CHIP-3

Concepts and history in psychology

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http://www.psy.gla.ac.uk/~steve/courses/chip.html

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Pure and applied science are different

1) They have a different logic

The Newtonian triad applies to pure science; where the aim is to uncover universal laws that are true everywhere for all time, but may be negligibly small in their effects in some contexts. The approach is to isolate the one law you are interested in ("control" away all other causal effects). Truth over as many contexts as possible is the goal, not effect size.

Applied science is fundamentally different in its characteristic logic.

Its measure of success is benefit to real people in real contexts.

1.2) Pure vs. applied

“Pure” focusses on a single cause and all its consequences

“Applied” on (achieving) a single effect and all its causes (necessary and sufficient conditions)

Applied success depends not on one law/factor, but on all the factors with significant effects in the context: just like running a business.

On the other hand, you can ignore true things if they are small:
Effect size not universal truth is what matters.

1.3) Applied: how it works

The first step in any problem is to find out what the biggest factors are; or the biggest factors you could possibly influence.

(Why effect sizes are important in applied science.)

The measure of success is not discovering truth but helping people (patients cured, learners attaining more, bridges that carry traffic).

2) They entail different research programmes

The different logics for conclusions entail different research programmes i.e. sequences of studies. This is important in conducting research, and in doing relevant critiques.

A programme for pure research will tend to go for identifying one single cause, learning how to control away all other causes, and then showing that (with appropriate controls and counter-balances) this factor is active in as wide a range of populations and contexts as possible.

A programme for applied research will tend to go for developing a procedure that is effective in real life contexts: e.g. a drug works on cells, then on rats, then on humans in the lab, then when given by a paramedic in remote rural village without safe water or electricity to keep it in a fridge. *[my first aid training]*

2.1) Shayer (1992)

Three stages for applied educational research:

1. Studying the primary effect
   (establishing that with the new method a gain is possible at all)

2. Replicating it without the original researcher.
   (Generalising to A.N.Other teacher, showing it can transfer.)

3. Generalising it = Teacher training
   (rolling it out to teachers who were not volunteers).

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4. Roll-out of an innovation.
   When adopters cannot be forced into using it, it may take a whole roll-out project (marketing campaign?) to get it used.

3) The fallacy that pure must precede applied

Many people think applied derives both logically and historically in each case from pure research. (A spontaneous misconception)

E.g. Theoretical physics - experimental physics - applied physics - mechanical engineering - engineers (building machines) - garage mechanic.

Who does?

Probably because explanations (that we hear) are deductive: from the general to the particular, from theory to cases and applications.

3.1) The fallacy that pure must precede applied

Sometimes pure does lead to applied.
But sometimes it is the other way round e.g.

- Vaccination (cowpox vaccination by Jenner 1796)
- Steam engines (thermodynamics by Carnot 1824; Kelvin 1851)
- Semiconductor technology ("whisker" detectors for radios 1906)
- Radium
- Superconductors
- Much of metallurgy / materials.
- Semmelweiss (1861) and childbirth deaths through sepsis

4) Bottom up research: observing the unexpected and/or untheorised

When applied precedes pure research, it is one kind of bottom up research, where observation precedes theory (induction driven research).

This is actually important everywhere in science.
E.g.

- Zoology
- Astronomy
- AIDS / HIV

In this kind of research programme, it goes:

- Observe
- Develop empirical categories and concepts
- Work “down” to theory as well as “up” to applications.

4.2) Petroski's argument

His argument in effect was that engineering learns largely from disasters (obviously unexpected).

Engineers learn mostly from disasters because we do not, and cannot, know all the factors that matter in advance. When we stray beyond the region where some unknown factor was small then a disaster tells us there is a new factor in town. Because there are literally an infinite number of factors, we can't in general discover them in advance.

Thalidomide (birth defects from a sleeping pill).

4.3) Testing for the unexpected

If we believe Petroski then could we test for the unexpected?

Open-ended observation and its largely undiscussed importance.

5) Construction-ism

Papert & Harel (1991)

A major class of evidence is the construction of a new artifact (or process). This is an existence proof. If it exists then it is possible and can be built. (In pure science, you must stay with what nature happens to have provided.)

Applied science, engineering, …. Medicine, education, ….

An artifact is a special case of an existence proof (cf. Popper): the very existence of an object proves it is possible, and disproves any assertions that it cannot be.

Argument structures

This set of slides is about argument structures.

There is not one single structure for scientific arguments;

Disciplines often focus on only one or two formats: but is this a weakness?
Can the convention holding sway in a given discipline at a given time obstruct or prevent progress?
What about psychology?

Reminder: the Newtonian triad

1) A theory

2) Calculation / prediction: generate testable consequences from the theory. (A theory that can explain anything implies we shouldn't think any more, or learn any more.)

3) Observation, experiment

<u>Some schemas:</u>

- <u>Falsifiability</u> —> must be able to do 2, then 3
- <u>Induction</u> —> take existing 3 and generate 1.
- Similarly the method of examples and counterexamples uses existing 3 to check 1: allows tests of theories without new 3. E.g. my arguments about emotion.

Argument schemas (0)

This slide may or may not belong here; or earlier lecture?

Four classes of inference (reasoning, argument types):

1. Deduction: Certain; usually from general to particular
2. Induction: from particular cases to a generalisation (never certain).
3. Abduction: to the best explanation: (Sherlock Holmes)
4. Transcendental: necessary explanation. Arguing what must be true of all possible cases/worlds.

Argument schemas (1)

Kuhn focussed on non-rational aspects of actual scientific research communities.

Disciplines often focus on only one or two formats for scientific arguments: but is this a weakness?

Can the convention holding sway in a given discipline at a given time obstruct or prevent progress?

Ted Nield pointed out (for geology) how a discipline at a particular time may only allow one of the possible argument types to be published, and this sometimes obstructs the publication of vital arguments. This kind of restriction is, say, semi-rational: a convention based on methodological problems but perhaps adhered to too rigidly.

Nield on Geology's Argument schemas

Nield (2007) has a bit on the influence of argument schemas in Geology and its obstruction to accepting the theory of continental drift and plate tectonics.

The Americans admired induction: real practical and objective fact gathering, from which generalisations might cautiously be made later; and despised grand European theorising from an armchair, which added no observations (no empirical content) and discarded evidence that didn't fit. (pp. 131-3)

Couldn't get US funding if it said it was testing deductions from theories, only if it looked like induction / abduction: getting new information and discussing it against multiple theories. (pp. 143-145)

Argument schemas (2)

E.g. Darwin's book "Origin of species"

- Proposed one theory, discussed all the supporting evidence
- But surely it had no experimental support, testing?

1) Later biologists do do evolutionary experimental work e.g. given a hypothesis that urban moths are soot-coloured, they might artificially colour moths and look at differential predation.

2) We need to recognise that some disciplines may publish more than one kind of argument schema. E.g. a grand theory, then experimental tests of its predictions.

3) The importance of grand theories is that they look at large collections of evidence as a whole, and seek to find a single synthesis that accommodates it all.
   Paul Nurse's point that many "cranks" e.g. climate change deniers are essentially selecting just a few observations that suit their view. This is legitimate from the viewpoint of counterexample arguments; but ….

Some argument schemas (3)

Obs = observation/dataset
th. = (general) theory
hyp = (specific) hypothesis / prediction
The new element being published is in red
=> shows the conclusion, if any, being asserted.

a) Propose one grand theory, discuss all the supporting evidence (Darwin) [1 th., <= N obs.] (Induction)
a2) Propose one hypothesis, discuss evidence for and against (Critical Thinking/Review) [1 hyp, <= N obs.]

b) Theory vs. theory (Popper). Decisive experiments. Two theories, one observation. [2 th., 1 obs. **=>** 1 th.]

c) Report one set of observations, discuss multiple alternative theories to explain them. [N th. 1 obs.]

Lecture theatre seating

Students were randomly assigned seating for a course (reversed at mid-semester)

Significant effect on eventual course grade of whether sitting in the front quarter vs. back quarter in the first half of term.

This is a case, rare in psych., of an observation with <u>NO</u> theory or hypothesis. The authors are physicists: perhaps with an appreciation of the difference between a fact and a theory.

Perkins,K.K. and Wieman,C.E. (2005) "The Surprising Impact of Seat Location on Student Performance" *The Physics Teacher* vol.43 January pp.30-33

Attendance:—>

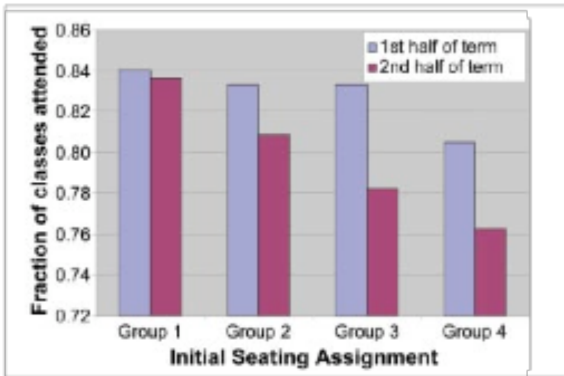

Fig. 1. Initial seating location vs attendance. The average attendance is plotted for the first (blue) and second (red) half of the term for students grouped by the distance of their initial assigned seat

Some argument schemas (4)

d) Publish observations without theory? You could say this is the Applied version of (a) above. Induction, may or may not have a hypothesis, but does not have a causal theory. [0 th. 1 obs.]

E.g. lecture theatre seating; epidemiology; Semmelweis.

e) Pure deduction (theory extension) (a lot of theoretical physics) e.g. Hawkins, black holes. [1 hyp. <= 1 th.]

? e.g. cognitive dissonance

f) Explanation of an old phenomenon (old puzzle), showing which deduction from an existing theory explains it. (Feynman, sprites, cosmic ray flashes) [1 obs, 1 hyp, 1 th.] (Abduction)

Argument schemas (5)

Veyne suggests that History and (Weberian) Sociology are almost identical, but that:

- History centres on events, uses theories to explain the observations
  [f] Take event (an obs.), select one theory, then explain (like Feynman)
  [1obs, 1 hyp, 1 theory]
  [b] Or perhaps contrast 2 theories, like Popper [1 obs, 2 th.]

- [a] Sociology centres on a theory, uses /selects events to illustrate or prove it.
  [cf. Darwin: 1 th. N obs.]

Argument schemas (6)

What of psychology?

It tends to do theory in literature review articles [a]

It does do a few decisive experiments, choosing between 2 theories. [b]

It is bad at publishing unexplained phenomena (but: visual illusions) [d]

It doesn't do much of any of the schemas above. Instead ...

[x] It most often seems to publish lab reports: assert a theory, assert the experiment tests it, assert the results confirm the theory. [1 obs, 1 hyp, => 1 theory]

The most common weak point, it seems to me, is "prediction": establishing a reliable link between the theory and how it is operationalised (into a hypothesis) in the experiment. The giant leaps from the actual expt. manipulation to the theoretical description of what matters about the difference in the treatments.

A place to finish the main part

Audio-tagging facility

There is for my lectures a facility for adding tags (labels, pointers) to the recordings of these lectures ("podcasts").

And to share these tags with the rest of the class, thus making the recordings increasingly useful by providing an index into them.

Pointers to this facility:
http://www.astro.gla.ac.uk/podcasting/track/chip

You can also get there from:
http://www.psy.gla.ac.uk/~steve/courses/chip.html

A place to stop

For the slides, handout etc. see:

http://www.psy.gla.ac.uk/~steve/courses/chip.html