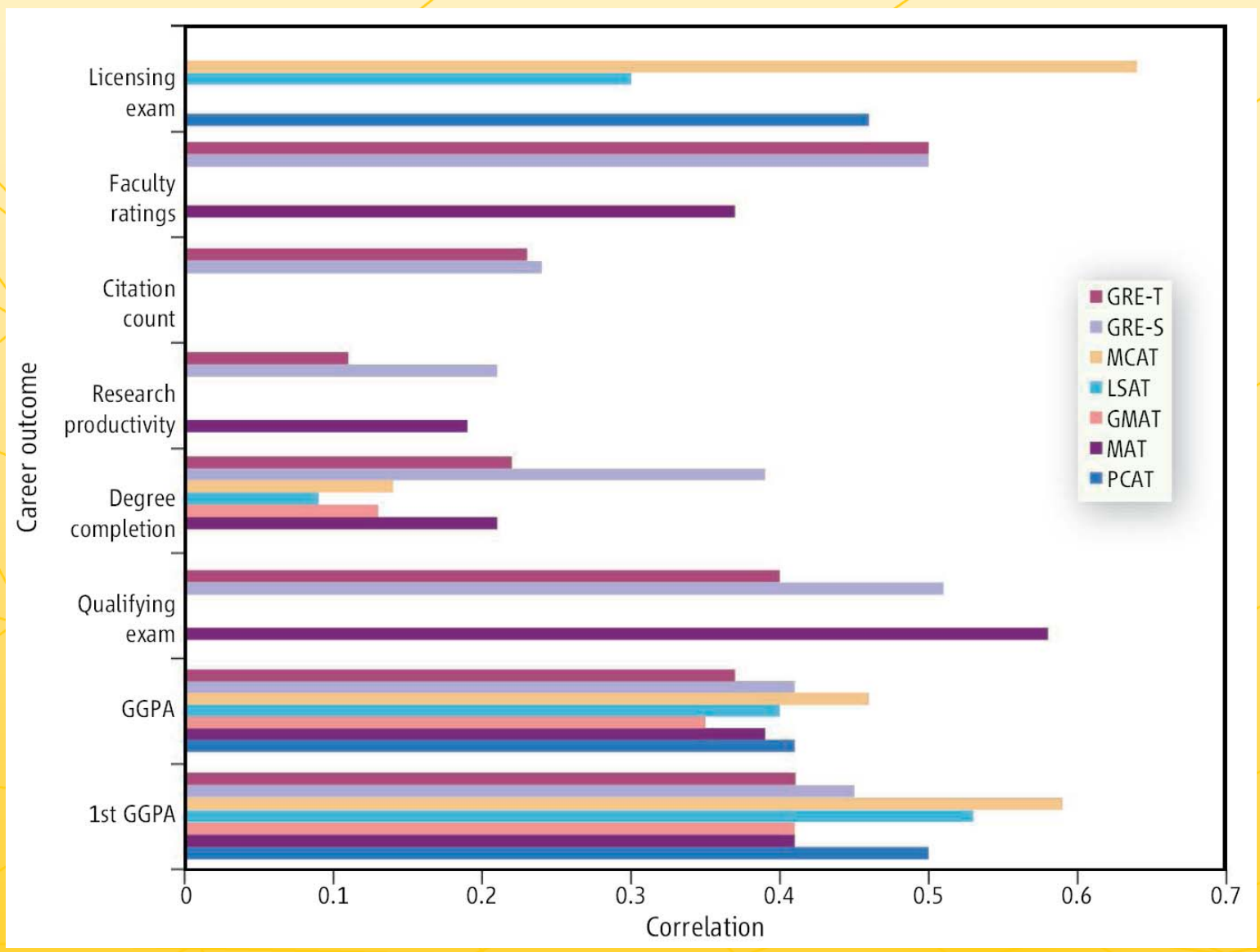

Kuncel & Hezlett (2007). *Science, 315,* 1080-1081.

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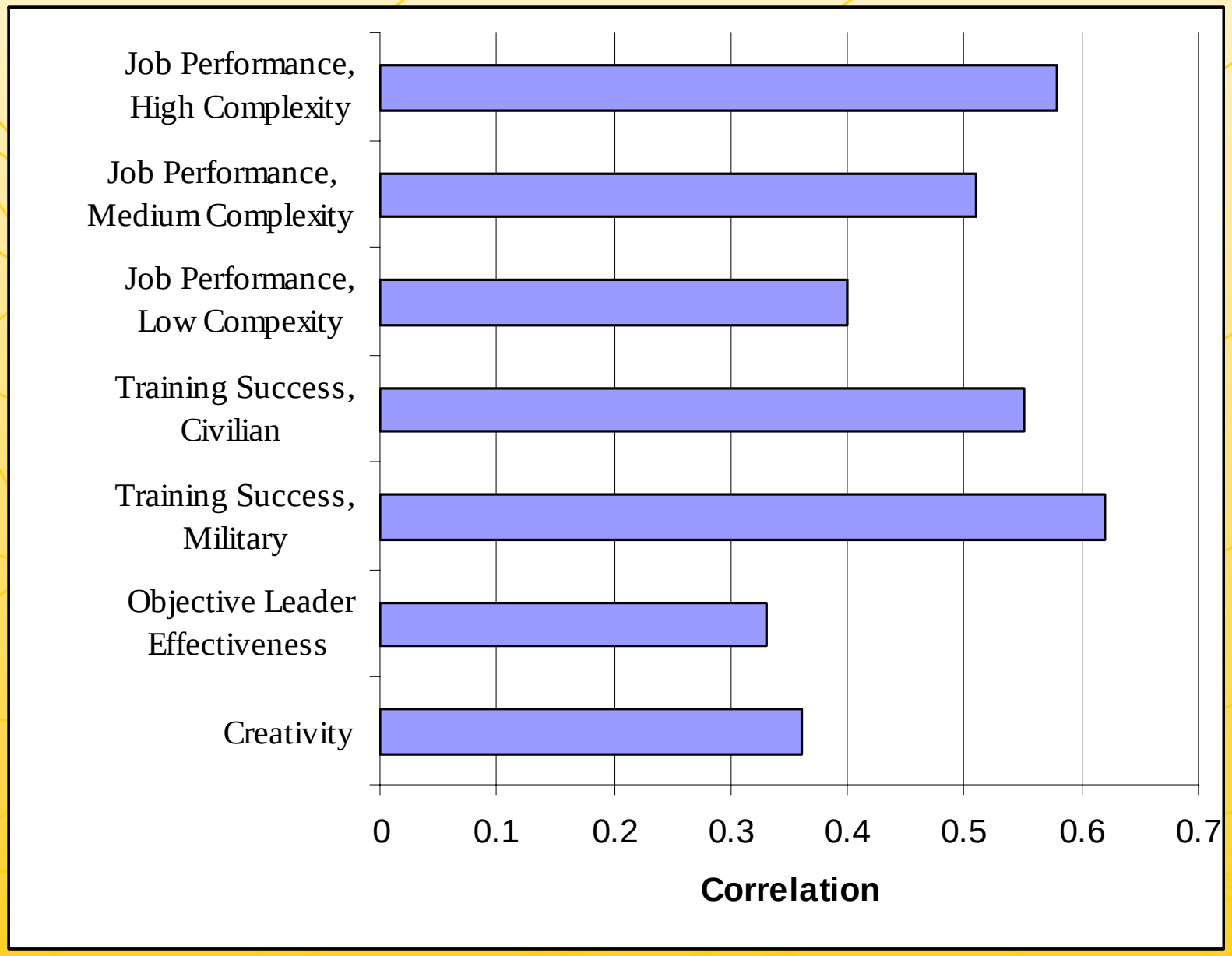

Kuncel & Hezlett (2010) *Current Directions in Psychological Science*

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Divorce

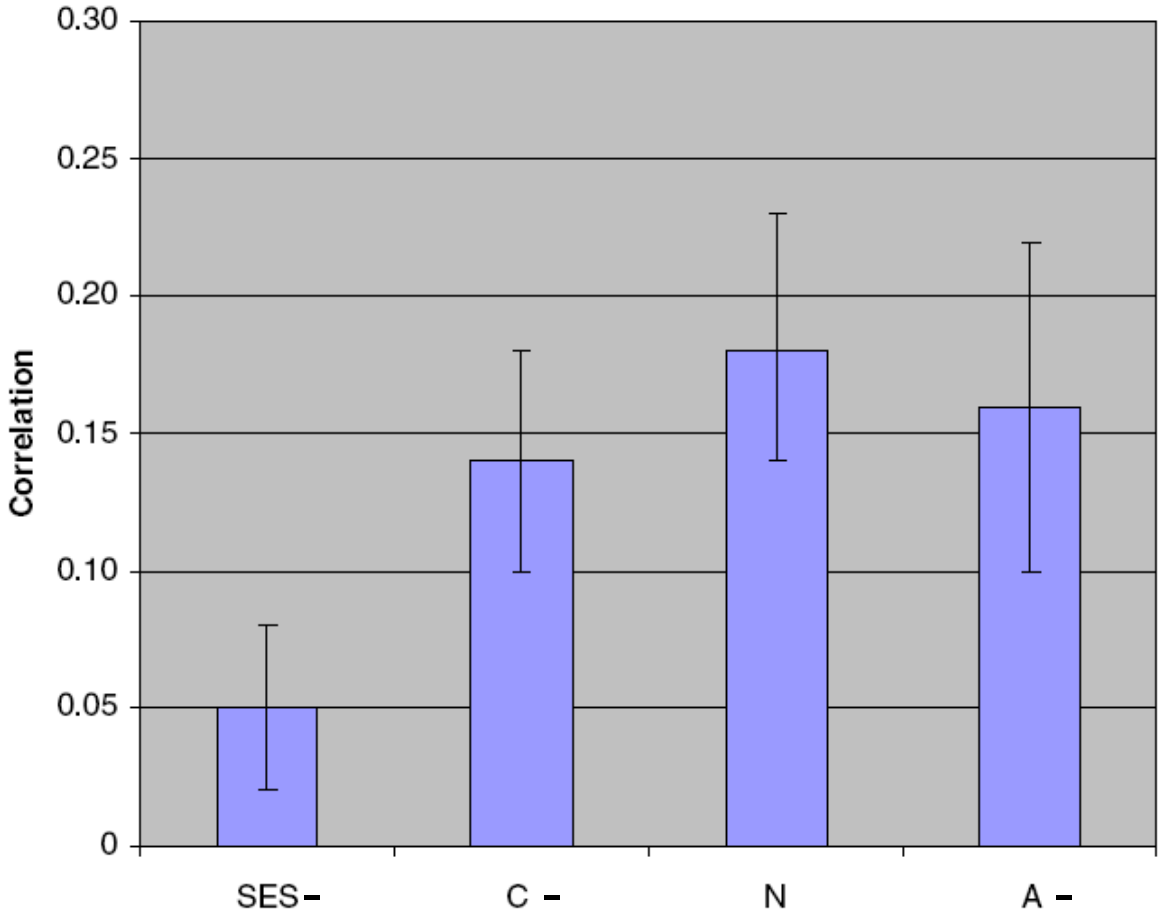


Fig. 2. Average effects (in the correlation metric) of low socioeconomic status (SES), low Conscientiousness (C), Neuroticism (N), and low Agreeableness (A) on divorce. Error bars represent standard error.

Roberts, Kuncel, Shiner, Caspi, & Goldberg (2007)

What kinds of advanced evidence do we need?

- CT should be trainable
- CT training gains should be predictive of important life outcomes
- CT training gains should be more strongly associated with important life outcomes than gains on other job relevant skills like
  - Being able to write coherently
  - Being able to use foundational math skills
  - Being able to read proficiently

Convergent Validity

	Critical Thinking Skills				
	N	k	r_{obs}	SD_{obs}	SD_r
Critical Thinking Skills	1,507	5	**.41**	.06	.03

Convergent Validity

Superstitious and Paranormal Beliefs					
	N	k	r_{obs}	SD_{obs}	SD_r
Critical Thinking Skills	497	5	**-.19**	.09	.00
Cognitive Ability	1,690	7	**-.13**	.18	.16

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**		

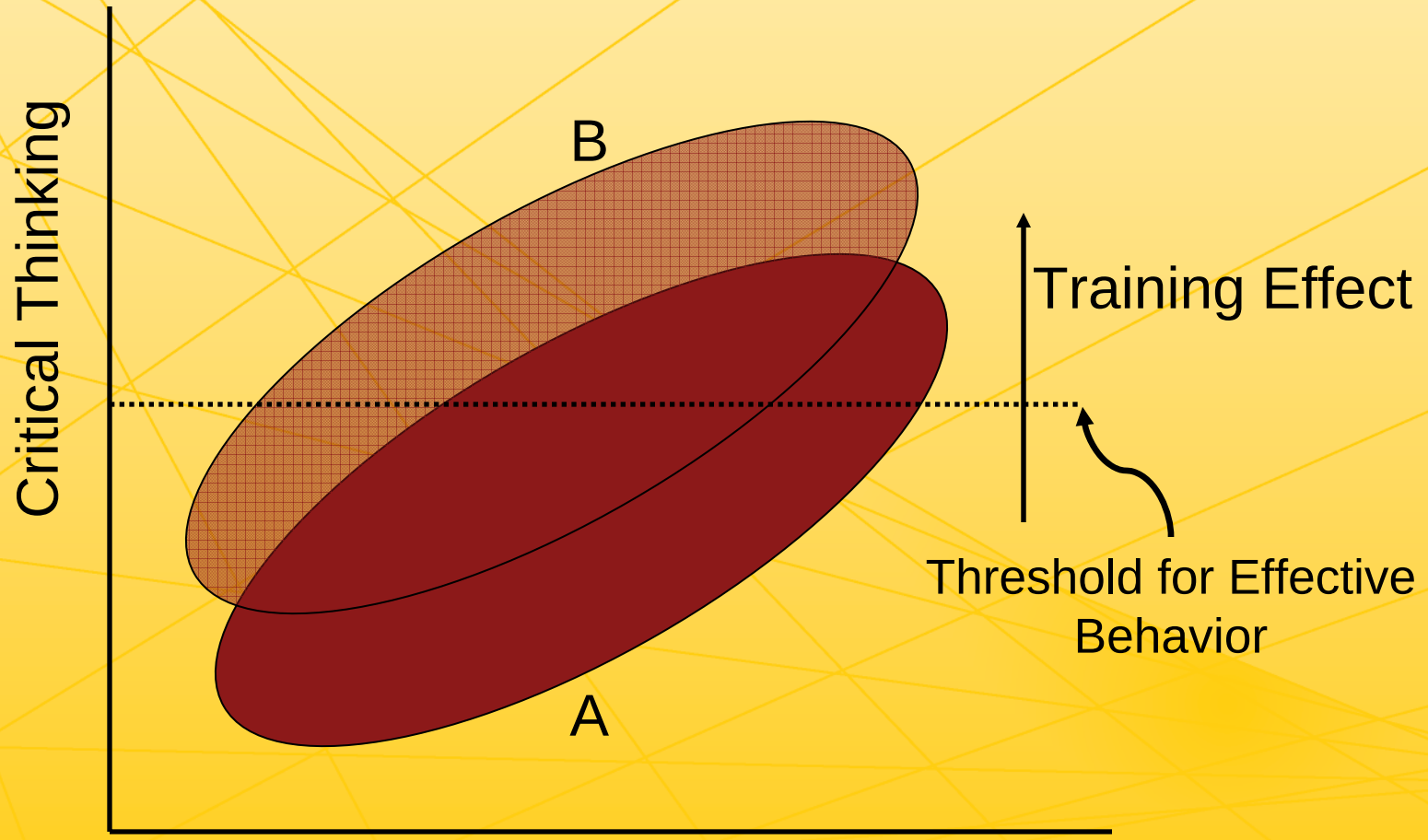
Predictive Validity

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

If it looks like a duck
and walks like a duck
and quacks like a duck
is it a duck?

General Mental Ability and Critical Thinking

Hypothetical Training Example



Example

- Grossbach and Kuncel (2010) reported that SAT and ACT scores were very strongly correlated with nursing licensing examinations NCLEX-RN.

Treatment Effects vs. Individual Differences Correlations

Instruction on CT Can Produce Gains

- Training on CT measures produces substantial gains
- College instruction is associated with modest CT gain
- College involvement produce very low to zero gains on CT measures
- Explicit instruction on CT skills produces transferable gain to task requiring the same skill

Fong and Nisbett Results

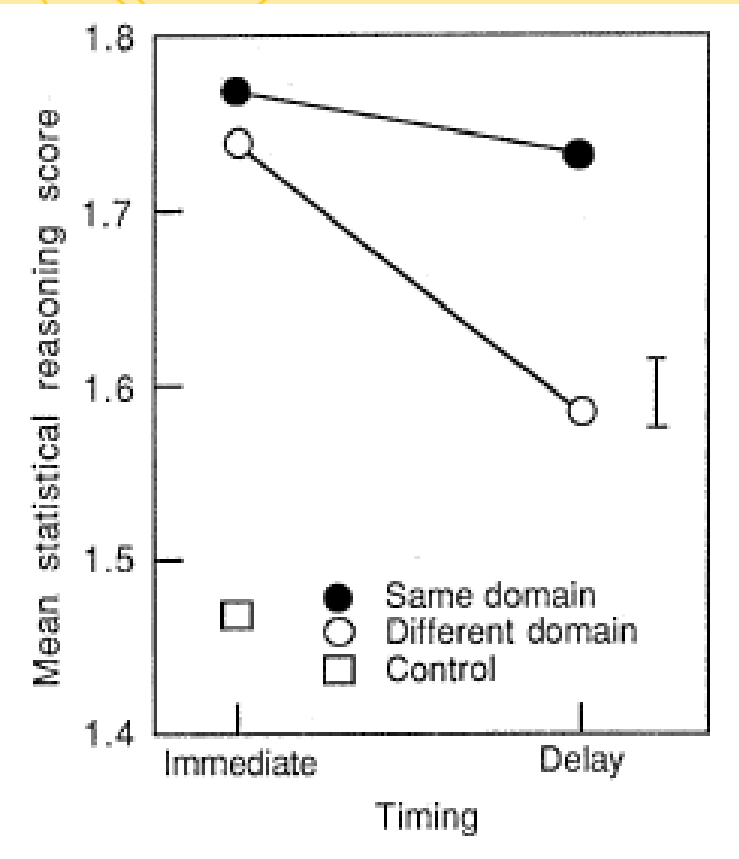


Fig. 1. Mean statistical reasoning score as a function of training and problem domain. Vertical bar represents one standard error of the mean ($N = 231$).

- 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

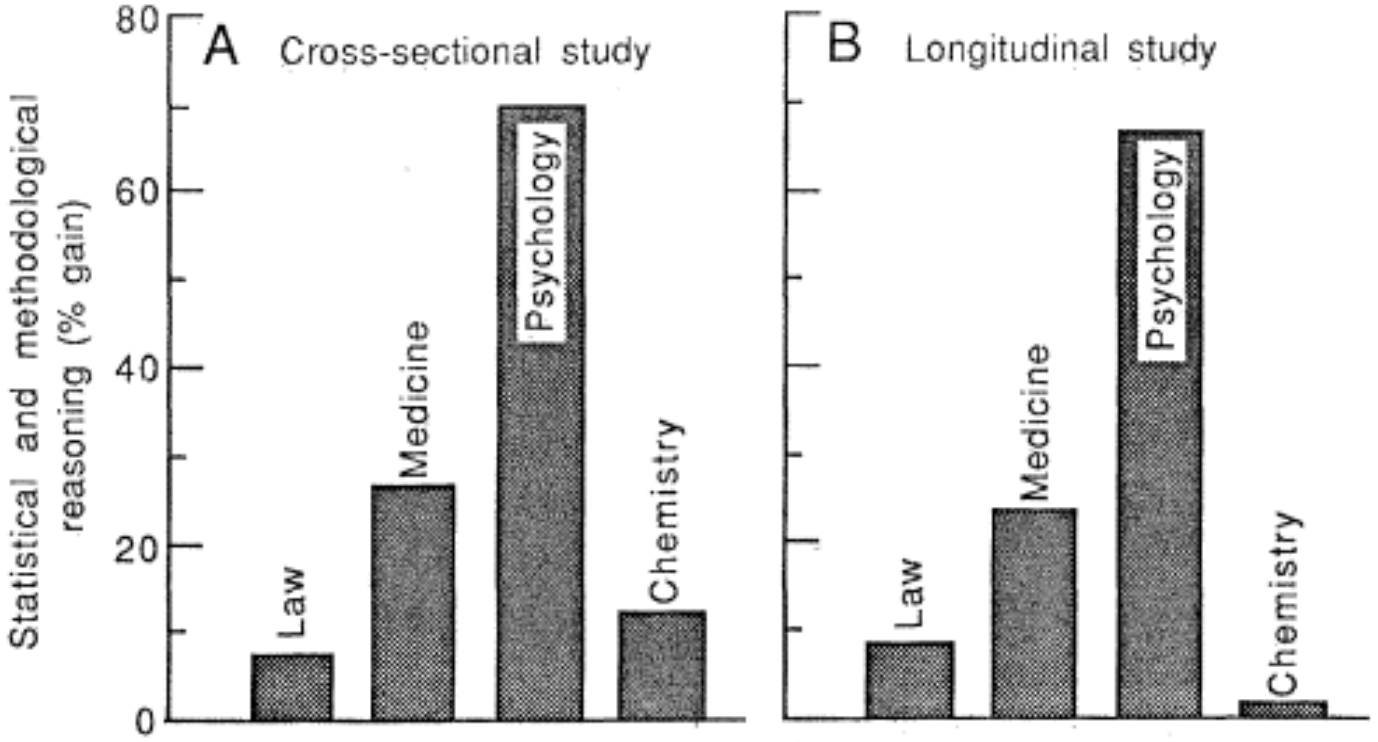

Fig. 2. Percentage of change in statistical and methodological reasoning score after 2 years of study as a function of graduate discipline. (**A**) The cross-sectional study examined first-year students and simultaneously enrolled third-year students. Sample sizes for first-year students were law, 213; 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 Different Than Critical Thinking for Social Scientists!

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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

Results and Implications

- It is possible to:
  - train specific skills that aid in making good judgments in some situations
  - make these specific skills generalize, to a degree to other situations that require the same skill.
- Previous research does not demonstrate:
  - it is possible to train a universally effective “CRITICAL THINKING SKILL” or to “Teach REASONING” across all domains and situations
  - such training has long term positive career or life implications
  - they are useful skills but specific to particular problems.

Key and Unavoidable Tradeoffs

- What best serves our society:
  - Specific training in one or more critical thinking skills?
  - Additional practice and feedback on basic skills (deliberate practice)?
  - Teaching additional field specific knowledge not currently covered by the curricula?

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)

Key Expertise Findings

- Deliberate practice is critical in refining skills including judgment and critical thinking.
- Good training and coaching can be critical.
- Experts and novices often display systematic differences in how they approach tasks.
- Experts also develop specific and sometimes extra-ordinary capacities that allow them to be more accurate, faster, or both.
- Novices will often display specific biases or errors in behavior that they learn to eliminate or control with practice and coaching.

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

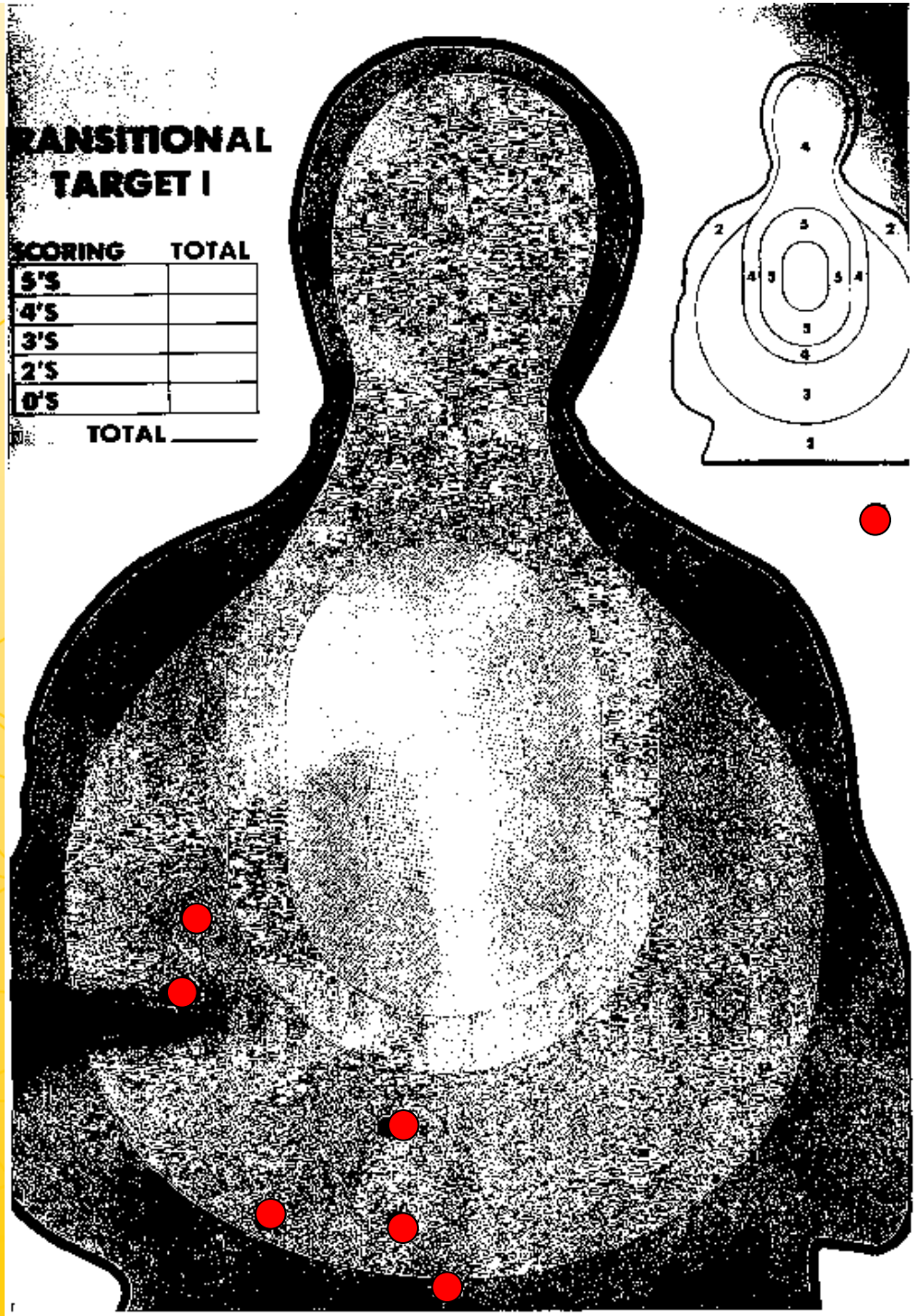
- Each fired 10 rounds with a short barreled .40 pistol at paper targets at a range of approx 48 feet.
  - Professor of Psychology
  - Lieutenant-Commander US Navy Seals
  - Special Agent with the US Secret Service

Professor of Psychology

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

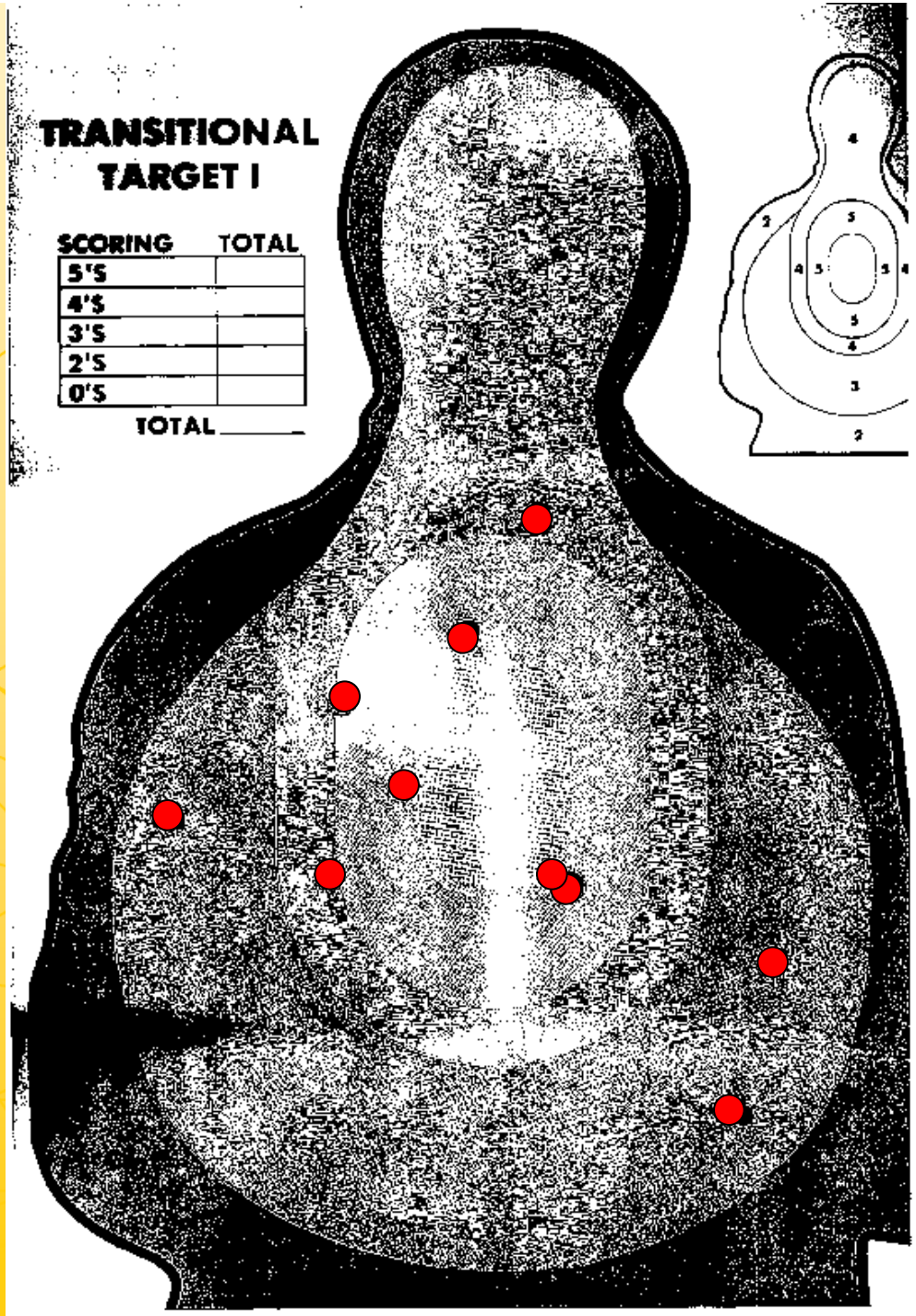
Note: Shots tend to fall to the bottom left of the target, a novice error

?



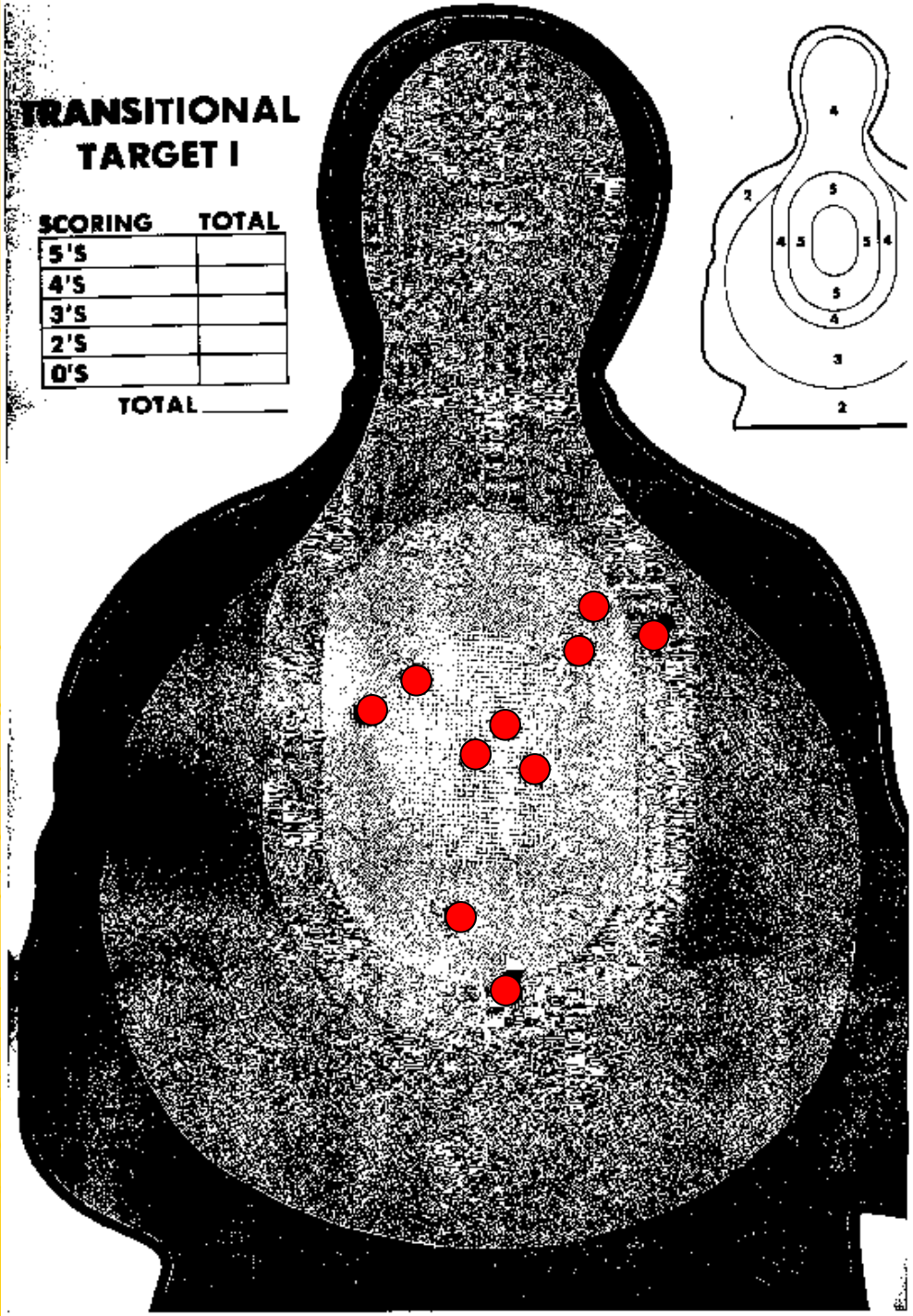
Lieutenant Commander US Navy Seals

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.

Overheard Starbucks Conversation

"But, like, you know that, after I was sober, I calmed down and wasn't so mad at him anymore."

"Why not?"

"Because it's total soap opera drama, I expect him to change and spend more time with me but it's really my fault. I put so much time into *us* but I know he won't."

"Oh, OK?"

"I should just move on but I feel like I already put so much into *us* I should keep going. That's totally stupid because it's just wasting more time, it's not good sense. It's called something I think."

"The sunk-cost decision bias."

"Ya, that's it!"

Thank You

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