Marine Mammal Science: Cognitive Bias and Education

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Facts Are Not Enough to Change the Minds of Science Skeptics

- Katherine Hayhoe, Climate Scientist
  - Presentation at American Association for the Advancement of Science, February 18, 2018
  - Title, "When Facts Are Not Enough"
- Nancy Shute, Editor in Chief, Science News
  - More data are not better
  - "Emotion trumps fact"

Insufficiently Effective Science Education in USA

- 32% - 45% do not recognize anthropogenic climate change

- 40% believe that earth and humans were created within the last 10,000 years

- 10% believe that vaccinations are unsafe

Marine Mammal Science is Vulnerable

- Many bills and other measures have been introduced by the current Congress to weaken the Endangered Species Act
- Basic marine mammal science is challenged

Cetacean and Pinniped Reproduction

- Patricia Brennan, Evolutionary Biologist
- Studies of marine mammal anatomy and fertility
- Research attacked for wasteful government spending
- Reproduction, obviously, is at the core of evolutionary success

Harbor Porpoise
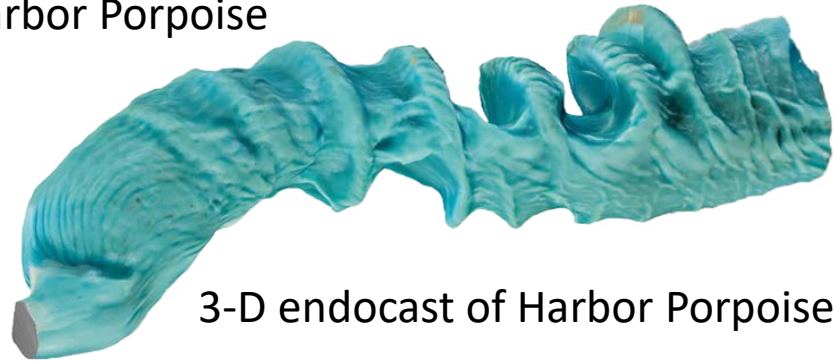
3-D endocast of Harbor Porpoise vagina

How do we change educational practice?

- Identify the disciplines with expertise in behavior change and education

- Identify the factors limiting educational change

- Address these factors

Disciplines with Expertise in Behavior Change

- Social Sciences
  - Psychology
    - Social Psychology
    - Cognitive Psychology
  - Political Science
  - Anthropology
  - Sociology
  - Economics
- Education
  - Formal Education
  - **Informal Education**—education outside the classroom

Factors Limiting Educational Outcomes

- Influence of two related myths
  - Myth 1: "If only people had more facts they would agree with us"
  - Myth 2: "People make rational, fact-based decisions"
- Cognitive biases
- Informal education
  - Frequently, uninformed presentation techniques
  - Frequently, insufficiently evaluated

Myths and Origins of Cognitive Bias

- The myth of the rational actor has been systematically dismantled, led by the Nobel prize winning research of Kahneman & Tversky
- Social, cognitive, and emotional factors determine decisions, judgments and beliefs
- Decisions emerge from a battle between intuition and logic
  - Intuition: fast, most commonly used
  - Logic: slow, requires energy, frequently not used

Mental Shortcuts and Cognitive Bias

- Cognitive contributions to decisions and beliefs usually involve shortcuts
  - **Generally get us to where we need to go,** this is why shortcuts are used
  - But, sometimes they do not
- Many shortcuts are called **heuristics**
  - Used for making judgments under conditions of uncertainty
  - Often emphasize one aspect of a complex problem
  - Often generate cognitive biases

Two Heuristics

- Representativeness—based on similarity to a prototype and assumption of similar causes and effects.

- Confirmation--to search for, interpret or recall information that confirm preexisting beliefs while paying less attention to alternative possibilities

Representativeness Heuristic→Cognitive Bias: Ignoring the Base Rate

- My dog Sam is tested for an uncommon disease, 1/1000 in the population
- Test for the disease is good
  - 99% identification if dog has the disease
  - 2% false positive rate
- Sam tests positive. What is the probability Sam has the disease?

Probabilities of Events

A: Sam has the disease

B: Sam tests positive

$P(A) = 0.001$

- one dog in 1000 has the disease

$P(B|A) = 0.99$

- probability of a positive test given infection is 0.99

$P(B|Not A) = 0.02$

- probability of a false positive, given no infection is 0.02

- We ask: $P(A|B) = ?$

  What is the probability Sam has the disease given a positive test?

Bayesian Analysis

$$P(A|B) = \frac{P(A \text{ AND } B)}{P(B)} \quad = \quad \frac{.00099}{.02097} \quad = \textbf{.0472}$$

	A	Not A		
B	.00099	.01998	.02097	P(B)
Not B	.00001	.97902	.097903	P(Not B)
	.001	.999	1	
	P(A)	P(Not A)		

Expected Frequencies

	Disease	No Disease	
Tests Positive	1	20	21
Tests Negative	0	979	979
	1	999	1000

Confirmation Heuristic

- Dolphins have a self-concept
  - Evidence: Dolphins "recognize" themselves in mirrors
  - Confirmation of an available, popular idea: dolphins are smart
- Alternative evidence
  - Mirror recognition in animals without hands is difficult to confirm
  - Does mirror "recognition" really illustrate self-concept?
  - Evidence provided for mirror recognition in dolphins is flawed

Dozens of Heuristics and other Mental Shortcuts

- Anchoring
- Availability
- Familiarity
- Fluency
- Gaze
- Recognition
- Halo effects
- Negative halo effects
- "Hot-hand" myth
- Etc.

Problematic Beliefs about Marine Mammals

- Extinction of marine mammal species is not important
- High boat speeds do not cause problematic levels of manatee injury and death.
- Noise is not a problem for whales and dolphins
- Sea temperature increases will be good for manatees
- Oceanariums serve no purpose useful to marine mammals
- It is good to swim with dolphins in the wild; they like it
- Feeding dolphins in the wild is healthy for humans and dolphins

- **Addressing these types of beliefs is facilitated by knowledge of cognitive biases and their resolution**

Social Identity Strategies for Addressing Environmental Cognitive Biases

(from Fielding and Hornsey, 2016)

TABLE 1 | Social identity strategies to encourage more pro-environmental attitudes and behaviors.

Social identity strategy	Example study
Use ingroup messengers Ingroup sources are influential because they are perceived to be more trustworthy and credible by ingroup members	Schultz and Fielding (2014). Messages about an alternative water source were more influential when coming from a scientist with a shared regional identity
Forge a superordinate identity A superordinate social identity can help to reduce intergroup conflict because it subsumes conflicting subgroup identities and transforms the group context from one of 'us' and 'them' to 'we'	Samuelson et al. (2003). Conflict over watershed restoration was transformed through forging a superordinate identity in a collaborative learning setting that allowed consensus to emerge and recommendations to be developed
Link social identity and pro-environmental outcomes Identifying with a pro-environmental group will lead group members to conform to the pro-environmental attitudes and behavior of that group	Van der Werff et al. (2014). Reminding people of their past behavior can strengthen their identification as a pro-environmental person and increase future pro-environmental actions
Promote pro-environmental ingroup norms Providing messages that highlight the ingroup's pro-environmental norms will increase group members' pro-environmental attitudes and behavior. Negative descriptive norms can be attenuated by: • emphasizing the pro-environmental injunctive norm (i.e., what group members approve of) • make salient a superordinate identity that does have pro-environmental descriptive norms • provide a comparison that makes the ingroup appear more pro-environmental • leaders can advocate a pro-environmental vision of the ingroup	Nolan et al. (2008). Messages that a majority of householders in the neighborhood saved energy reduced household energy use Schultz et al. (2007). An injunctive norm countered the effect of a negative descriptive norm in relation to energy use Rabinovich et al. (2012). British participants thought of themselves as more pro-environmental when compared to the U.S. Seyranian (2014). Group leaders who used inclusive language influenced group members support for renewable energy

Other Approaches to Cognitive Bias

- Aligning arguments with pre-existing beliefs
- Highlighting positive outcomes of environmental mitigation
- Emphasizing proximate consequences vs. distal ones.

Informal Education

- Sites for education outside the classroom
  - Aquariums and Oceanariums
  - Zoos
  - Museums
  - Botanical Gardens
  - Television
  - Computer and Other Media
  - National Parks

Learning Science in Informal Environments
People, Places, and Pursuits

Committee on Learning Science in Informal Environments

Philip Bell, Bruce Lewenstein, Andrew W. Shouse, and Michael A. Feder, *Editors*
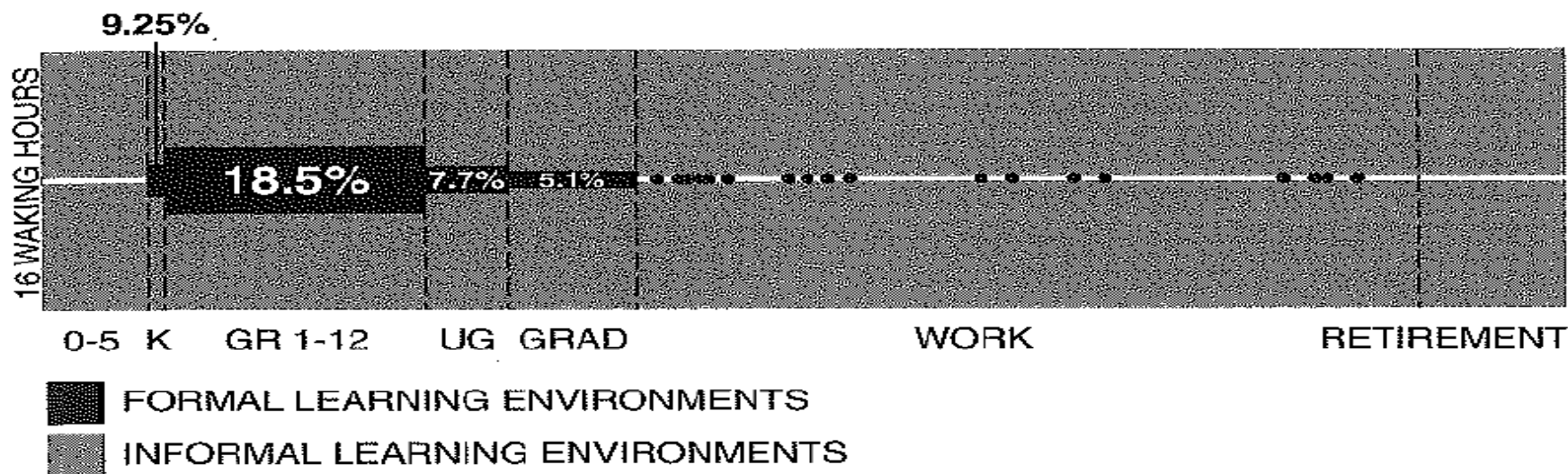
Board on Science Education
Center for Education
Division of Behavioral and Social Sciences and Education
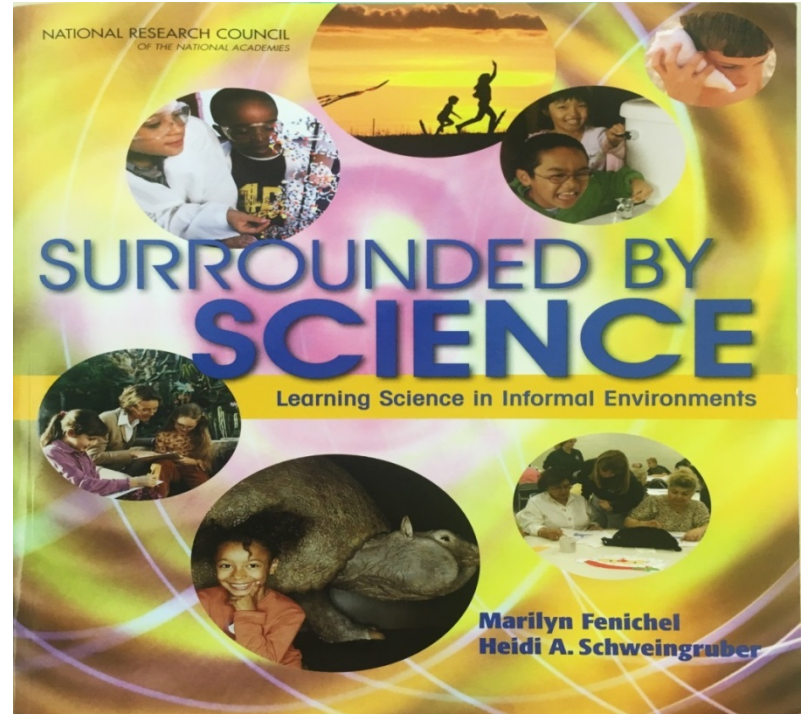
NATIONAL RESEARCH COUNCIL
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LIFELONG AND LIFE-WIDE LEARNING

Estimated time spent in school and informal learning environments.

Quality of Informal Education Research

- Need for **more**, good quality evaluation of informal education
- Useful research may be sequestered as proprietary

Conclusions of NRC Study (2009)

- People learn about science throughout the life span

- Great deal of learning takes place out of school

- Learning in informal environments generates positive science-related attitudes

Suggestions for Future Action

- Formal education in behavioral sciences
    - Medical School--recommended
    - MCATS—tested
    - Biology graduate programs and veterinary schools—should be considered
- Collaboration with social scientists
- Invite social scientists and educators to professional meetings
- Increase and improve evaluation of informal education venues
- Research-based education at oceanaria and zoos
    - Assess education programs
    - Modify programs based on assessments
    - Emphasize changes in behavior rather than attitudes
    - Publish evaluations of education programs
- Get more social scientists interested in conservation and marine mammal research
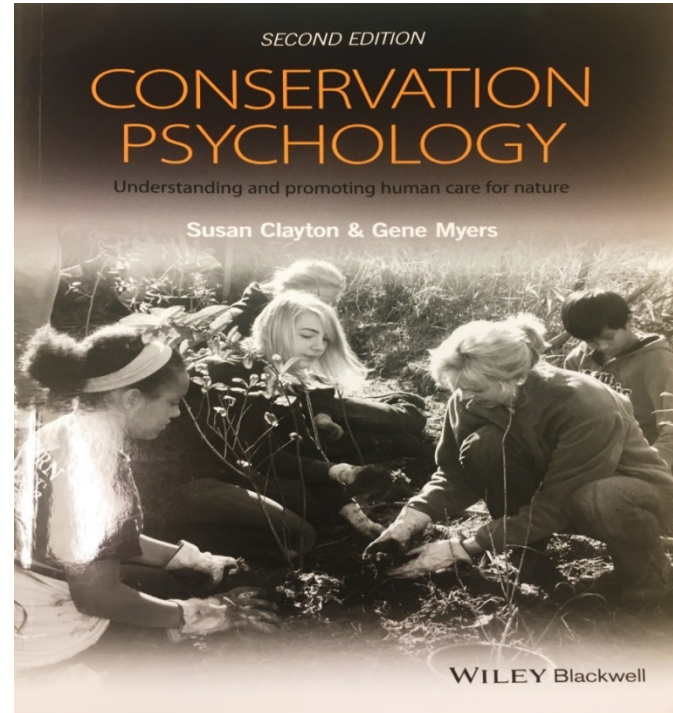
Policy and Informal Education

- The next two speakers will provide more detail on education and public policy

- Frank Alcock will talk about politics, information and climate change, and how they intersect

- Heidi Harley will provide an example of informal science education about dolphins

Frank Alcock

- Professor of Political Science, New College of Florida

- Former Director of Environmental Studies Program

- Former Director of the Marine Policy Institute, Mote Marine Laboratory

- Senior Fellow with Collins Center for Public Policy

- Political Analyst, ABC News in Sarasota

Heidi Harley

- Professor, Cognitive Psychology, New College of Florida

- Director of Environmental Studies

- SUS TIP Award for Exceptional Teaching

Acknowledgments

- Char Callahan, New College of Florida Professor Emeritus of Social Psychology for discussions of literature and basic principles of cognitive bias

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