Re-Assessing the Experiment / Observation Divide

Florian J. Boge

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ARTICLE

Re-Assessing the Experiment / Observation-Divide

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Abstract

The article reevaluates the distinction between experiment and observation. It is first argued that to get clear on what role observation plays in the generation of scientific knowledge, we need to distinguish "experiential observation" as a concept closely connected to experience from "observation" in a technical sense and from "field observation" as a concept that reasonably contrasts with "experiment." It is then argued that observation construed as field observation can enjoy systematic epistemic advantages over experiment, contrary to appearances.

1. Introduction

Observations are central to empirical science, though what *counts* as an observation is all but obvious: van Fraassen (1980) coined a notion that allowed him to distinguish observation from inference by tying observation to unaided sense-perception; Shapere (1982) criticized empiricist notions as inappropriate to scientific usage, but his own account was criticized as too narrow (Bogen and Woodward 1988) or even off target (Linden 1992). So what *is* observation, and what *role* does it play in the generation of scientific knowledge?

Furthermore, there is a complicated relation between observation and *experiment* that "mainstream philosophy of science has had rather little to say about" (Okasha 2011, 223). On one hand, experiments seem unthinkable without observations: Michelson and Morley (1887) observed interference-fringes to determine earth's motion relative to the ether and Geiger and Marsden (1913) scintillations on a fluorescent screen to probe the nucleus's structure. On the other hand, "observational" is sometimes used as an *antonym* to "experimental," and we see claims to experiment's epistemic superiority over observation (Okasha 2011, 226–27; Woodward 2003b, 43–45). But this cannot be right if the preceding is too. So how *does* observation relate to experiment?

These questions can be answered only after due disambiguation. I shall hence distinguish "observation in the technical sense" (TO) from "experiential observation"

Introduction

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2. 'observation' ∼'inferentially establishing'
   - connection / difference?

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- Michelson and Morley (1887) observed interference-fringes to determine earth's motion relative to the ether;
- Geiger and Marsden (1913) observed scintillations to explore nucleus' structure
- how compatible with 'observational' being an antonym to 'experimental'? (Okasha, 2011; Woodward, 2003b)

Agenda

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- clarify the notion of ‘observation’

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- establish the epistemic hierarchy between them (or: whether there is one)
- check whether there is a dichotomy

Part I: Three Notions of Observation

van Fraassen (1980)

Seeing with the unaided eye [is] a clear case of observation

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- ‘observation’ of Higgs boson

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$\rightsquigarrow$ barely involves looking & seeing

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information [...] transmitted [...] without interference, to [an appropriate receptor] from the entity *x* [...]

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- 'observation' of Higgs boson means 'effect $\geq 5\sigma$'

$\rightsquigarrow$ sometimes: decidedly statistical

Bird (2022)

a representation [...] that carries information that *p* that is causally dependent on the fact that *p* and which can fulfil the role of basic scientific evidence [...].

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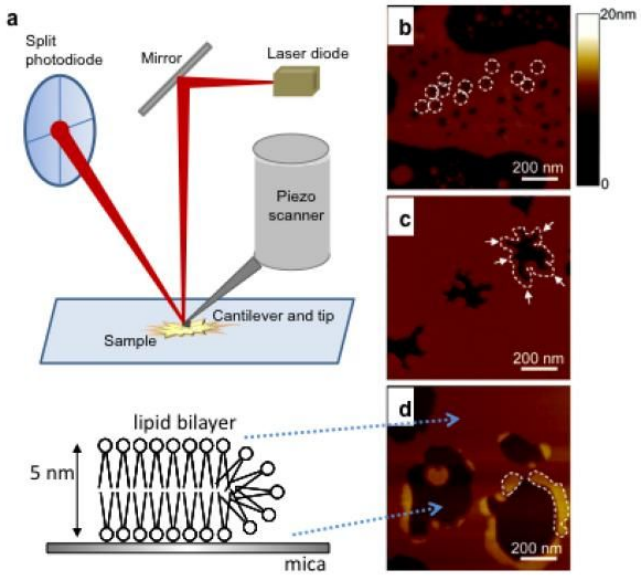
- not always appropriate
- 'observation' of Higgs boson ($\geq 5\sigma$) contrasts with 'evidence' ($\in [3, 5)\sigma$).

$\rightsquigarrow$ 'We do have evidence for x's existence but we have not (really) observed it (yet).'


a
Split photodiode
Mirror
Laser diode
Piezo scanner
Cantilever and tip
Sample
lipid bilayer
5 nm
mica
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20nm
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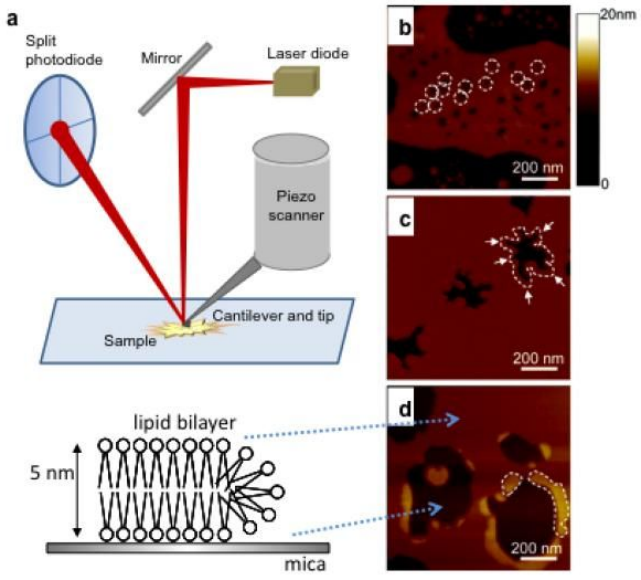
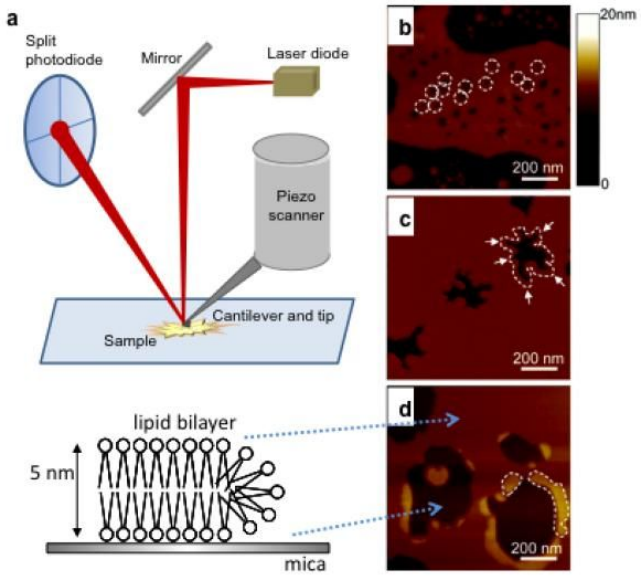


- *pace* Bird: observation takes place when images are interpreted as showing relevant phenomena



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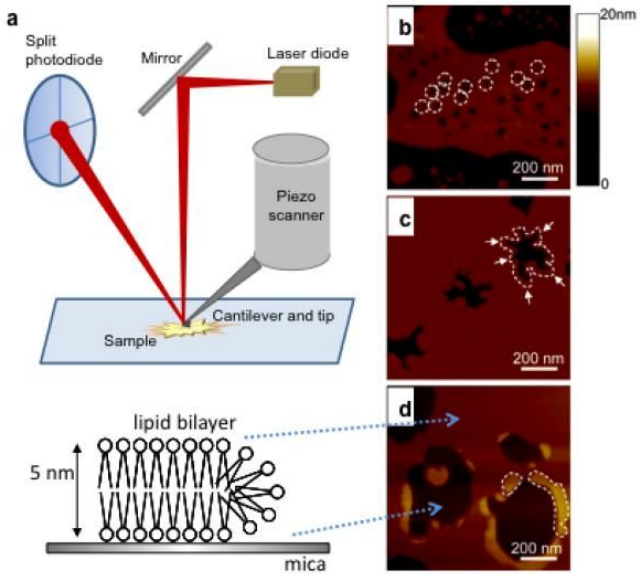
- *pace* Shapere: receiver? tip? cantiliever? laser beam? electronics used to convert beam into image…?



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⇝ family of technical terms that vary across disciplines / applications (Fodor, 1984)

What unites the family?

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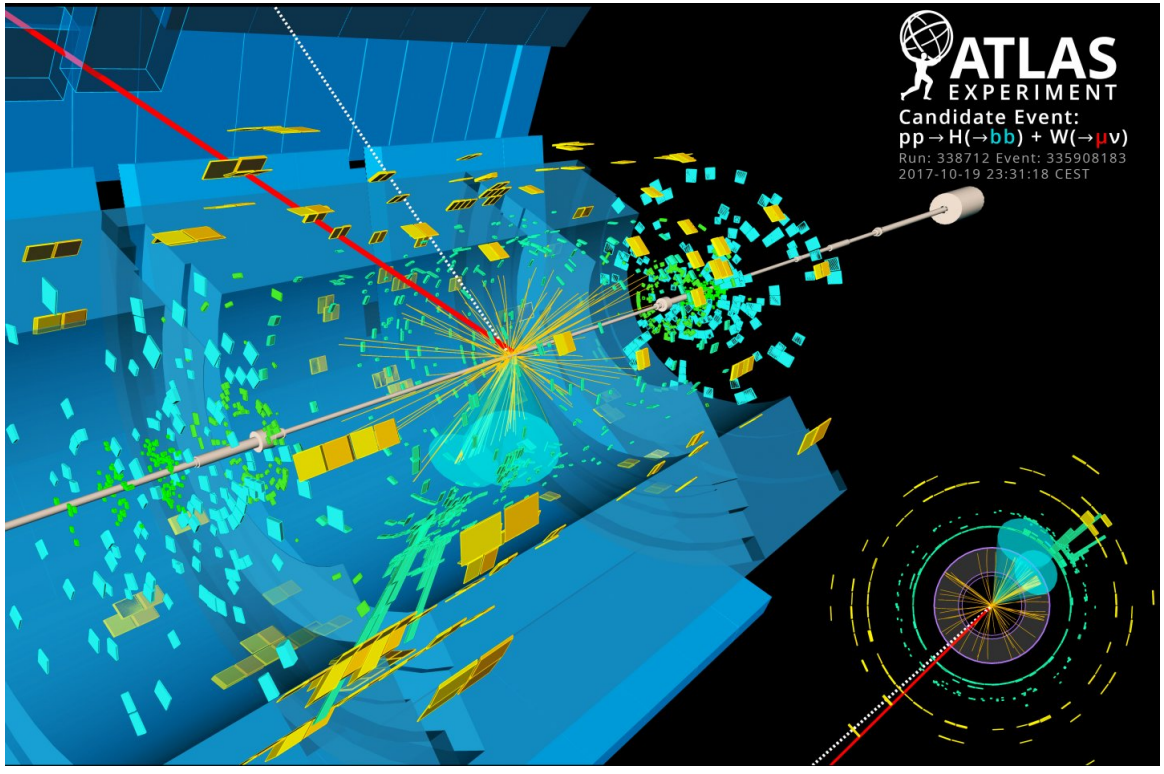

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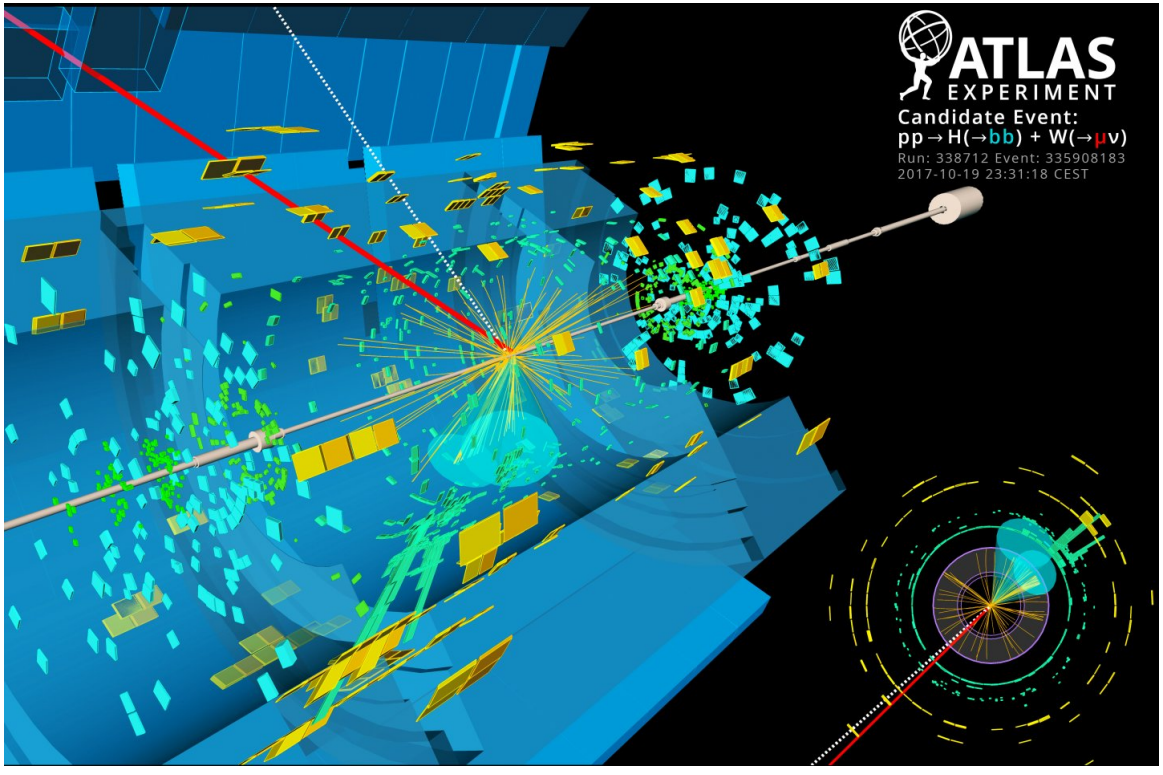

causal contact

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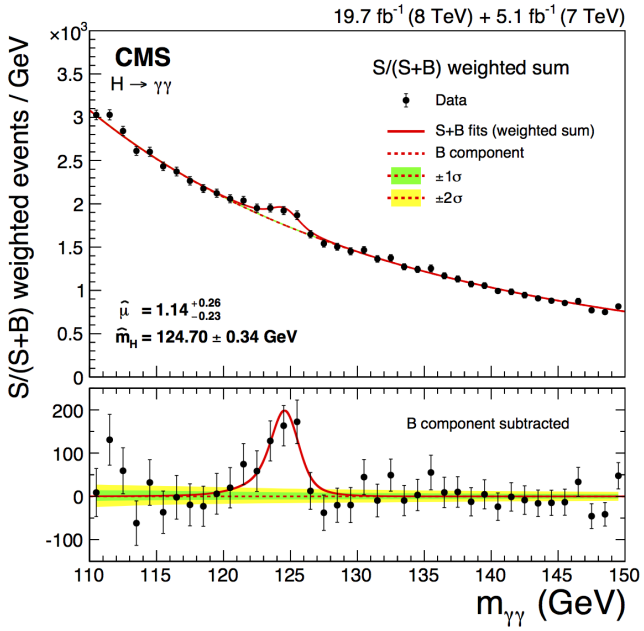

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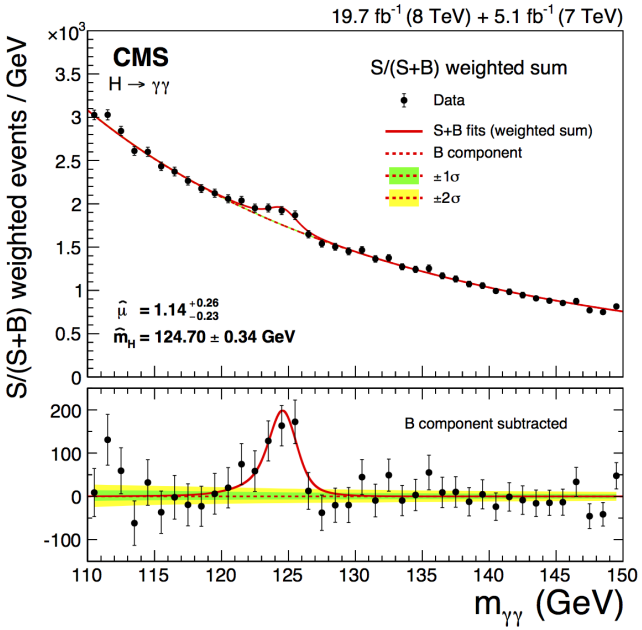

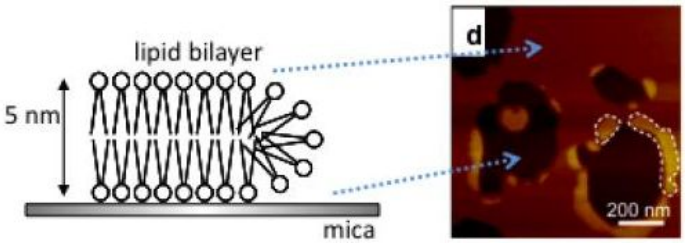

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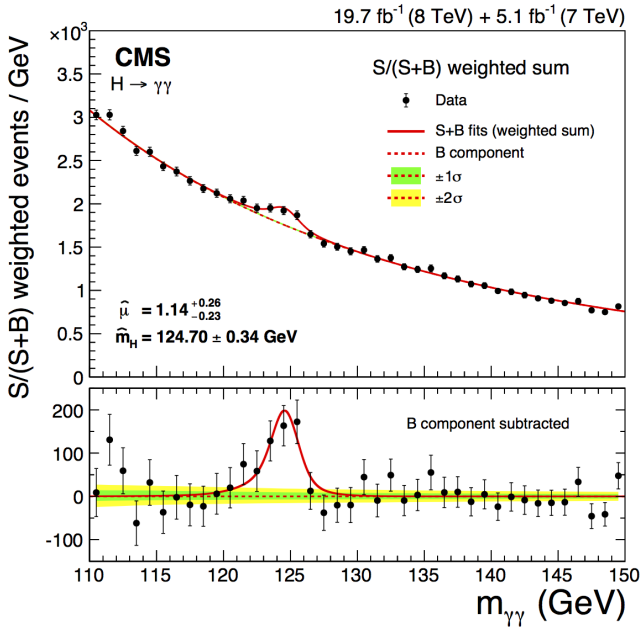

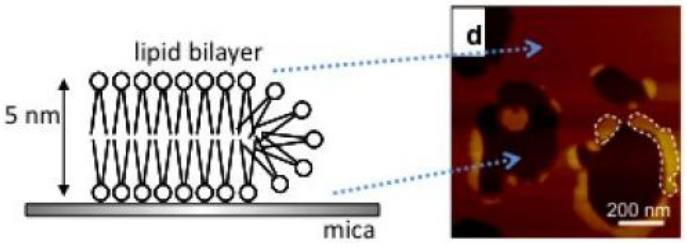

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- null results may be TOs

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- ... TO can occur in experiment as well ...
- contrast observation-experiment?

observation in the field

(Currie and Levy, 2019; Perović, 2021)

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- doesn’t allow control

Field Observation (FO)

Process *p* is a field observation (FO) of *y* by *x* *only if* in the course of *p*, *x* takes data on *y* in an unperturbed fashion, *i.e.*, without *x* exerting control over *y* by relevantly manipulating *y*'s state.

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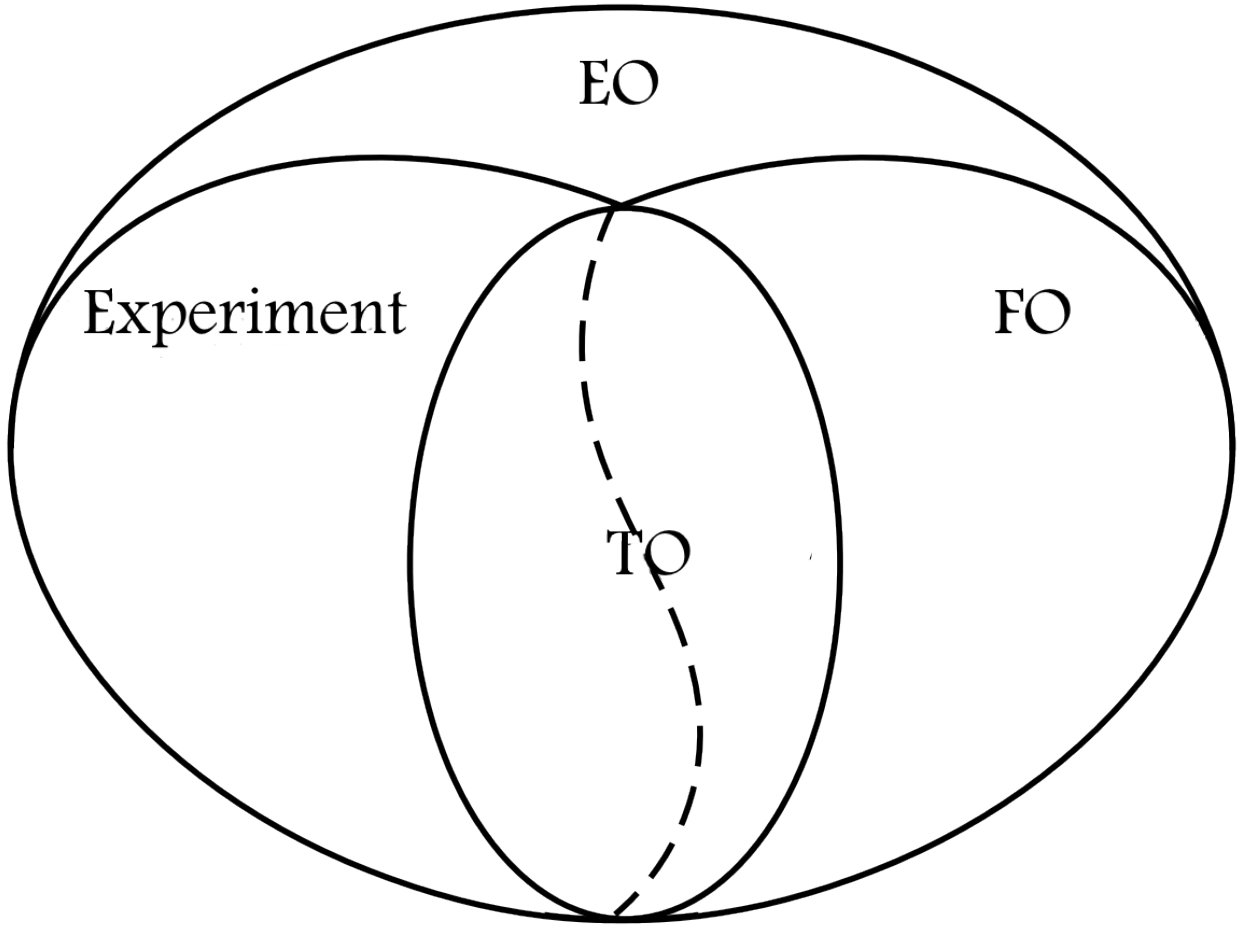
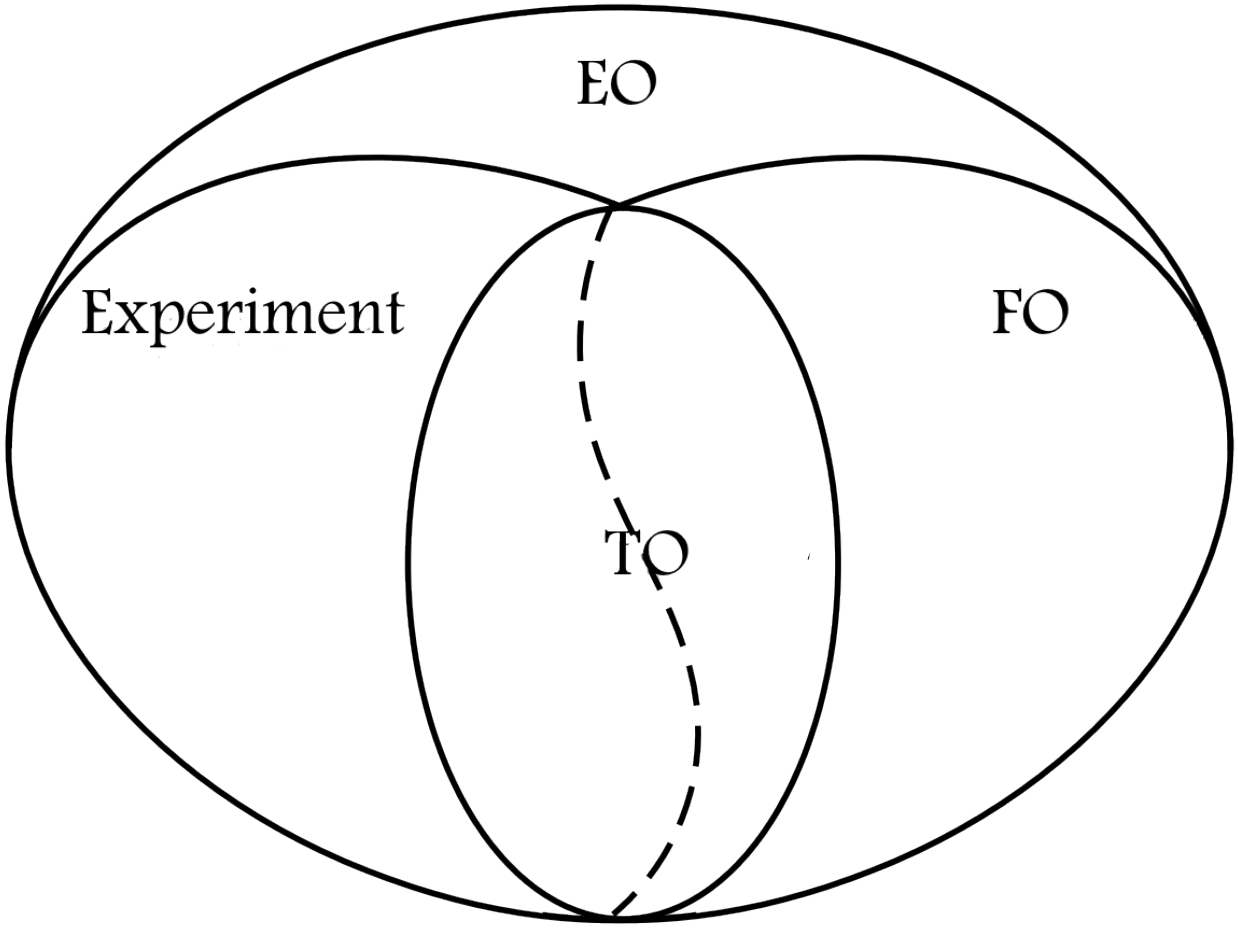
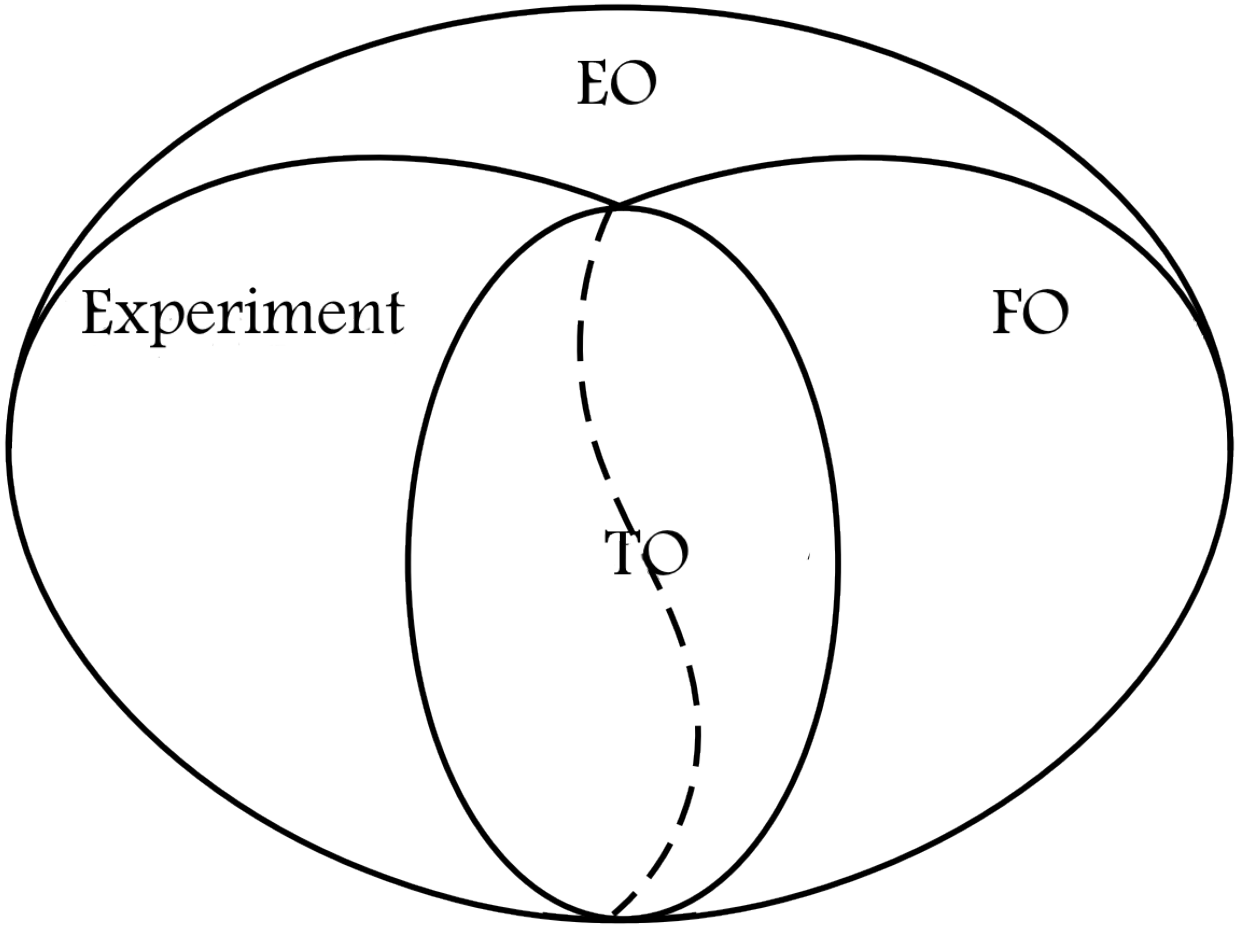
- still: representational (Bogen and Woodward, 1988; Delfino, 2020)
- causal contact


EO
Experiment
FO
TO



- boundary sharp?



- boundary sharp?
- does it signify epistemic priority?

Part II: The Experiment / Observation Divide

Benefits of experiment

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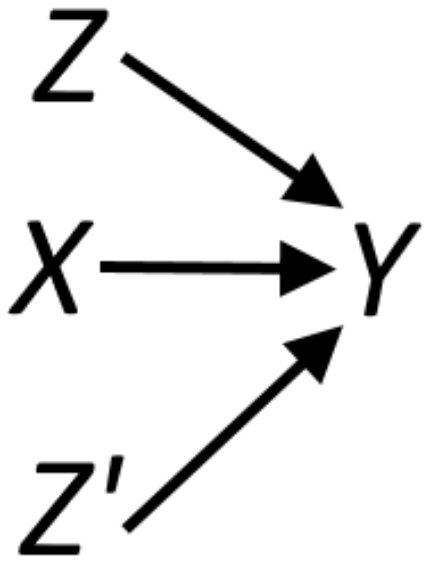

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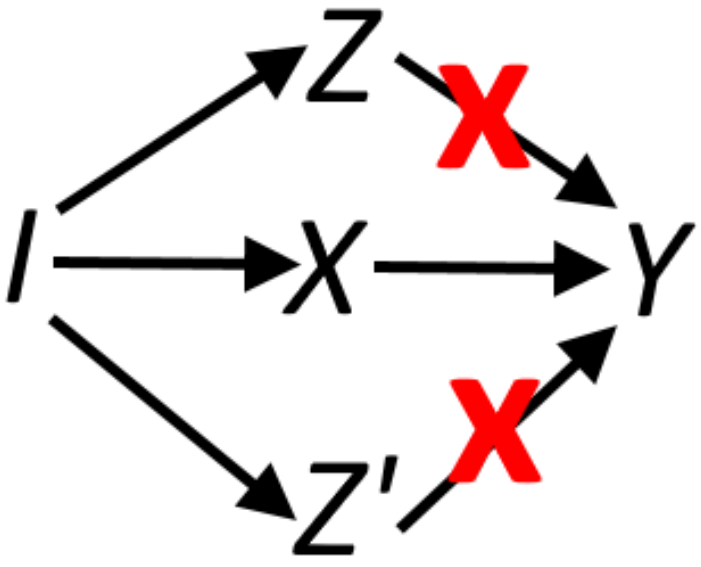

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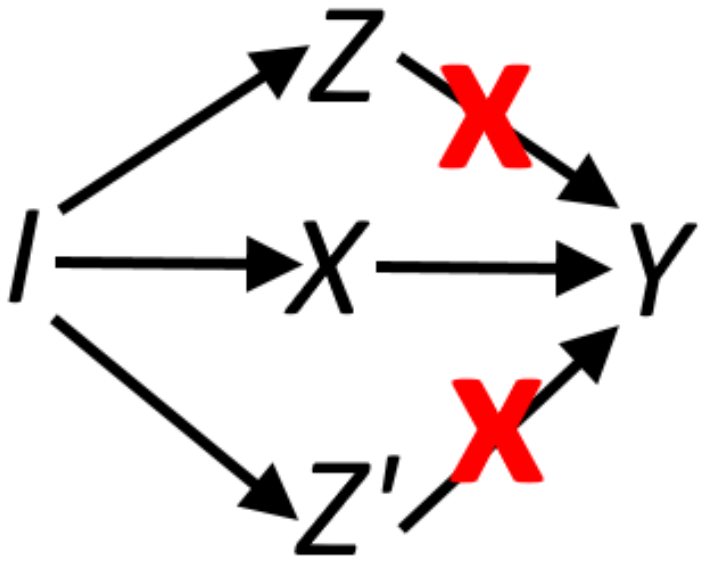
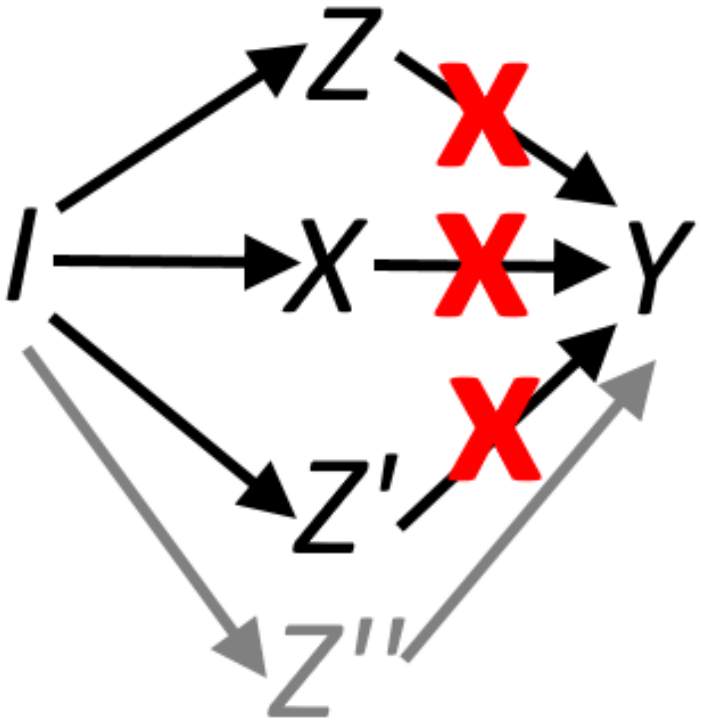


(Woodward, 2003b)

Benefits of experiment



Benefits of experiment

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Okasha (2011)

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- $p(\forall x(Fx \rightarrow Gx)|Ga \wedge Fa) = p(\forall x(Fx \rightarrow Gx)) \times p(Fa \wedge Ga|\forall x(Fx \rightarrow Gx))/p(Fa \wedge Ga)$

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- oversimplifying, but...
- could also be realized in observation (Boyd and Matthiessen, 2023; Okasha, 2011; Woodward, 2003b)

Benefits of observation?

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- intrinsic benefits of FO?

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- detailed engagement with workers: increase in motivation
- plethora of effects (McCambridge et al., 2014)

Only psychology?

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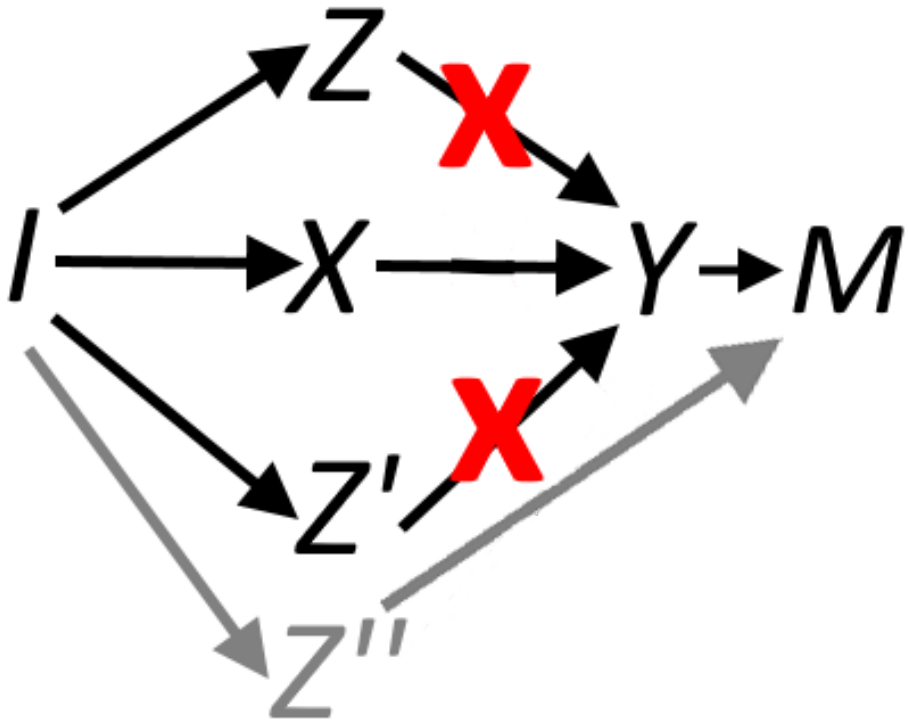

(Craver and Dan-Cohen, 2021)

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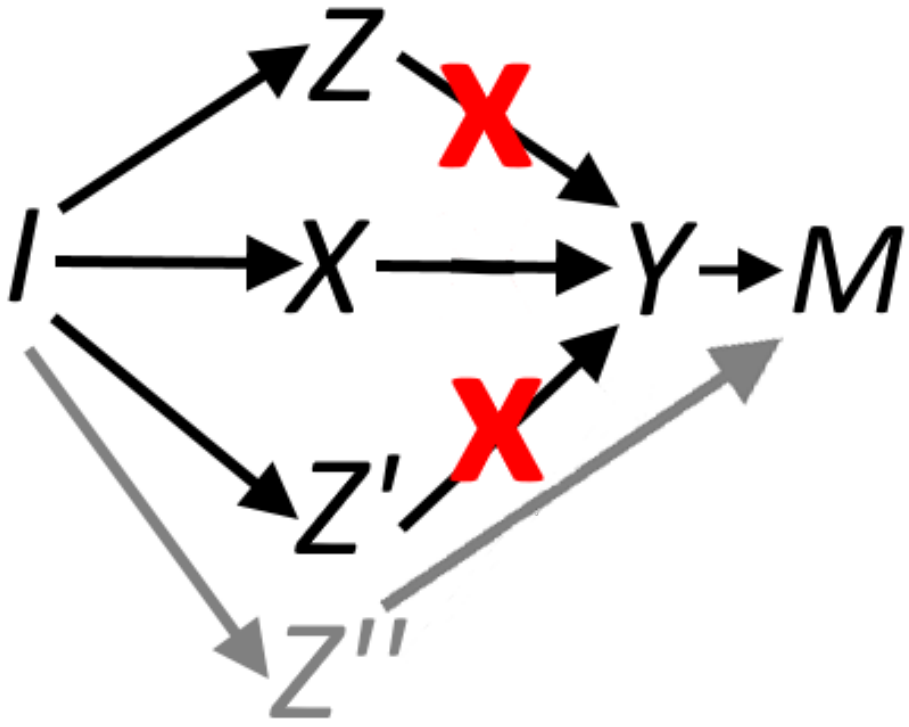

(Craver and Dan-Cohen, 2021)

... possible... but...

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preparation artifacts [...] arise when the biological specimen is fixed, cut, stained, or decorated for light or electron microscopy [...] probably still one of the most frequent forms of error in biological laboratories.

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... doesn't show that the relevant information could be gathered by means of FO

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internal vs. external validity of RCTs

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- internal validity: freedom from systematic biases

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- securing internal validity means exerting control
- does this impact external validity?

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- e.g, on influence of ‘undocumented factors’ on treatment variability (ibid.)

Coda: Bordeline Cases?

Morgan (2013, 343)

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- include interventions, so ipso facto experiments
- 'field' in FO refers to natural behavior
- here, refers to natural environment

Woodward (2003a, 103)

An event or process not involving human action at any point will qualify as an intervention [...] as long as it satisfies [certain conditions]. [...] It is this possibility that scientists have in mind when they speak of “natural experiments.”

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- still an FO, since no control exerted by human
- underscores that FO may be epistemically on a par

Mättig (2021, 14432–3)

the collisions of interest are primarily not those of protons, but of the quarks and gluons inside the proton. These can hardly be varied by targeted intervention [...].

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[W]hat the LHC delivers is a huge range of different final states. The "properties of interest" are obtained by selecting certain types of events, comparable to surveys of galaxies by telescopes. In consequence, the material information obtained from the LHC is a mixture of targeted intervention and observation [...] a hybrid of experimental practices and observation

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- administering drugs to mice, we want to find out about organs, not mice
- “properties of interest” will always be obtained by selecting certain types of events (experimental noise)
- does that make animal studies “a hybrid of experimental practices and observation”?

Conclusions

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  - paying dedicated attention to an object of experience (EO)

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  - paying dedicated attention to an object of experience (EO)
  - taking data in an unperturbing fashion (FO)
  - successfully establishing a relevant claim based on causal contact (TO)

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  - both are complementary sources of information that should be used in concert whenever possible
- more work needs to be done!

Thanks

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