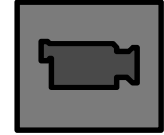


# Using Pseudoscience to Teach Scientific Thinking

1



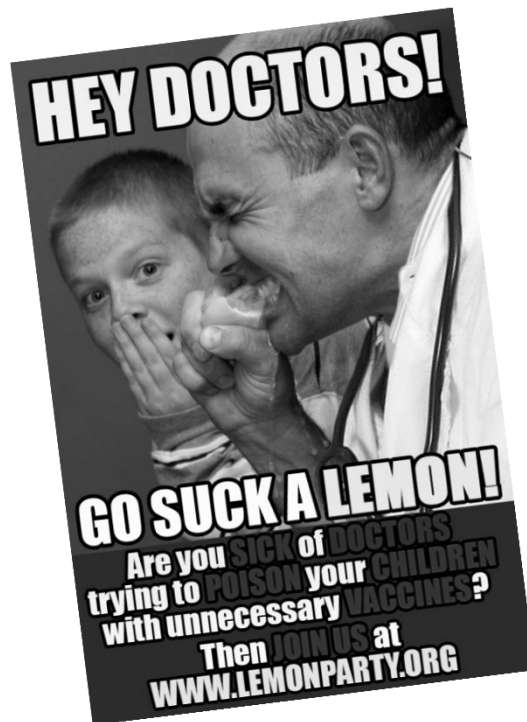
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<https://uwinnipeg.ca/~clark/sci/epist>



# Outline

2



- Prevalence of pseudoscience
- Negative Consequences
- Psychology of Pseudoscience
- Interventions
- Challenges

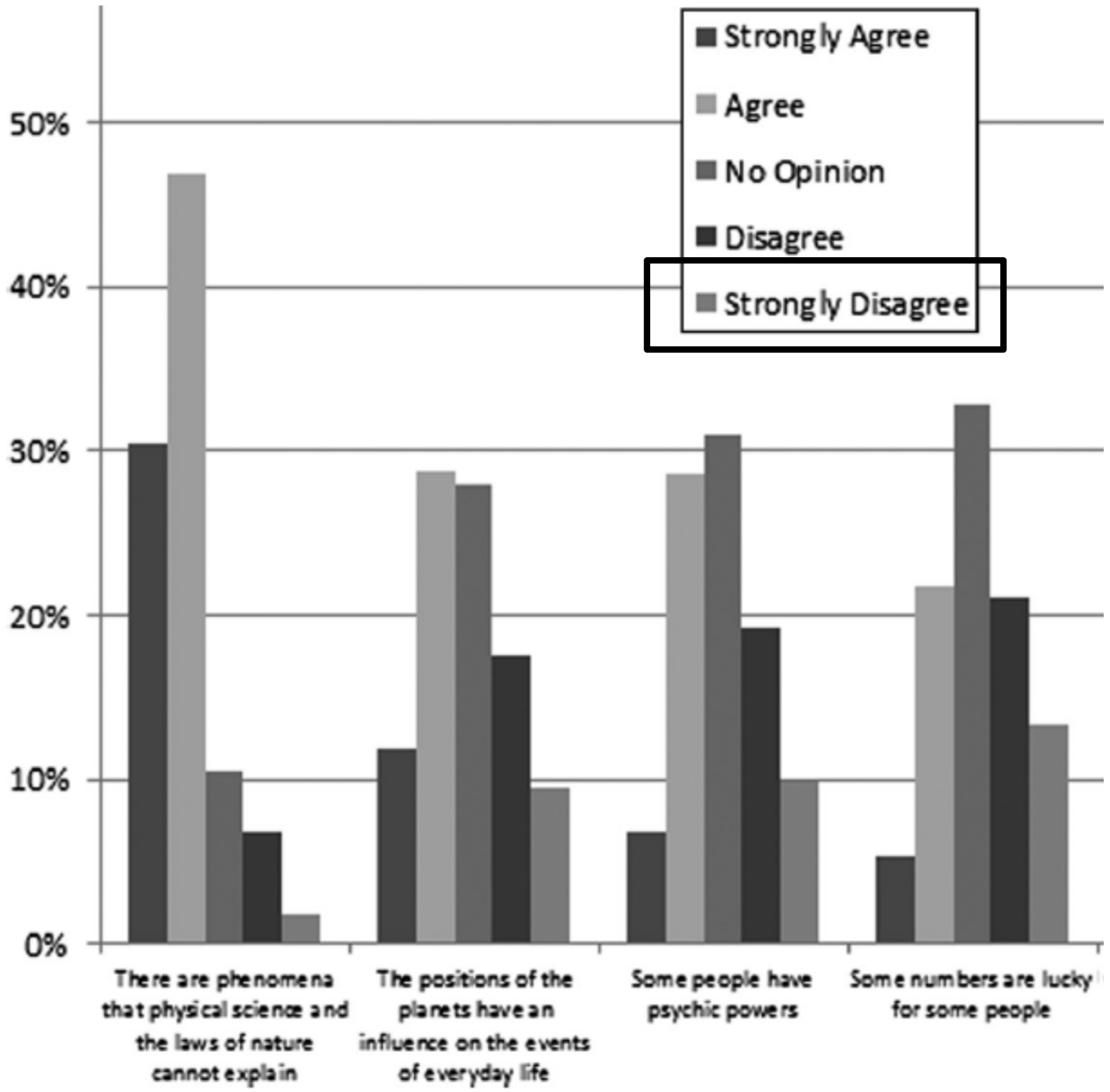
I worry that, especially as the Millennium edges nearer, pseudo-science and superstition will seem year by year more tempting, the siren song of unreason more sonorous and attractive.  
(Carl Sagan)

"Science is a way of trying not to fool yourself." (Feynman)

# Prevalence

3

- Nearly two-thirds of adults in a national Pew (2009b) survey reported at least one of the following:
  - 24% reincarnation
  - 26% “spiritual energy” in physical entities, such as trees
  - 25% astrology
  - 16% “evil eye”
  - 29% personally communicating with the dead
  - 18% seeing or experiencing a ghost
  - 15% visiting a fortuneteller or psychic



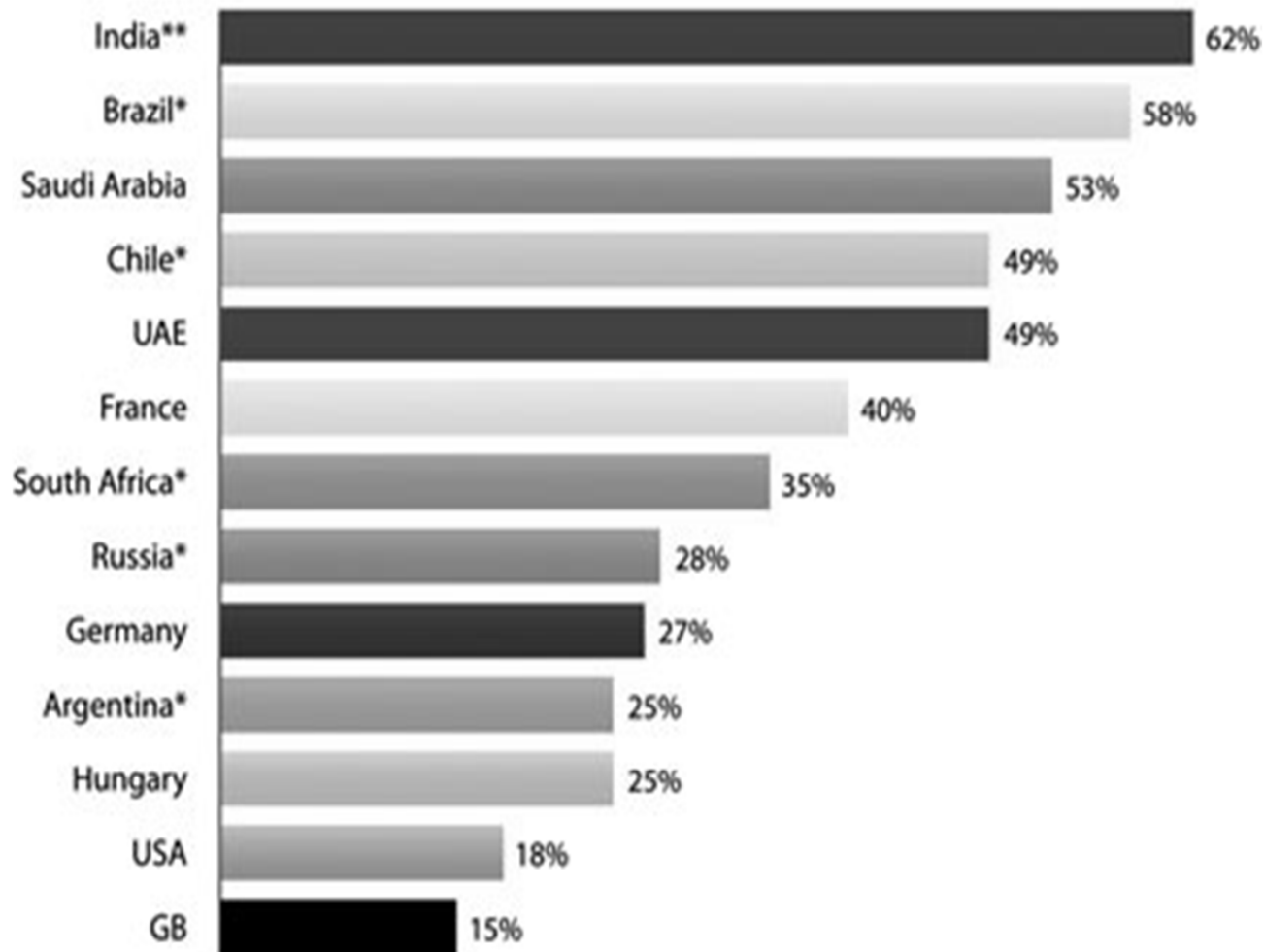
Impey et al (2012): survey of more than 11,000 students over 22 years

# Lobato et al (2014)

5

- Pseudoscience
  - 42% Childhood vaccines are causal factor in autism.
  - 38% Homeopathy is as valid as medical treatment for serious illnesses.
  - 58% Reiki healing, known as Palm healing heals the body.
- Conspiracies
  - 67% US government was involved in events of 11 September 2001.
  - 32% Barack Obama is a native born US citizen. (reversed)
  - 29% John Lennon was the target of an assassination conspiracy.
- Paranormal
  - 71% Some humans can move objects using mind or predict future.
  - 55% A full moon causes people to behave oddly.
  - 67% Astrology explains the behaviors and personality of people.
  - 63% Some crystals, precious metals, magnets, have mystical properties.

## 'I trust homeopathic medicine' - % agree



Base: Individuals aged 18+

\* Respondents from urban areas only

\*\* Respondents from ABC socio-economic groups in urban areas

Source: Global TGI

Homeopathy:  
Curative  
powers of  
highly diluted  
substances (1  
part per  $10^{60}$ )

- **Increasing?**

Religious or  
Mystical Experience

1962      22

1976      31

1994      33

2006      47

Belief in  
Astrology

18-29      30

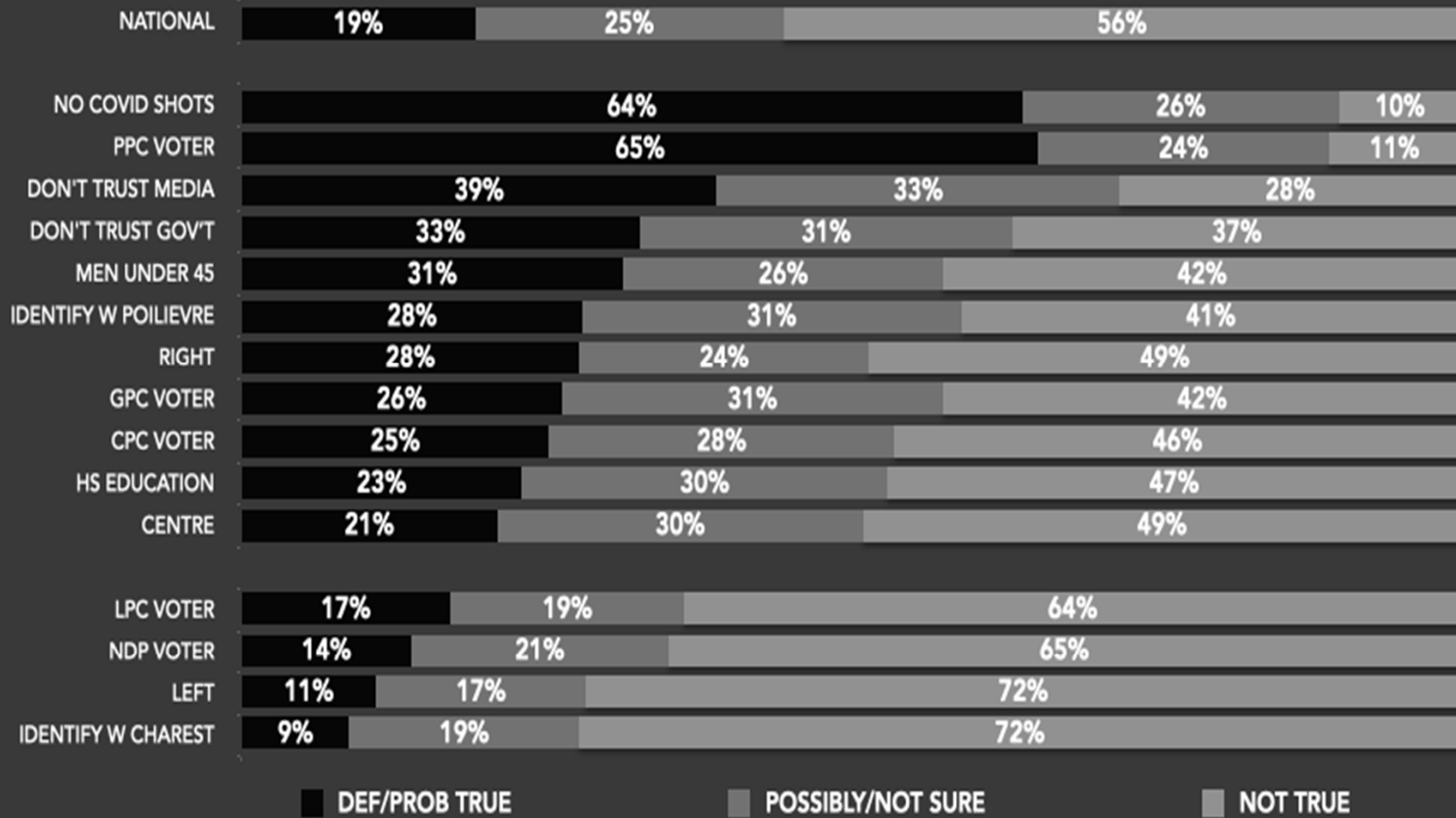
30-49      26

50-64      23

65+      18

- **COVID PseudoScience**
- Vaccine
  - Causes cancer, miscarriages, infertility, heart problems, neurological damage, prion disorders, blood clots, ...
  - Virus mutates so fast vaccine cannot work
  - Alters human DNA, turns people into monkeys
  - Contains magnetic ingredients
  - Leads to disease enhancement, COVID super strains, ...
  - “will unleash a global catastrophe”
- Source: 5G
- Treatments: Ionization, Homeopathy, Cow urine, Cocaine, Chlorine dioxide, ...

**COVID VACCINES HAVE KILLED MANY PEOPLE,  
WHICH HAS BEEN COVERED UP**



# Negative Consequences

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- **Pseudoscience & COVID**

(Fasce et al, 2020)	PB	CCB
Pseudoscience	.69	.71
Paranormal Beliefs		.57
COVID Conspiracy Beliefs		
(Gratz et al, 2021)	CPs	SD
General Pseudo	.61	-.30
COVID Pseudo		-.34
Social Distancing		

- Makayla Sault
  - Left chemotherapy treatment for cancer
  - Alternative treatment at Hippocrates Health Institute
    - Licensed as massage establishment
    - Sued for practicing medicine without a license
- Steve Jobs
  - Delayed medical treatment 9 months
    - Tried “to cure himself through acupuncture sessions, drinking special fruit juices, visiting ‘spiritualists’ and using other treatments he found on the internet.”
- Decreases trust in conventional science & medicine

# PSYCHOLOGY OF PSEUDOSCIENCE

12

- No sharp definition like triangle, even number, ...
  - Prototypical view (Lilienfeld, 2005)
    - Rely on anecdotes and testimonials
    - Emphasize confirmation rather than refutation
    - Ad hoc hypotheses immunize claims
    - Fails to build on existing science
    - Lacks self-correction, stagnant
    - Burden of proof put on skeptics, not proponents
    - Evade peer review
    - Jargon gives facade of science
    - Fail to specify settings under which claims do not hold
  - Two Examples
    - Homeopathy
    - Therapeutic Touch

- **Homeopathy**

- Implausible mechanisms
  - Water retains memory
- Archaic concepts: “like cures like”
- Anecdotal evidence
- Confirmation bias
- Equals placebo in test trials
  - Unless not double-blind
- Questionable “authorities”
- Regression to mean
- ...



## • Therapeutic Touch

- Non-contact energy healing therapy
- Restores harmony to person's energy fields
- Based on ancient practice
- Emily Rosa study
  - 44% success
  - “experimental setting interferes with energy fields”
  - “only works with believers”



- **Common psychological component?**
  - Various unsubstantiated beliefs correlated
- Lobato et al (2014): Measured three types of false beliefs in 455 university students
  - Pseudoscience, Conspiracy, Paranormal (slide #5)



# Lobato Results

Table 2. Correlations among the different types of beliefs

	Paranormal	Conspiracy	Pseudoscience
Paranormal	–	.52	.36
Conspiracy		–	.49
Pseudoscience			–

*Note:*

*N* = 455.

- Lindeman & Aarnio (2006)
  - Measured diverse pseudoscientific beliefs and possible predictors in 3,261 respondents, Finland, ~24 years old

Table 1. Correlations between paranormal beliefs

	1	2	3	4	5	6	7	8	9	10	11	12
1. Spiritualism												
2. Extraordinary life forms	0.70											
3. Precognition	0.64	0.63										
4. PSI	0.65	0.63	0.61									
5. Witchcraft	0.62	0.72	0.59	0.62								
6. Religion	0.42	0.41	0.37	0.31	0.44							
7. Amulets	0.48	0.43	0.46	0.40	0.36	0.15						
8. Rituals	0.39	0.34	0.39	0.31	0.30	0.15	0.64					
9. Omens of luck	0.29	0.33	0.34	0.28	0.26	0.16	0.48	0.42				
10. Astrology	0.56	0.52	0.64	0.50	0.44	0.22	0.50	0.40	0.42			
11. Lunar effects	0.52	0.51	0.50	0.45	0.44	0.21	0.49	0.43	0.32	0.51		
12. Feng shui	0.48	0.43	0.42	0.41	0.34	0.13	0.47	0.39	0.30	0.51	0.46	
13. Food and health	0.49	0.40	0.44	0.39	0.36	0.22	0.40	0.34	0.23	0.49	0.51	0.54

- Belief in conspiracy theories predisposes people to accept even fictional ones!

- Red Bull

- Red Bull contains illegal drugs to increase desire for it.
- 23 year old Klaus Weber died from drinking too much Red Bull.

- Correlation of False & Fictitious conspiracies:  $r = .86$

Variable	$\beta$	$t$	$p$
Belief in general conspiracy theories	.45	8.08	<.001
Paranormal beliefs	.15	2.57	.011
Crystallised intelligence	-.11	-2.02	.044
Self-esteem	-.09	-1.61	.109
Superstitious beliefs	.08	1.51	.131
Conformity	-.05	-0.82	.415

# Psychological Processes

Predictors	Magico-religious beliefs	
	$\beta$	$r$
Intuitive thinking	0.25**	0.37***
Humanism	0.23***	0.33***
Analytical thinking	-0.17***	-0.19***
Instability	0.14***	0.20***
Peer attitude	0.10***	0.24***
Parental attitude	0.09***	0.20***
Gender	-0.09***	-0.19***
Negative life events	0.08***	0.16***
Behavioural inhibition	-0.07**	0.12***
Affective attention	-0.05*	0.14***
Desire for control		-0.07**
Behavioural activation		0.18***
Age		0.02

- Intuitive Thinking
  - I like to rely on my intuitive impressions
- Humanism
  - Unity between nature and human beings
- Analytical Thinking
  - I enjoy solving problems that require careful, logical analysis

# Swami et al. (2014)

- 990 British residents
- Belief in Conspiracy Theories & Thinking Style
  - Rational: I enjoy problems that require hard work.
  - Intuitive: I often use instinct when deciding on an action.

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	B
Rational thinking style	-.42
Intuitive thinking style	.26
Emotional thinking style	.13
Imaginative thinking style	.16
Actively open-minded thinking	-.13
Need for cognition	.05
Need for closure	.05

Table 3. Predictors of epistemically unwarranted beliefs

Predictors	Belief survey	
	$\beta$	$t$
Gender	-.13	-2.92**
RA	-.24	-5.47***
NFC	.12	2.46*
DOC	.12	2.42*
CORE	-.35	-8.33***
Extraversion	-.15	-3.23**
Agreeableness	.08	1.74
Conscientiousness	-.05	-1.19
Openness	-.07	-1.58
Neuroticism	-.11	-2.50*

Note:  $N = 455$ .

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

CORE, core ontological confusions; RA, religious affiliation;  
NFC, need for cognition; DOC, desirability of control.

Gender coded such that 1 = male and 2 = female.

Religious affiliation coded such that 1 = non-religious and 2 = Christian.

## Lobato et al (2014)

- NFC: I prefer complex problems.
- DOC: I like control over what I do.
- CORE: Stars live in the sky.

# INTERVENTIONS

22

- Scientific knowledge does not prevent false beliefs
- Individual classes limited benefit
- Pseudoscience Courses

# Impey et al (2012)

23

- Survey
  - 11,000 undergraduate students over 22 years
  - Measured knowledge and attitudes to science and various pseudoscience and superstitious beliefs
  - ***“Nonscientific ways of thinking are resistant to formal instruction, changing surprisingly little over the course of a college career that typically includes three science courses.”***
  - ***“Challenge for educators*** who seek to improve low levels of science literacy among many college graduates and members of public.”

# Impey et al. (2012)

24

- Average science knowledge scores as a function of belief in unscientific phenomena

Science Literacy Score  
(max = 15)

Unscientific  
Phenomena

Agree	10.9	n = 1457
Disagree	11.7	n = 1599

# Lehman & Nisbett (1990)

25

- Some evidence general competencies grow from first to last year of university (% change below)
- Specific to different disciplines?
- Fail to decrease acceptance of pseudoscience?

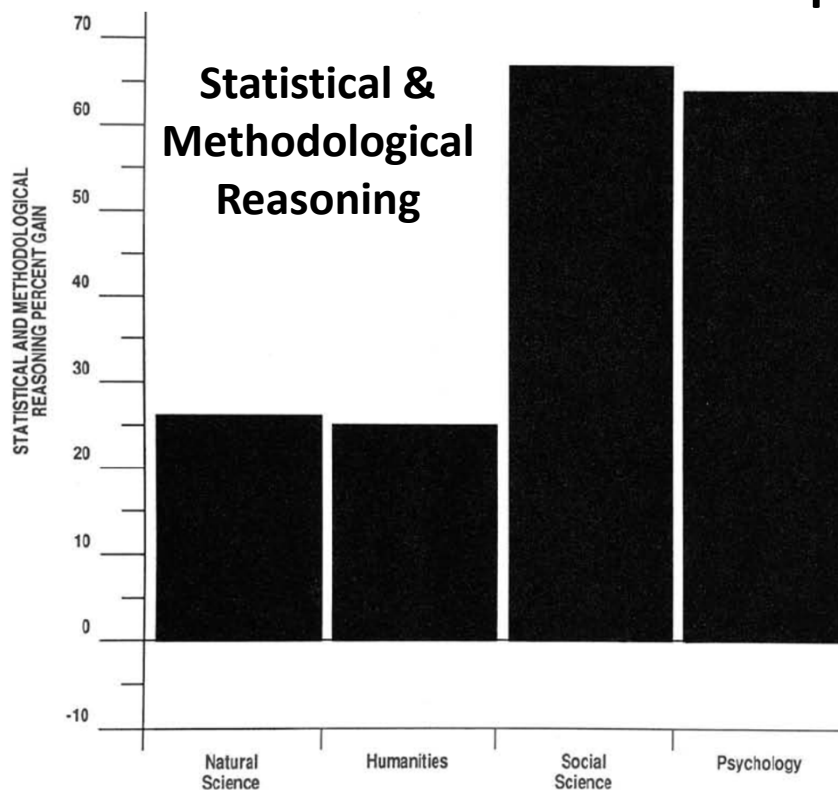


Figure 2. Change scores for statistical and methodological reasoning as a function of year and undergraduate studies.

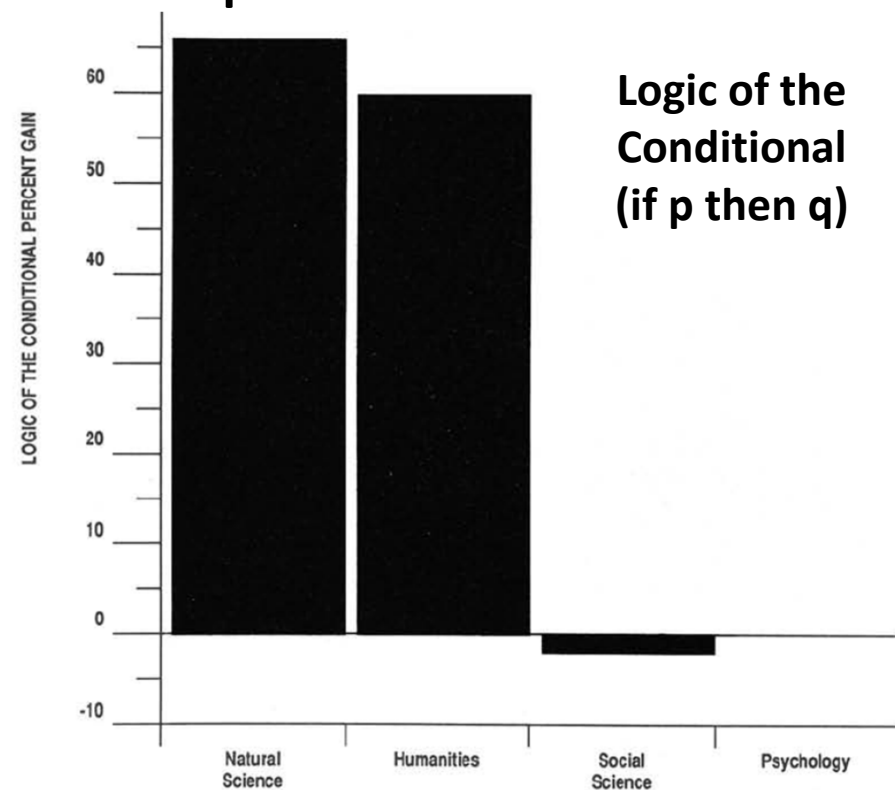


Figure 3. Change scores for conditional reasoning as a function of year and undergraduate studies.

# “Pseudoscience” Course

26

- Lilienfeld Model Course
  - Class 1 Philosophy & nature of science and scientific method
  - Classes 2&3 How thinking can go wrong
  - Class 4&5 Parapsychology
  - Class 6 Astrology
  - Class 7 Biorhythms, lunar lunacy effect
  - Class 8 Brain myths: Subliminal perception ...
  - Class 9 Polygraph testing, “truth serum” ...
  - Class 10 Pseudoscientific assessment methods
  - Class 11 Unsubstantiated psychotherapies
  - Class 12 Reconstructive nature of memory

# 3 Credit Course (Wilson, 2018)

27

Class section

Lecture topic

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First

Scientific Method  
Pattern Recognition in the Brain  
Sensory Systems and Perception  
Critical Thinking Skills and Probability Theory  
Logical Fallacies

Second

Photographs and Trick Photography  
Natural Laws - Physics and Chemistry  
Natural Laws - Biology  
Near Death Experience

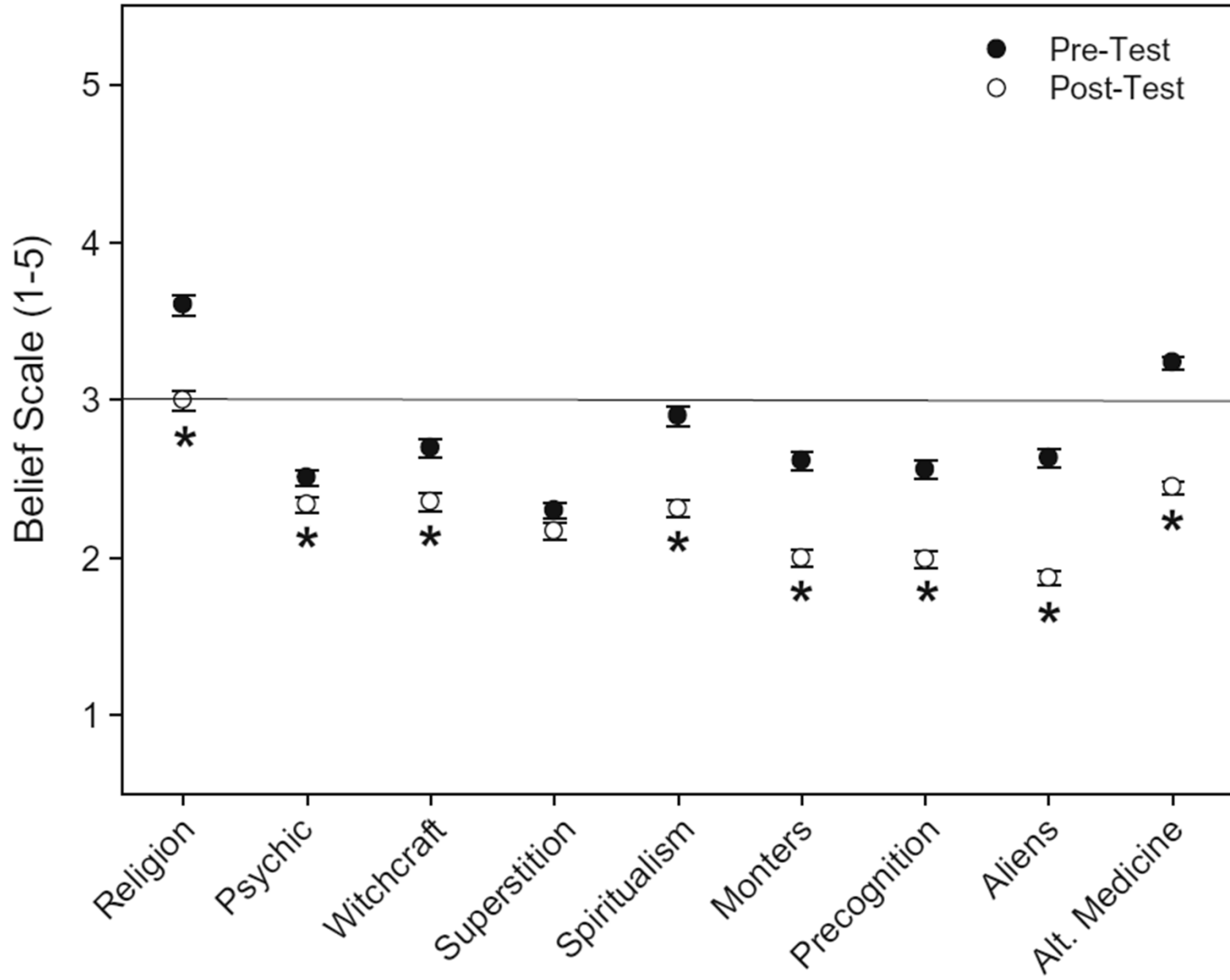
Third

Ghosts and the Search for the Soul  
ESP/Psychics  
Alternative Medicine/Detoxification  
Astrology

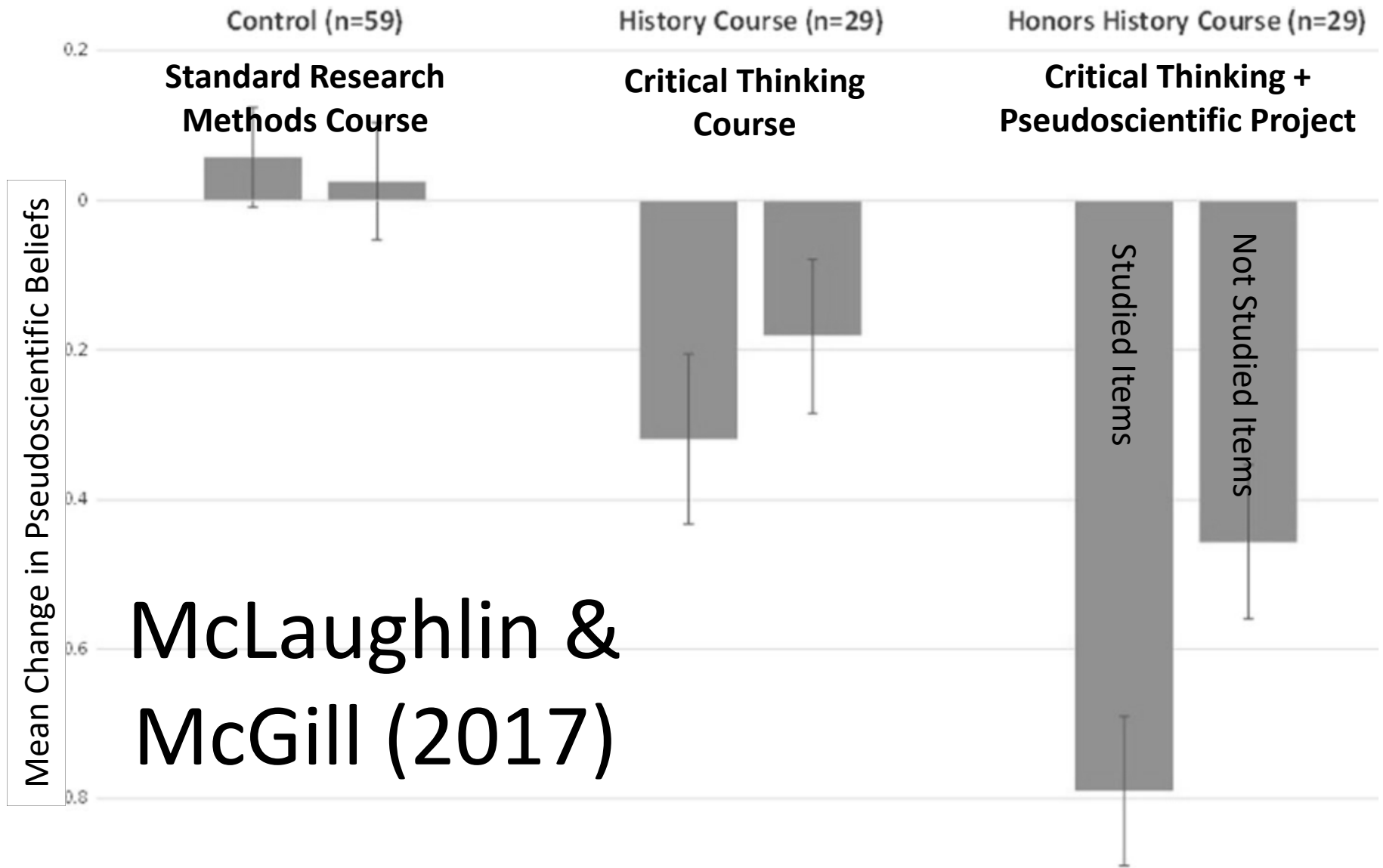
Fourth

Bigfoot and other “hidden creatures”  
Vampires  
UFO - Brief History of famous “sightings”  
UFO - Natural Phenomena typically confused with aliens  
Science of Life/Extra-terrestrial life requirements  
Scientific search of life in the Universe  
UFO Abduction

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# Pseudoscience Project Course



McLaughlin & McGill (2017)

# CHALLENGES

30

- University advantages
  - Relevant courses on research methods, statistics, ...
  - Can offer entire course on Pseudoscience
    - <http://casa.colorado.edu/~dduncan/pseudoscience/>
  - Much flexibility in content of courses
- High School
  - Set curriculum that must be covered
  - Fewer opportunities for individual class activities?

# Adams & Manson (2014)

31

- Single class activity
- Pre- and Post-Test Measure: 4 scenarios with 1+ flaws
  - Anecdotal evidence, Role of chance, Small samples, No control group, Correlation vs Causation, Participant differences, Placebo, Experimenter bias, Order effects, Practice effects
  - Rate believability and identify flaws
- Example
  - Famous Nobel Prize–winning scientist announces that magnets can relieve back pain when rubbed on a person’s back. He found 10 people with back pain and gave each magnet therapy. After therapy, most people told him that their back pain was reduced. He concluded that magnets relieve back pain.

- Activity
  - Infomercial for bracelet that improved energy & balance
    - [https://www.youtube.com/watch?v=mv\\_NK\\_qSgfU](https://www.youtube.com/watch?v=mv_NK_qSgfU)
  - Group discussion of claims, evidence, further evidence that could be collected, ...
- vs Lecture on same research methods material

## Number of Flaws Identified

	Pre-test	Post-test
Class		
Activity	2.33	4.02
Lecture	2.72	3.12

# High School Example

33

- Kristy Morrison: Halton District School Board
- Grade 9 project
  - Information on Science Teachers Association of Ontario website
  - <https://connex.stao.ca/classroom-catalyst/pseudoscience-evaluating-evidence>
- Evaluation?

# Some Pseudoscience in Schools Links

34

Ed Walsh's "Bad Science" for Schools

<https://www.scienceinschool.org/article/2012/badscience-2/>

Nature of Science at ENSI web

<https://ensiweb.bio.indiana.edu/index.html>

Dean Baird's phyz.org Skepticism Site

<http://phys.org/skepticism/>

Rodney Schmaltz's Pseudoscience Super Challenge

<https://nobaproject.com/blog/2017-05-10-the-pseudoscience-super-challenge-helping-students-spot-pseudoscientific-claims>

# Societal Counter-Forces



- Public Support for Science?
  - Evolution as “natural process” lower in general population than scientists
- Personal beliefs of students
- Media
  - 76% scientists agree news does not distinguish well-founded findings
  - Pseudoscientific television & beliefs
- Pseudoscience in Society
  - Alternative medicine and healthcare
  - Governments: Hindu prayer & COVID
- Scientists need to speak out more
- Non-science colleagues?
  - Study of education students

# Education Students

