

SCIE 300

Misconceptions in Science: *Knowing the Challenges*

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- Politics, Religion, **Ideology** in general.

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- Logical fallacies

Common logical fallacies



strawman

Misrepresenting someone's argument to make it easier to attack.



false cause

Presuming that a real or perceived relationship between things means that one is the cause of the other.



appeal to emotion

Manipulating an emotional response in place of a valid or compelling argument.



the fallacy fallacy

Presuming that because a claim has been poorly argued, or a fallacy has been made, that it is necessarily wrong.



slippery slope

Asserting that if we allow A to happen, then Z will consequently happen too, therefore A should not happen.



ad hominem

Attacking your opponent's character or personal traits instead of engaging with their argument.



tu quoque

Avoiding having to engage with criticism by turning it back on the accuser - answering criticism with criticism.



personal incredulity

Saying that because one finds something difficult to understand that it's therefore not true.



special pleading

Moving the goalposts or making up exceptions when a claim is shown to be false.



loaded question

Asking a question that has an assumption built into it so that it can't be answered without appearing guilty.



burden of proof

Saying that the burden of proof lies not with the person making the claim, but with someone else to disprove.



ambiguity

Using double meanings or ambiguities of language to mislead or misrepresent the truth.



the gambler's fallacy

Believing that 'runs' occur to statistically independent phenomena such as roulette wheel spins.



bandwagon

Appealing to popularity or the fact that many people do something as an attempted form of validation.



no true scotsman

Making what could be called an appeal to purity as a way to dismiss relevant criticisms or flaws of an argument.



genetic

Judging something good or bad on the basis of where it comes from, or from whom it comes.



black-or-white

Where two alternative states are presented as the only possibilities, when in fact more possibilities exist.



begging the question

A circular argument in which the conclusion is included in the premise.



the texas sharpshooter

Cherry-picking data clusters to suit an argument, or finding a pattern to fit a presumption.



middle ground

Saying that a compromise, or middle point, between two extremes is the truth.



appeal to authority

Using the opinion or position of an authority figure, or institution of authority, in place of an actual argument.



composition /division

Assuming that what's true about one part of something has to be applied to all, or other, parts of it.



appeal to nature

Making the argument that because something is 'natural' it is therefore valid, justified, inevitable, or ideal.



anecdotal

Using personal experience or an isolated example instead of a valid argument, especially to dismiss statistics.

Common logical fallacies

Very common in argumentation; **AVOID**

 strawman Misrepresenting someone's argument to make it easier to attack.	 false cause Presuming that a real or perceived relationship between things means that one is the cause of the other.	 appeal to emotion Manipulating an emotional response in place of a valid or compelling argument.	 the fallacy fallacy Presuming that because a claim has been poorly argued, or a fallacy has been made, that it is necessarily wrong.
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 special pleading Moving the goalposts or making up exceptions when a claim is shown to be false.	 loaded question Asking a question that has an assumption built into it so that it can't be answered without appearing guilty.	 burden of proof Saying that the burden of proof lies not with the person making the claim, but with someone else to disprove.	 ambiguity Using double meanings or ambiguities of language to mislead or misrepresent the truth.
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Hallmarks of pseudoscience

<https://yourlogicalfallacyis.com/>

Common logical fallacies

“Doctors don't know what they're doing. My mother's blood pressure medicine made her so sick she had to go to the emergency room. My uncle got vaccinated for shingles and still got it a month later.”

How would you respond?

Some of the most consequential scientific misconceptions

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- Vaccines are harmful.
- Alternative medicine is a credible alternative to “mainstream” medicine.
- Homeopathy, naturopathics, etc. are credible alternatives to traditional pharmaceuticals.

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BIOLOGY

- The science behind climate change is dubious.

EARTH SCIENCE

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PHYSICS

- Chemicals = Toxins.
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CHEMISTRY,
BIOCHEMISTRY

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MEDICINE

Factors that Influence Public Views of Scientific Knowledge

STRONG

MEDIUM

WEAK

CLIMATE CHANGE AND ENERGY

	Political affiliation	Age	Education, Science Knowledge	Gender	Race, ethnicity	Religion, strength of belief
Earth is warming due to human activity	STRONG	STRONG	MEDIUM	MEDIUM	MEDIUM	WEAK
Stricter power plant emission limits	STRONG	STRONG	MEDIUM	MEDIUM	STRONG	MEDIUM
More offshore drilling	STRONG	STRONG	WEAK	MEDIUM	WEAK	MEDIUM
Increased use of fracking	STRONG	WEAK	WEAK	MEDIUM	MEDIUM	MEDIUM
Prioritize alternative energy development over oil, coal, gas	STRONG	STRONG	WEAK	STRONG	WEAK	WEAK
Building more nuclear power plants	MEDIUM	STRONG	STRONG	MEDIUM	WEAK	WEAK
Growing world population will be a major problem	MEDIUM	WEAK	WEAK	WEAK	STRONG	STRONG

Factors that Influence Public Views of Scientific Knowledge

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BIOMEDICAL & FOOD SAFETY

	Political affiliation	Age	Education, Science Knowledge	Gender	Race, ethnicity	Religion, strength of belief
Modifying genes to reduce a baby's risk of disease	MEDIUM	STRONG	WEAK	WEAK	WEAK	MEDIUM
Use of bioengineered organs for human transplant	MEDIUM	WEAK	MEDIUM	WEAK	MEDIUM	WEAK
Childhood vaccines should be required	MEDIUM	STRONG	WEAK	WEAK	WEAK	MEDIUM
Childhood vaccines are safe	WEAK	MEDIUM	WEAK	WEAK	STRONG	NA
Safe to eat genetically modified foods	WEAK	WEAK	STRONG	MEDIUM	MEDIUM	WEAK
Safe to eat foods grown with pesticides	MEDIUM	WEAK	MEDIUM	MEDIUM	MEDIUM	WEAK

Factors that Influence Public Views of Scientific Knowledge

STRONG

MEDIUM

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EVOLUTION

Political
affiliation

Age

Education,
Science
Knowledge

Gender

Race,
ethnicity

Religion,
strength
of belief

Humans have evolved
due to natural processes

Ideology

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Beliefs and opinions hold little weight in scientific discourse. Science relies on objective argumentation, robust theories, and independent evidence that supports those arguments and theories. *No scientific principle is sacred.*

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Common examples:

Political ideology (e.g. libertarianism, authoritarianism)

Economic ideology (e.g. capitalism, socialism)

Religious ideology (e.g. Christianity, Islam)

Social ideology (e.g. liberalism, conservatism)

...And combinations of the above.

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...And combinations of the above.

However, some challenging ideologies share no specific ties with these common examples.

Disclaimer:

A person's or society's ideology is often a major obstacle to effective science communication: no one is above this obstacle.

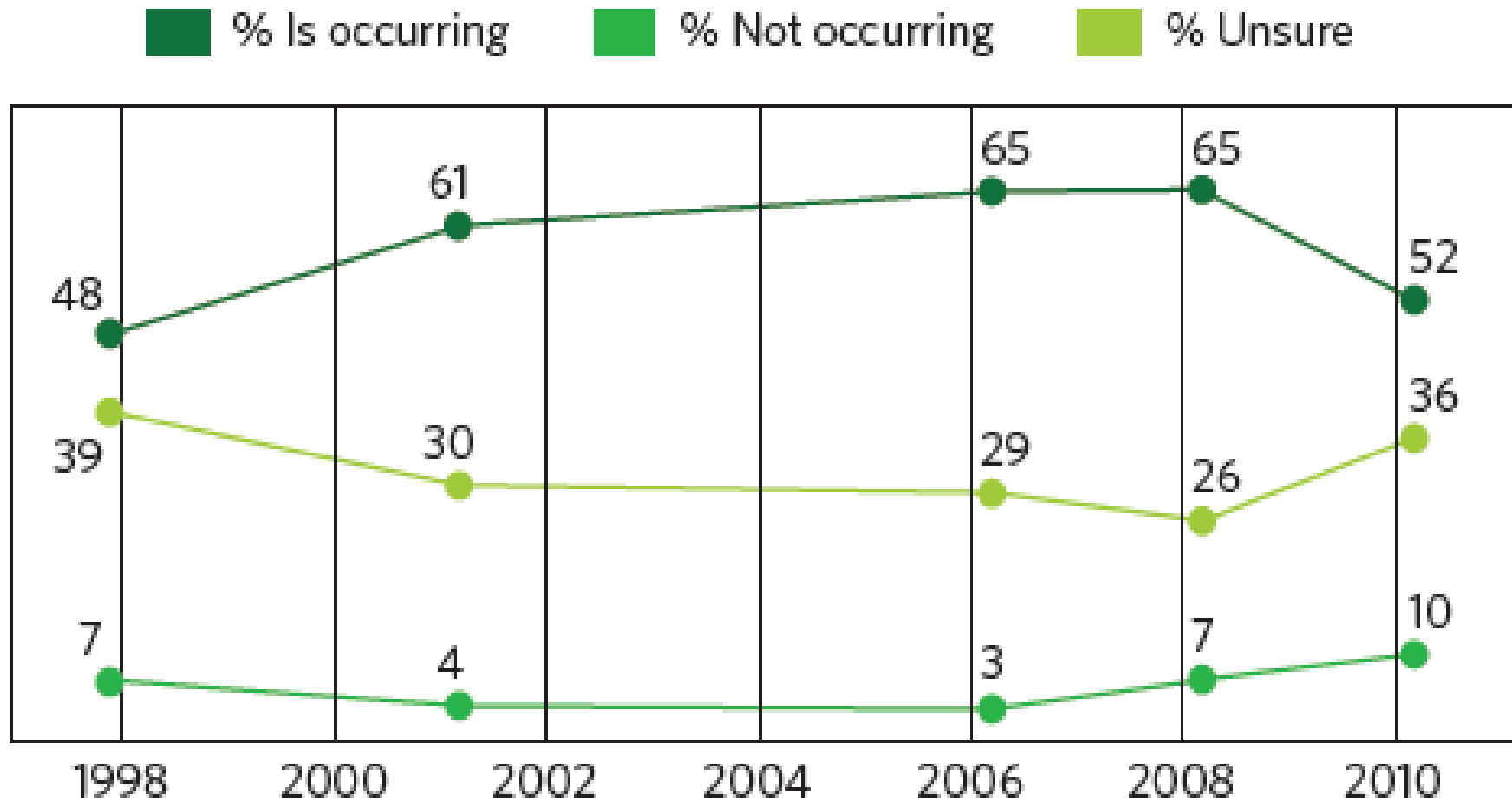
We all subscribe to different ideologies with varying tenacity. Being aware of our own ideological biases, and those that we are likely to encounter when communicating science, allows us to take steps to overcome these ideological obstacles.

POLITICS

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Climate change beliefs: US

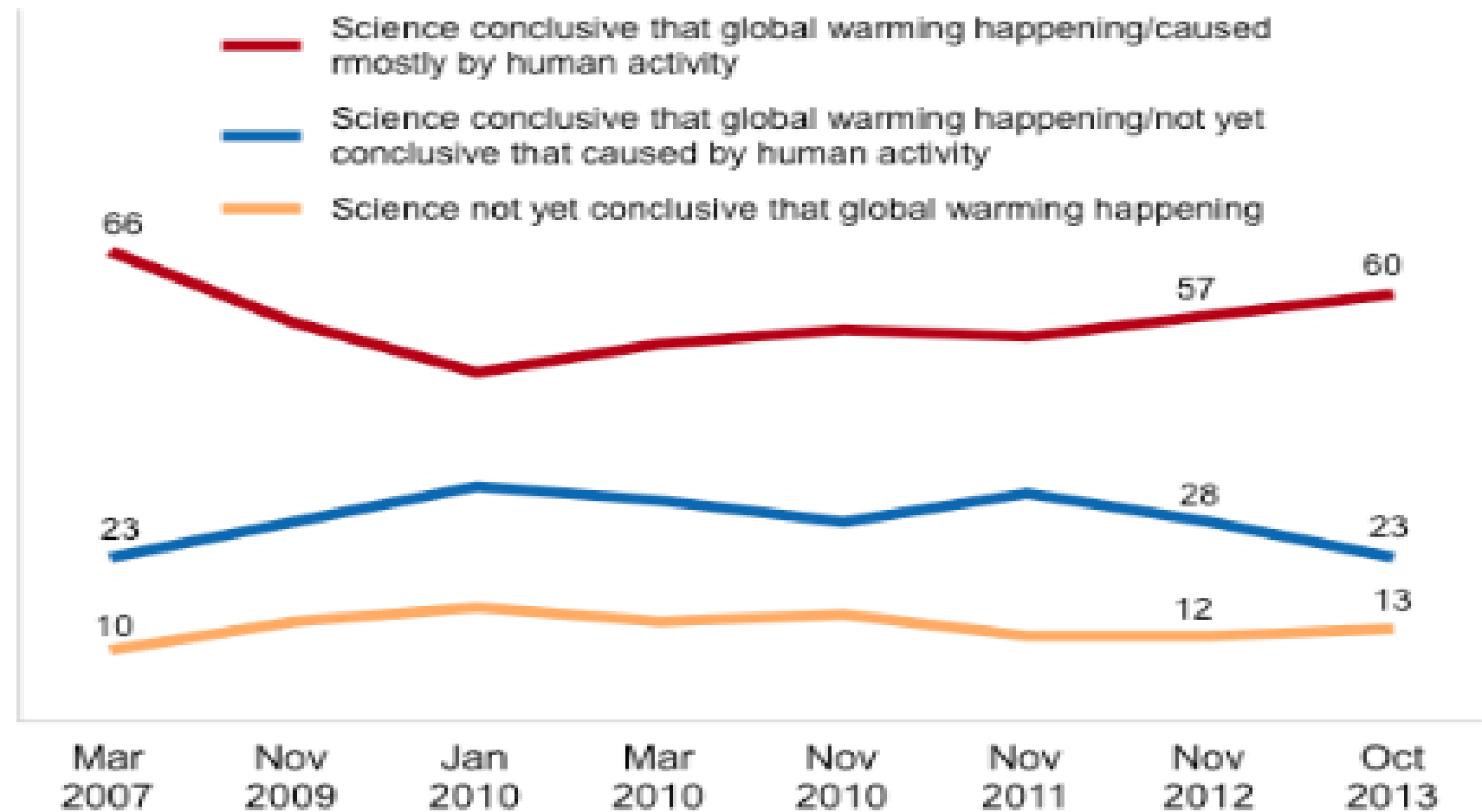
Do most climate scientists agree that climate change is occurring?



Climate change beliefs: Canada

Science of climate change

2007 - 2013



Climate change beliefs: US & Europe

In Europe and U.S., Deep Ideological Divides on Concern about Climate Change

	Global climate change is a very serious problem				Global climate change is harming people now			
	Left	Mod	Right	Right-Left Diff	Left	Mod	Right	Right-Left Diff
	%	%	%		%	%	%	
Italy	69	59	42	-27	74	62	64	-10
France	70	55	49	-21	71	61	50	-21
UK	53	41	34	-19	59	50	44	-15
Spain	60	52	46	-14	69	63	51	-18
Germany	58	52	57	-1	73	63	59	-14
Poland	16	25	18	+2	25	23	36	+11
U.S.	Lib	Mod	Conserv	Conserv - Lib Diff	Lib	Mod	Conserv	Conserv - Lib Diff
	%	%	%		%	%	%	
	68	45	30	-38	59	37	32	-27

Note: Statistically significant differences in **bold**.

% of U.S. adults who say global warming is...

	Occurring	Caused by humans	Very serious problem
Age 18-29	74	54	51
Age 30-49	68	47	47
Age 50-64	66	43	44
Age 65+	65	36	41

Pew Research Center, 2014

% of U.S. adults who say global warming is...

	Occurring	Caused by humans	Very serious problem
<i>Attend religious services...</i>			
Weekly or more	63	38	39
Monthly/yearly	71	47	48
Seldom/never	73	52	53

% of U.S. adults who say global warming is...

	Occurring	Caused by humans	Very serious problem
Republican	45	22	21
Democrat	86	64	67
Independent	70	46	45
Conservative	51	28	29
Moderate	74	48	47
Liberal	88	69	70

Pew Research Center, 2014

RELIGION




impeding science communication

Creationism: Canada, US, UK

Angus Reid, 2012

Creationism and Evolution

Which of these statements comes closest to your own point of view regarding the origin and development of human beings on earth?

	CANADA 	UNITED STATES 	BRITAIN 
Human beings evolved from less advanced life forms over millions of years	61%	30%	69%
God created human beings in their present form within the last 10,000 years	22%	51%	17%
Not sure	16%	18%	14%

Creationism: Canada

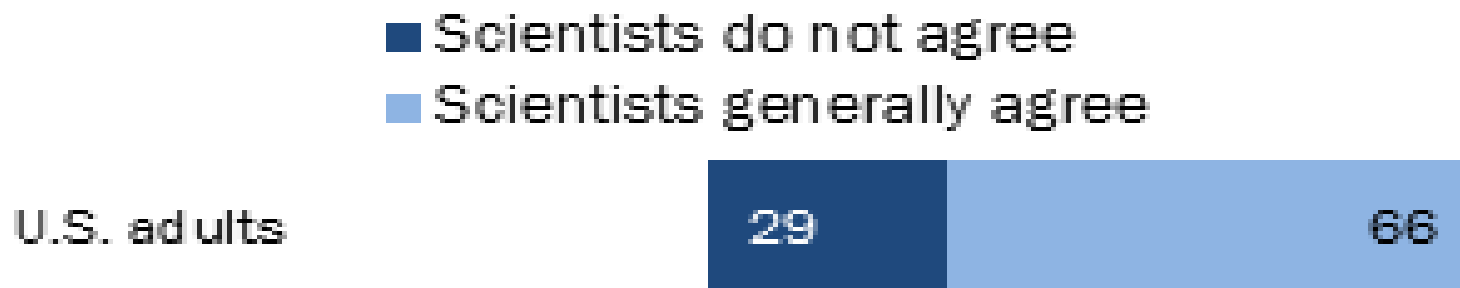
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		Region					
	TOTAL	BC	AB	MB/SK	ON	QU	AT
Human beings evolved from less advanced life forms over millions of years	61%	62%	48%	53%	60%	71%	58%
God created human beings in their present form within the last 10,000 years	22%	22%	35%	24%	24%	13%	27%
Not sure	16%	16%	17%	23%	16%	16%	16%

30% of the US public thinks that scientists dispute evolution

Do Scientists Generally Agree About Evolution?

% of U.S. adults saying scientists generally agree or do not agree that humans evolved over time



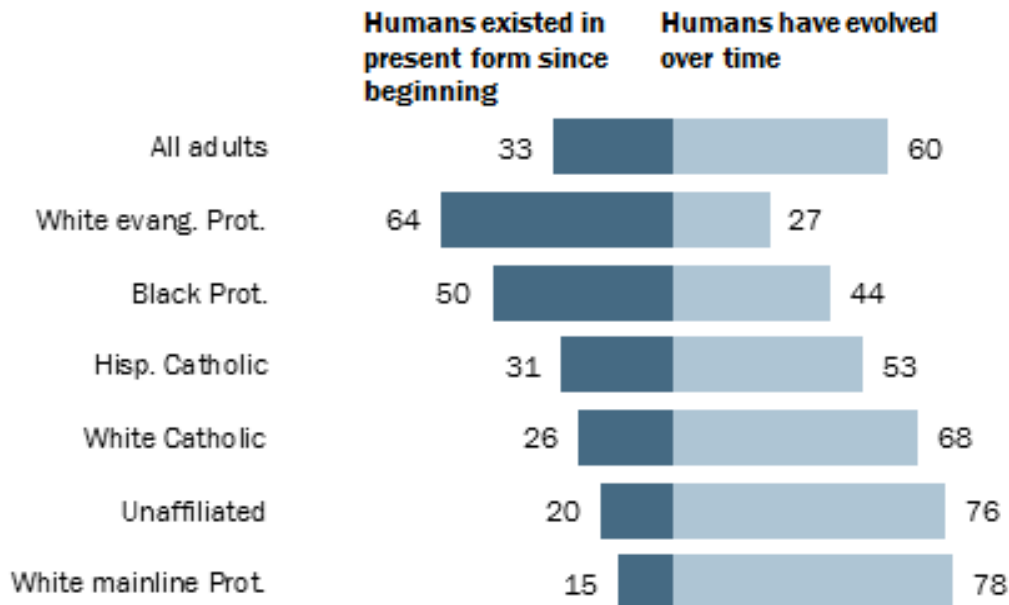
Survey of U.S. adults Aug. 15-25, 2014. Q18, "Don't know" responses not shown.

PEW RESEARCH CENTER

Creationism: Christianity & Islam

Views About Human Evolution, by Religion

% of U.S. adults saying that humans and other living things have existed in their present form since the beginning of time, or humans and other living things have evolved over time



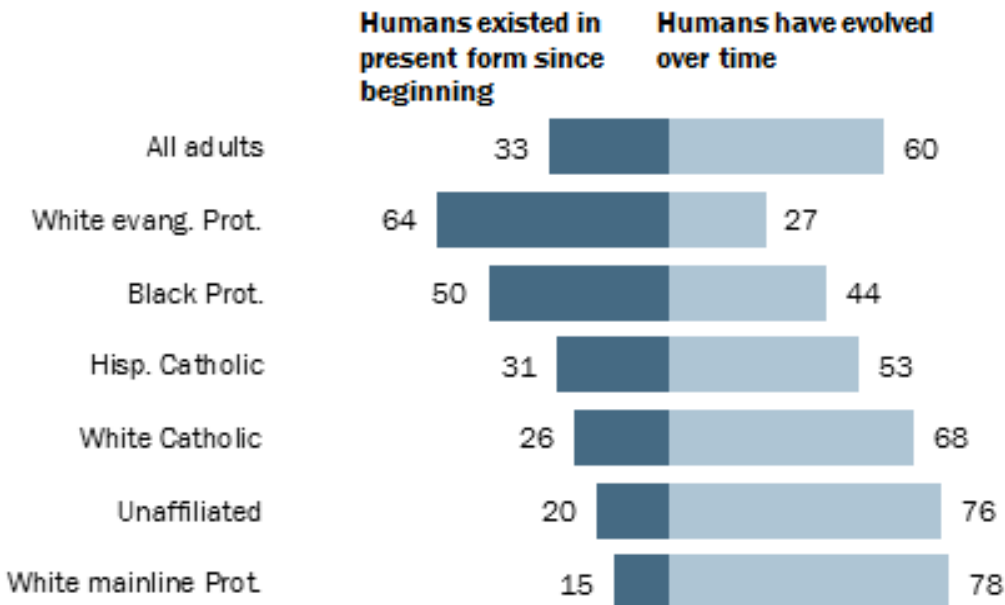
Source: Pew Research Center survey March 21-April 8, 2013. Q54. Those saying "don't know" are not shown. Whites and blacks are those who are non-Hispanic. Hispanics include those of any race.

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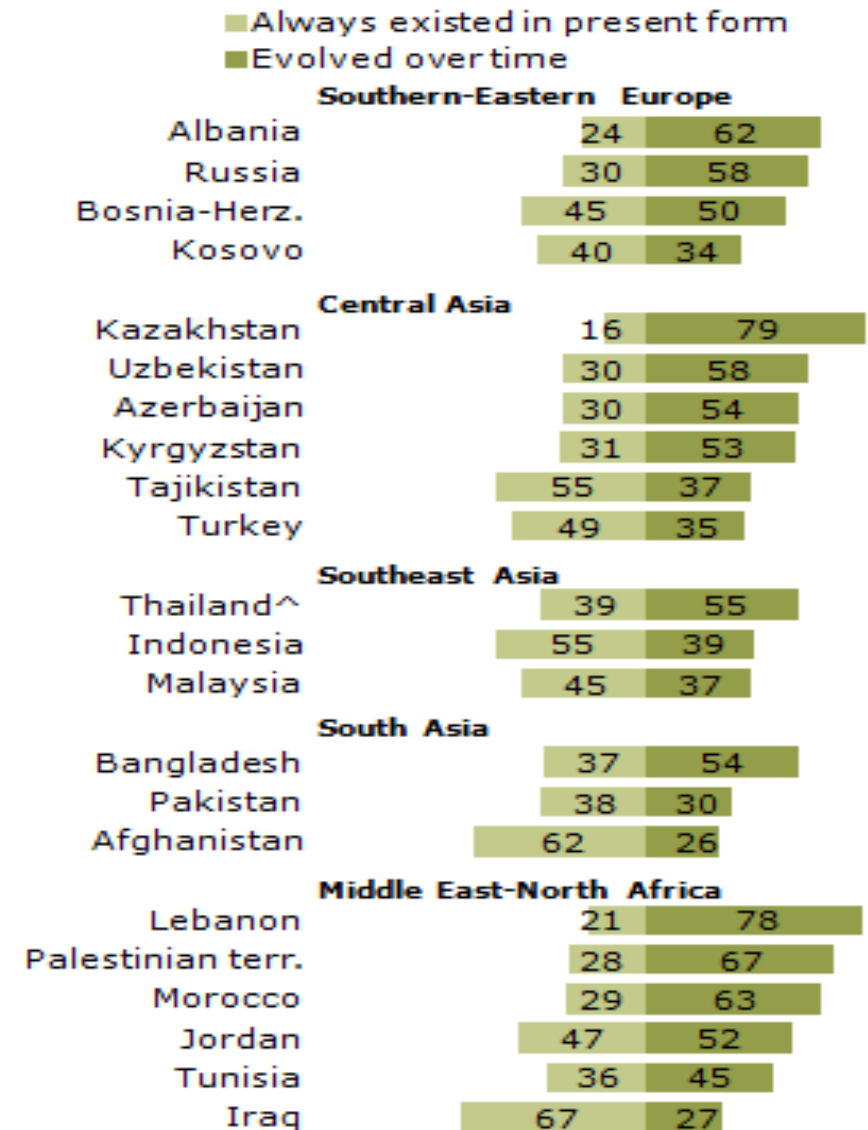
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PEW RESEARCH CENTER

Note: Saudi Arabia explicitly bans the teaching of evolution in favour of creationism as part of its national curriculum.

Belief in Evolution

% of Muslims who believe humans and other living things have ...



This question was not asked in sub-Saharan Africa.

Religious Thought in Conflict with Science

- These are not just correlations. From Pew 2009 study in US:
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 - **64% would continue to hold to the religious belief.**
- From 2007 Gallup poll in US:
 - **Only 14% cite lack of evidence as the main reason they do not believe in evolution.**
 - Most popular reasons: Jesus (19%), God (16%), religion (16%).

other **IDEOLOGY**
impeding science communication

“Chemicophobia”

“I don't like to put chemicals in my body....”

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- Claim that vaccines cause autism
- Claim that fluorinated water, toothpaste, mouthwash, etc. are toxic
- Roundup (glyphosate) poisoning in GM crops

“Chemicophobia”

“I don't like to put chemicals in my body. Fluoride is toxic. I would never drink fluorinated water.”

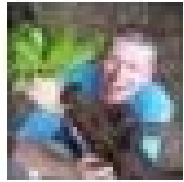
How would you respond?

“Chemicophobia”

Table 1 Provincial and territorial estimates for community water fluoridation coverage in 2007⁵

Province	Total population	Population with fluoridated water	Population without fluoridated water	Percentage with fluoridated water	Percentage without fluoridated water
British Columbia	4,113,000	152,241	3,960,759	3.7%	96.3%
Alberta	3,290,350	2,457,406	832,944	74.7%	25.3%
Saskatchewan	968,157	356,096	612,061	36.8%	63.2%
Manitoba	1,148,401	803,116	345,285	69.9%	30.1%
Ontario	12,160,282	9,229,015	2,931,267	75.9%	24.1%
Quebec	7,546,131	489,420	7,067,711	6.4%	93.7%
New Brunswick	729,498	188,607	540,891	25.9%	74.2%
Nova Scotia	913,462	519,031	394,431	56.8%	43.2%
Prince Edward Island	135,851	32,174	103,677	23.7%	76.3%
Newfoundland/Labrador	505,469	7,572	497,897	1.5%	98.5%
Nunavut	29,474	0	29,474	0.0%	100.0%
Northwest Territories	41,464	23,400	18,034	56.4%	43.6%
Yukon	30,372	0	30,372	0.0%	100.0%
Canada	31,611,911	14,258,078	17,364,803	45.1%	54.9%

“Naturopophilia”



Mike Adams via **NaturalNews.com**

 Follow

August 18, 2013 · 

Ideas: Five **natural supplements** to **detox your body** of **toxic GMO** foods

http://www.naturalnews.com/041664_GMOs_detoxification_diet...



naturalnews.com

Use these five natural supplements
to detox your body of toxic GMO
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NATURALNEWS.COM

GMOs

- Distrust and fear of GMOs is widespread, common misconceptions:
 - GMOs are not “natural”
 - GMO tech. is not properly tested
 - GMO tech. is driven by corporate interests, greed (Big Pharma, Big Agri)
 - very little public understanding of the chemistry, biology, genetics behind GMOs

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Some truth to these ideas. Corporate interests can conflict with scientific process.
Not unique to GMOs.

GMOs

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- All have been thoroughly tested.
- However, each new GM crop is different and requires serious testing. Corporate interests can sometimes interfere with independent testing efforts.
 - e.g. Brazil nut allergens in GM soybeans in the 1990's only discovered by independent researchers.

Séralini & GMOs

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- Claimed to show GM corn (Roundup resistant, glyphosate) caused cancerous tumours in lab rats.

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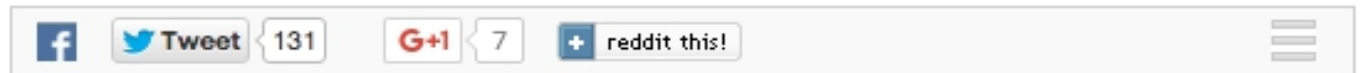
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- “Science by press conference”: press conferences with media held before research published; reporters had to sign confidentiality agreements preventing them from talking to outside experts.

Séralini & GMOs

Science journal retracts French study on GM foods

A controversial French study purportedly linking genetically modified foods to tumours and organ failure in rats — research widely hailed by anti-GM activists and fiercely denounced by scientists — has been retracted.

Paper retracted,
2013



JOHN THYS / AFP/GETTY IMAGES

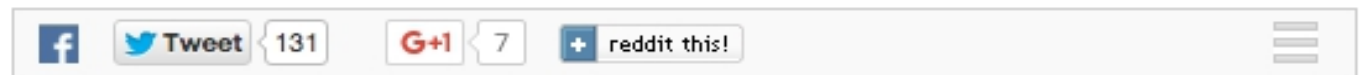
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But his lab
continues
pumping out
similar “studies”,
funded quite well
by special interest
groups.



JOHN THYS / AFP/GETTY IMAGES

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- Even stronger opposition in much of Europe.

GMOs

Fear of GMOs can have serious implications for global health and hunger:

- 11 African nations ban all imported GM foods, including food necessary to feed the population.
 - Angola, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Swaziland, Tanzania, Zambia, & Zimbabwe

GMOs

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- ***Approximately 200 million children affected worldwide by Vitamin A deficiency; 1 in 3 globally under the age of 5.***
- VAD causes blindness and decreases the body's ability to fight infection. ***About 500,000 children go blind each year and about 500,000 children die each year from VAD.***

VAD is entirely preventable: golden rice could accomplish this.

PSEUDOSCIENCE

impeding science communication

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Mehmet Oz, “Dr. Oz”



Stephen Meyer

Deepak Chopra



Pseudoscience

- ***Public audiences often cannot tell the difference between science and pseudoscience. Pseudoscientists explicitly capitalize on this disconnect.***



Mehmet Oz, “Dr. Oz”



Stephen Meyer

Deepak Chopra



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Often have their own “Centres” and “Institutes”: e.g.

Canadian Institute of Alternative Medicine or National Center for Complementary and Integrative Health (part of the US NIH!).

Pseudoscience

- A sampling of pseudoscience examples, non-medical:
 - phrenology
 - alchemy
 - numerology
 - UFOs, alien abduction, ancient aliens
 - ghost hunting
 - astrology
 - flat earth, hollow earth
 - **intelligent design, creation science**
 - conversion therapy
 - parapsychology
 - quantum mysticism
 - biocentrism

Intelligent Design

“Evolution is a theory, just like Intelligent Design. Why shouldn't we teach both?”

How would you respond?

Pseudoscience

- A sampling of pseudoscience examples, Complementary & Alternative Medicine (CAM):
 - applied kinesiology (not actual kinesiology!)
 - chiropractics
 - reflexology
 - crystal healing
 - naturopathy, holistic healing
 - acupuncture
 - “traditional” or folk medicine
 - homeopathy
 - magnet therapy
 - new age epigenetics, quantum consciousness

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 - Some provinces license CAM practitioners (e.g. chiropractors), and some provincial health programs cover certain CAMs (not BC). Regulation is weak.

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 - Random chance
 - False positives and false negatives always present

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- Know how to spot and dismantle logical fallacies.
- **Don't shy away from ruffling a few feathers.**
- **Speak up!**