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Lay Sensitivity to Sampling and Selection Errors in Scientific Studies

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Introduction

Individuals are regularly exposed to science media that makes causal claims about health and behavior yet they struggle to distinguish good from bad science and judge whether evidence is consistent with the claims (Shah et al., 2017; Sinatra & Hofer, 2016). In particular, people are overly influenced by prior beliefs and motivations (e.g., Lewandowsky et al., 2012) and accept unwarranted causal inferences based on correlational data (Seifert et al., 2022).

Here, we address the extent to which people are able to notice specific flaws to internal and external validity: Non-random assignment (Unequal attrition, Blocked Assignment, Self-Selection) and use of a Biased Sample

Methods

Experiment 1. 316 online participants completed a series of article comparisons (see Fig 1), in which they compared news-style reportings of scientific studies *with* and *without* flaws related to sampling and selection.

After comparing the two articles, they were asked (1) to judge which study better supported the author's conclusions, and (2) what they would do to improve the worst of the two studies.

Individual difference data were collected on: Subjective Numeracy, Intuitive/Deliberative Thinking (Cognitive Reflection Test), Actively Open-Minded Thinking (AOT), Self-reported familiarity with research methods.

Experiment 2. 438 online participants rated only one article that varied according to the type of error and the framing: control (no error), implicit framing, or with the error explicitly called out to see if they recognize that the critical flaws are problematic for evaluating the study.

Acknowledgements

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Materials

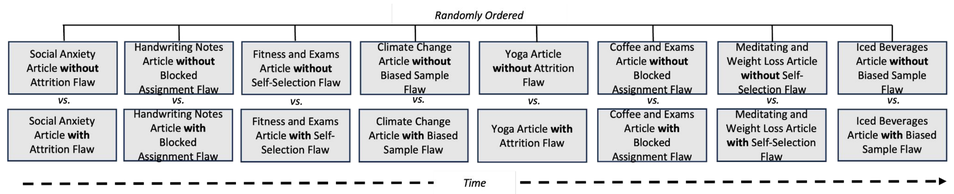
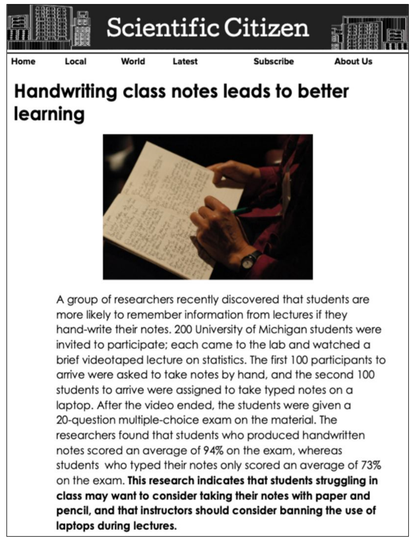


Figure 1. Experiment 1 Methods



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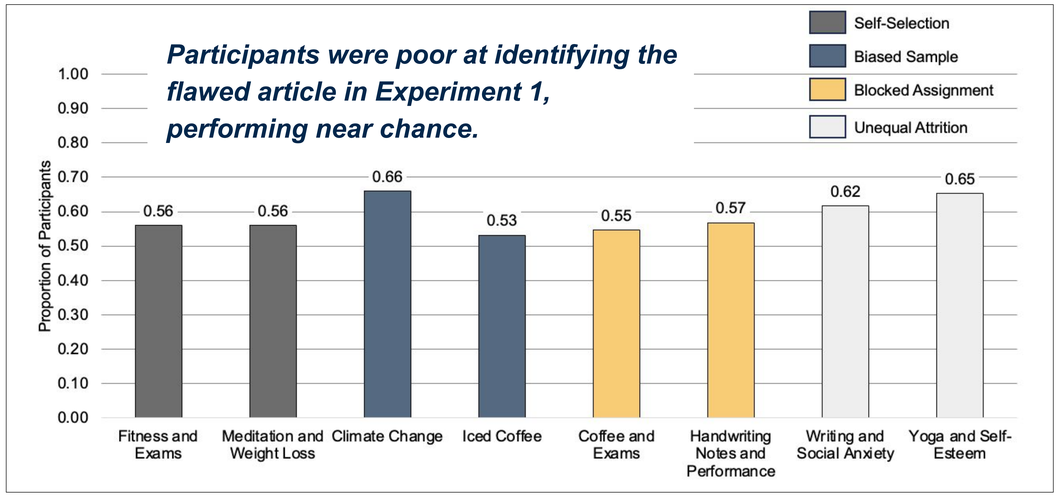
Handwriting class notes leads to better learning

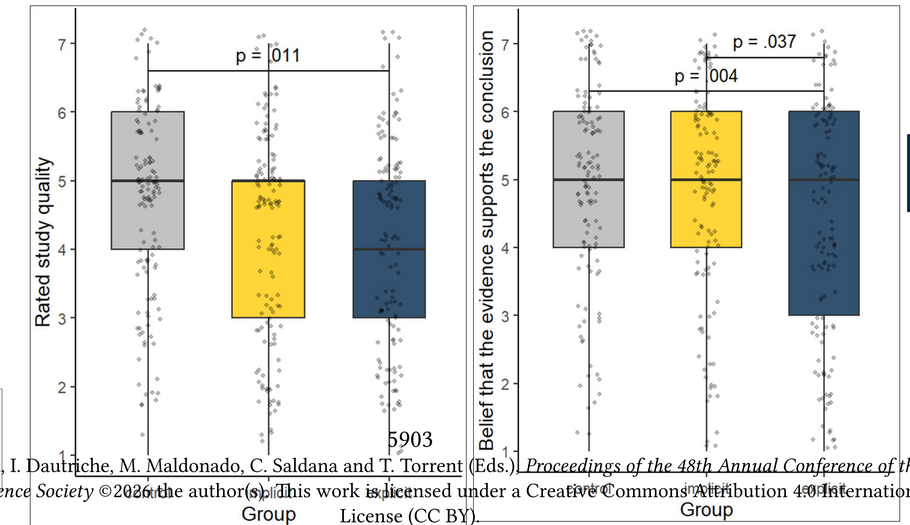
A group of researchers recently discovered that students are more likely to remember information from lectures if they hand-write their notes. 200 University of Michigan students were invited to participate; each came to the lab and watched a brief videotaped lecture on statistics. The first 100 participants to arrive were asked to take notes by hand, and the second 100 students to arrive were assigned to take typed notes on a laptop. After the video ended, the students were given a 20-question multiple-choice exam on the material. The researchers found that students who produced handwritten notes scored an average of 94% on the exam, whereas students who typed their notes only scored an average of 73% on the exam. **This research indicates that students struggling in class may want to consider taking their notes with paper and pencil, and that instructors should consider banning the use of laptops during lectures.**

Figure 2. Example Article

Results



In Experiment 2, participants were more sensitive to errors when they were made explicit in the article, reporting lower rated study quality (p = .011) and belief in evidence (p = .004).



	Blocked Assignment – Coffee and Exams			Blocked Assignment –Notes and Exams		
	Estimate	*SE*	*Sig*	*Estimate*	*SE*	*Sig*
Prior Beliefs	0.12	0.20	.53	-0.006	0.22	.98
Subjective Numeracy	-0.12	0.32	.70	0.15	0.34	.66
Methods Familiarity	0.84	0.43	.05	0.99	0.45	.03*
AOT	1.36	0.37	< .001**	1.53	0.38	< .001**
CRT	0.64	0.39	.10	0.34	0.38	.38
	Unequal Attrition – Writing and Anxiety			Unequal Attrition - Yoga		
	Estimate	*SE*	*Sig*	*Estimate*	*SE*	*Sig*
Prior Beliefs	-0.27	0.22	.22	-0.23	0.23	.30
Subjective Numeracy	-0.04	0.31	.89	-0.15	0.30	.60
Methods Familiarity	0.53	0.36	0.18	0.34	0.36	.35
AOT	1.53	0.40	< .001**	1.30	0.36	< .001**
CRT	0.60	0.39	.12	0.38	0.36	.30
	Biased Sample – Climate Change			Biased Sample – Iced vs Hot Coffee		
	Estimate	*SE*	*Sig*	*Estimate*	*SE*	*Sig*
Prior Beliefs	0.21	0.28	.44	-0.10	0.20	.63
Subjective Numeracy	0.27	0.30	.36	0.57	0.32	.07
Methods Familiarity	0.20	0.33	.54	0.001	0.34	.99
AOT	1.52	0.35	< .001**	2.13	0.47	< .001**
CRT	0.29	0.34	.39	-0.34	0.39	.38
	Self-Selection – Fitness and Exams			Self-Selection – Meditation		
	Estimate	*SE*	*Sig*	*Estimate*	*SE*	*Sig*
Prior Beliefs	0.12	0.20	.55	-0.98	0.22	.72
Subjective Numeracy	-0.11	0.30	.71	0.14	0.31	.64
Methods Familiarity	0.64	0.37	.08	0.59	0.37	.10
AOT	1.46	0.34	< .001**	1.60	0.36	< .001**
CRT	0.39	0.35	.27	0.31	0.35	.38

Higher actively open-minded thinking was associated with better error identification across contexts (p < .001).

Conclusions & Discussion

- Laypeople struggle to detect sampling, selection, and assignment errors in scientific studies.
- Higher AOT predicts flaw detection, suggesting analytic disposition and effortful engagement — not just knowledge — are crucial for evidence evaluation.
- Explicit labeling enables recognition, suggesting detection failures reflect inattention rather than inability.
- How can we foster AOT in science education?

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