What does social science research have to say about communicating about basic science?

A Little … And Plenty

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The challenge, as we understand it …

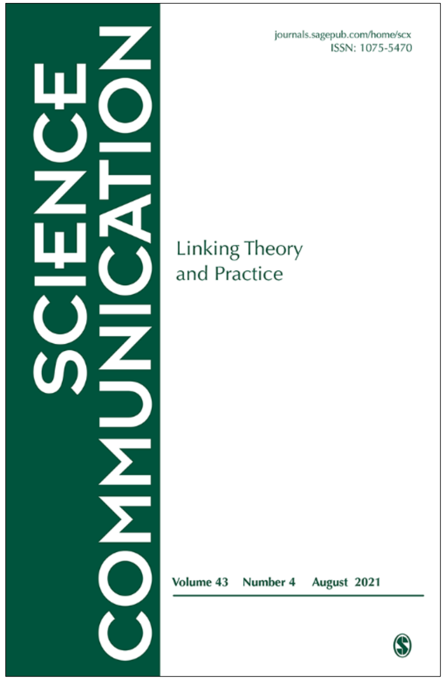
Is there an evidence-based literature *specifically* focused on basic science *that basic science communicators could* draw on when making decisions?

Our piece of the puzzle:
Four Key Science Communication Journals

(Based on Web of Science database)

Logic: If a 'basic science communication' literature exists then it should appear in these four journals.

$N_{1994\text{-}2020}$ = 1,061**
(Online, open-access)



$N_{1994\text{-}2020}$ = 629
(Online, open-access)

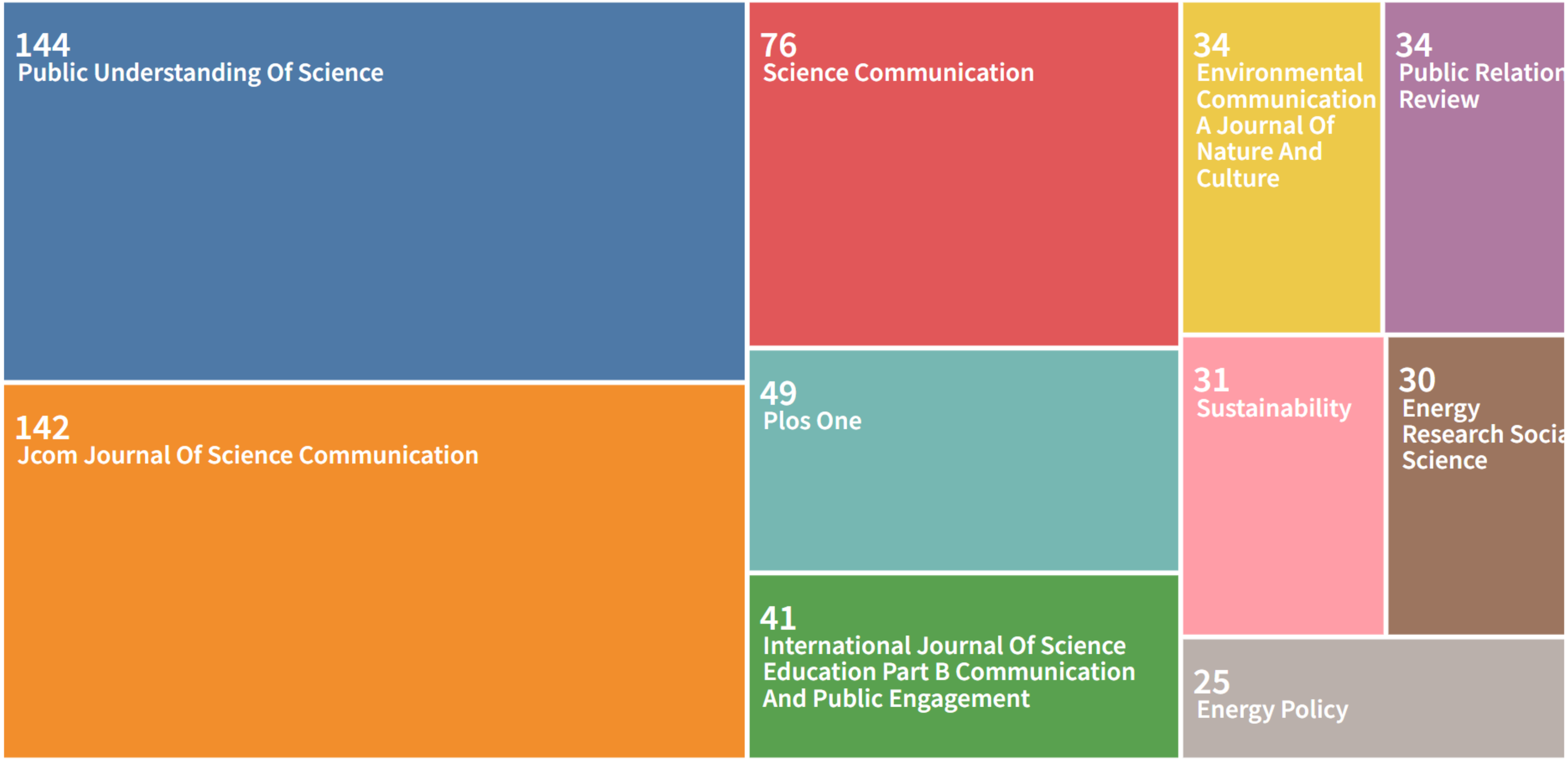
$N_{2009\text{-}2020}$ = 513***
(Online, open-access)

$N_{2011\text{-}2020}$ = 183
(Online, open-access)

*Articles labeled as 'article' (not commentary, book reviews, etc.); **Appears to miss some early content; ***Database appears to have expansive category of what is included as 'articles.'

An example for why these four journals:

Where does the term 'public engagement' appear?*



*Web of Science visualization tool with search term "public engagement" for all sub-databases (N =4,556)

But … here is the only article in which the term "basic science" seems to be used in these journals' key data*

The Inferior Science and the Dominant Use of English in Knowledge Production

A Case Study of Korean Science and Technology

KUMJU HWANG
University of Leeds

This article examines international scientific activities in the context of hierarchical international relations and how English use is related to inequality in core-periphery relationships. However, the author recognizes that the theoretical concept of colonialist discourse *is too dichotomous to apply to the multilayered structure of the real world. To some extent, Traweek's notion of "the acceptance of the Euro-American dominant scientist" can be related to English use in the means of achieving a competent scientist for nonnative English speakers who are located in the periphery. This becomes a social-structural problem of using another language to nonnative English-speaking scientists and engineers. Korean scientists' and engineers' international scientific activities are greatly motivated by sociocultural determinants such as cultural prejudice, their peripheral position, reputation and recognition, and English competence. Although English use greatly affects their international activities, especially paper publication in international journals, they tend to disregard the general English problem by separating general English use from scientific English use.*

Keywords: *inferior science; international scientific activities; Korean science and technology; reenactment of colonialist discourse; scientists' perceptions of Korean science; dominance of English use in science and technology; unbalanced structure between basic science and technology; basic research and implementation skills*

*Search is in titles, abstracts, and keywords, only

Getting started …

	Step 1: Keyword queries (N = 2,386)	Step 2: Human Coding to Confirm Relevance*
	Articles Returned	Article Retained (a = .81, N = 2,386)
Astron+	28	25
Cosmol+	2	2
Galaxy	1	1
Neutrino	1	1
Particle	2	2
Planet+	9	6
Quark	2	1
Solar system	1	1
Astrophy+	2	2
Chemi+	22	14
Evolution+	60	29
Nanosci+	7	7
Nanotech+	63	60
Neuro+	22	15
Physics	45	24
True Total***	237	161
Percentage	10%	7%

n = 38

- Keyword strategy to reduce articles
  - Source 1: Collaborator discussion of words that might suggest a 'basic science' focus
  - Source 2: Department of Energy, Kavli Foundation websites
  - Source 3: NVivo keyword 'cloud' to identify missing words
  - Separate list of 'applied' words (~technology, health focused)
- Human coding* of keyword-selected articles
  - Reduced to n = 161 (*a* = .81, n = 24)
  - Articles can have more than one code/keyword

*Two independent coders, trained on subset of content while refining coding rules and then remaining content without knowing what content was being double coded

Other keywords …

Table 2. Number of articles with 'applied science' keywords from (N = 2,386) from *Public Understanding of Science* (n = 1,061), *Science Communication* (n = 629), *Journal of Science Communication* (n = 513), and *International Journal of Science Education Part B: Communication and Public Engagement* (n = 183)*

Keyword	#	Keyword	#	Keyword	#	Keyword	#	Keyword	#
Technology	650	Threat+	63	Therap+	22	Renewable	9	Carbon dioxide	3
Polic+	318	Religio+	61	Species	22	Flu	7	Recycling	3
Education+	313	National Science	59	Philosoph+	21	Physician	7	Wind	3
Risk+	271	Career	52	Synthetic	20	Curiosity	7	Car	3
Fund	265	Agricul+	48	Zoo+	19	Invasive	7	Turbine	2
Politic+	246	Sustainab+	43	Diagnos+	18	Artificial intelligence	7	Agron+	1
Govern+	243	Ecology	42	Mobile	18	Vehicle	7	Astrol+	1
Health+	233	Math+	41	Embryo+	17	Autism	6	Computer Scientists	1
Genetic+	215	Energy	41	Virus	17	Ebola	6	Aquatic	1
Climate	198	Psychology	38	Doctor	16	Chemistry	6	Carbon capture	1
Environmental+	197	Global warming	38	Genetically engineered	16	Hydraulic fracturing	6	Crispr	1
Histor+	138	GM	35	Cancer	15	H1N1+	5	Battery	1
Medic+	121	Biomed+	35	Clinic+	15	Pharma+	5	Solar Panel	1
Food+	97	Animal+	35	Law	14	Cognitive science	5	Translational	0
Museum	93	Nuclear	31	Weather+	14	Geoeng+	5	Aerosp+	0
Accept+	90	Conservation	29	Corona+	12	SARS	4	Astrob+	0
Biotech+	86	Vaccin+	28	Autonomous	11	Biosci+	4	Atomic	0
Engineer+	83	STEM Cell	27	Drug	10	Geolog+	4	Dam	0
Genetically modified	75	Earth+	26	Chemic+	10	Endangered	4	Hydropower	0
Regulat+	72	Patient	25	GMO+	9	Storage	4	Solar cell	0
Industry	71	Epistemolog+	24	Botan+	9	Hydrogen	4	Automobile	0
Disease	69	Clone	24	Fracking	9	Social Psychology	3	Drone	0
Biolog+	66								

Notes: # refers to the number of articles retrieved using the keyword from the title or abstract downloaded from Web of Science up to December 31, 2020.

Step 3. Human coding for method

(To find data that might speak to best practices)

	Step 1: Keyword queries (N = 2,386)	Step 2: Human Coding to Confirm Relevance*	Step 3: Coding of Relevant Retained Articles to Determine the Type of Data Included in the Article (n = 161)**					
	Articles Returned	Article Retained (a = .81, N = 2,386)	Quantitative (a = .95)	Qualitative (a = .79)	Content Analysis (a = .81)	Theoretical (a = .65)	Case Study (a = .85)	Historical (a = .NA)
Astron+	28	25	7	5	6	2	5	1
Cosmol+	2	2	0	0	1	0	1	0
Galaxy	1	1	1	0	0	0	0	0
Neutrino	1	1	0	0	1	0	0	0
Particle	2	2	1	0	0	1	0	0
Planet+	9	6	1	1	2	0	2	0
Quark	2	1	0	0	0	0	1	0
Solar system	1	1	0	1	0	0	0	0
Astrophy+	2	2	2	1	0	0	0	0
Chemi+	22	14	5	4	5	2	1	0
Evolution+	60	29	4	2	9	10	2	2
Nanosci+	7	7	2	2	1	2	2	0
Nanotech+	63	60	22	16	11	9	7	0
Neuro+	22	15	2	4	4	2	2	1
Physics	45	24	7	6	3	4	5	3
True Total***	237	161	47	37	35	26	21	6
Percentage	10%	7%	29%	23%	22%	16%	13%	4%

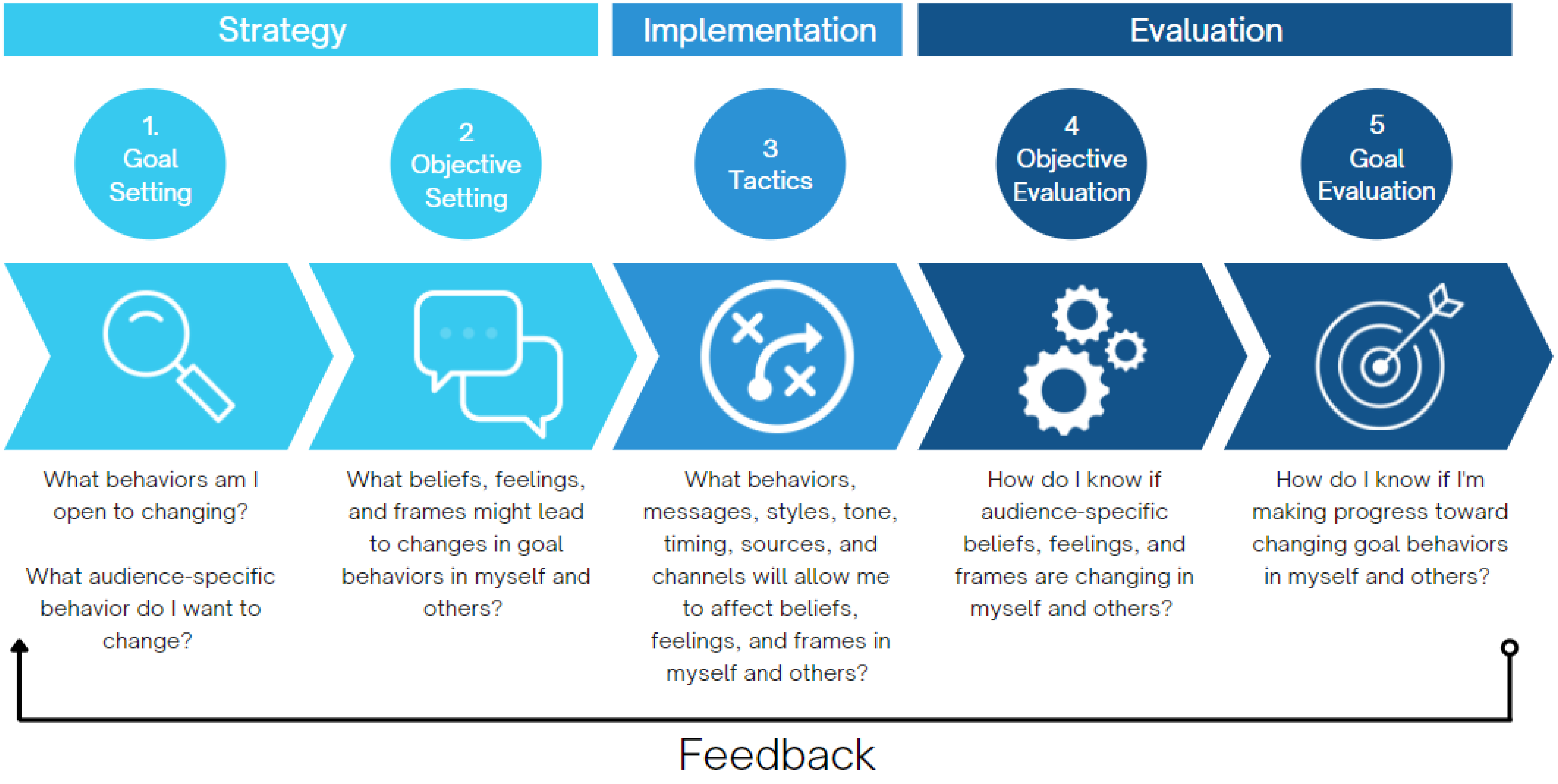
**Two independent coders, trained on subset of content while refining coding rules and then remaining content without knowing what content was being double coded (n = 49, ~30% of sample), review based on downloaded copy of full article. ***Articles could be coded for more than one category.

- Articles could include multiple forms of ‘data’
- *Main Conclusion:* Only about 5% of all articles are (a) substantively focused on basic science and (b) include contemporary, non-content analysis data

Step 4. Qualitative read* of (a) quantitative, (b) qualitative, and (b) case study abstracts

- Looking for broadly-defined potential …
  - *Goals:* Behavior-like outcomes such as funding, support, science career choice, long-term relationships, <u>scientist research choices</u>
  - *Objectives:* Individual outcomes such as non-scientists' <u>or scientists'</u> scientific knowledge, evaluative beliefs (e.g., risk/benefits, norms, self-efficacy, or trustworthiness-related beliefs), feelings/emotions, frames, or psychological processes (e.g., cognitive engagement)
  - *Tactics/Activities:* Communicative behaviors (e.g., timing, location), messages (e.g., images, words), styles/tones (e.g., humor, serious, narrative), source choice, channel

Step 4. Qualitative read* of (a) quantitative, (b) qualitative, and (b) case study abstracts



Besley, J. C., Dudo, A., & Yuan, S. (2018). Scientists' views about communication objectives. *Public Understanding of Science, 27(6), 708-730.* Besley, J. C., Newman, T., Dudo, A., & Tiffany, L. A. (2020). Exploring Scholars' Public Engagement Goals in Canada and the United States. *Public Understanding of Science, 29(8), 855-867.* Besley, J. C., O'Hara, K., & Dudo, A. (2019). Strategic science communication as planned behavior: Understanding scientists' willingness to choose specific tactics. *PLoS ONE, 14(10), e0224039.*

Step 4. Qualitative read* of (a) quantitative, (b) qualitative, and (b) case study abstracts

Articles seem to focus on …

- *Tactics/Activities:* Primary focus on events, exhibits, media use
- *Objectives:* Near exclusive focus on fostering/understanding scientific knowledge, risk and benefit beliefs (especially in nanotech context), and emotions/feelings (e.g., awe, interest)
- *Goals:* Some focus on public acceptance/support (especially in nanotech context) and youth career choice

*Thematic analysis using NVivo with emergent codes and theory derived codes

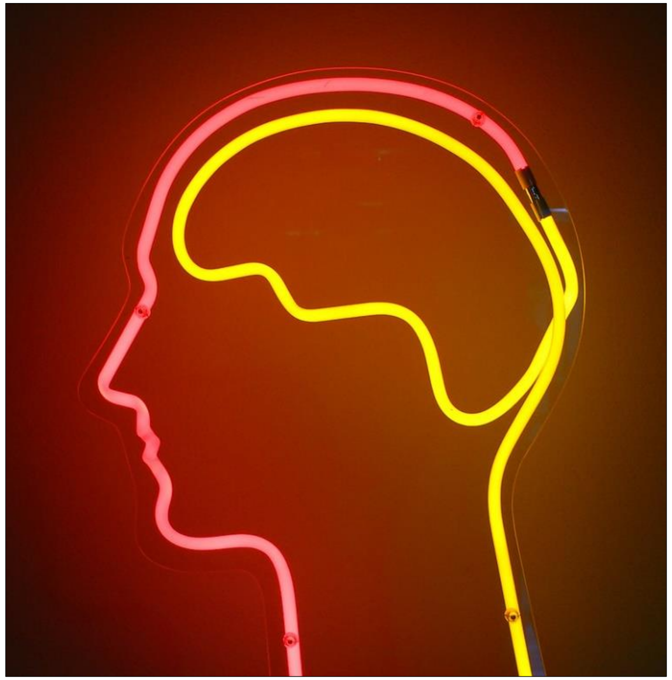
What about ‘two way’ public engagement?

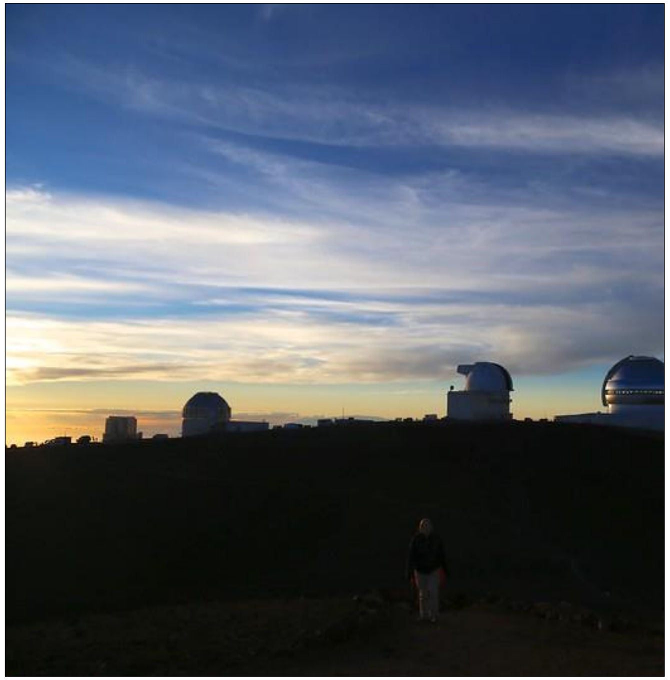
We saw almost no research where a goal or objective was changing scientists’ behaviors, knowledge, evaluative beliefs, feelings, or frames

Step 5 … exploratory deep dive into neuroscience and astronomy communication literature

(with forays beyond the 'core' journals)

Similar to other topics, with some specific emphasis on how neuroscience is perceived and the danger of misuse, especially in context of brain imagery





Similar to other topics, with some specific emphasis on career goals and funding, positive emotions (e.g., awe and wonder), as well as imagery

Brain by Dierk Schaefer and Jesse Richmond, both via Flickr Creative Commons

Our questions now …

- Is it worth fostering more discussion within basic science communities about long-term communication goals?

- Would more discussion about long-term goals help broaden the range of communication objectives being studied in the context of basic science topics?

- Would more discussion of near-term communication objectives help people in the scientific community identify and evaluate specific communication activities/tactics?

Key point: Clarity about behavioral goals and individual-level communication objectives lets you use literature from across the social sciences