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Philosophy of Science

A Brief Introduction to Selected Topics: Categorization, Justification, and the Relation between Observation and Theory

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Introduction[2]

We have a long tradition of viewing scientific knowledge as the greatest achievement of the human mind, the epitome of rationality and reliability; or, as Ian Hacking puts it, "the crowning achievement of human reason" (1995:1). One may of course raise certain doubts about this description. Scientists basically do what we all do in our everyday lives, namely make inquiries and observations, draw inferences and construct beliefs about the world around us or certain limited aspects of it. But scientists have at their disposal a huge apparatus of normative principles as well as methodological and statistical techniques designed to help safeguard the tenability and truth of their claims and theories. Science has much stricter standards and ideals for evidence, argumentation and justification than does common sense.

Philosophy of science is not commonsensical; it is, rather, located at a fairly high level of abstraction. Paradoxically, this does not preclude it from being very applicable to commonsensical belief constructions, as I hope to demonstrate. Basically, the philosophy of science comprises what might be called

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meta-concepts – concepts that enable us to discuss science: its methods, its representations and their relation to the objects within their scope. There is an abundance of such concepts, including theory, data, induction, truth, meaning, evidence, realism, falsification, foundationalism, observation, justification, models, demarcation and hypotheses – all of which have been much debated. Needless to say, not all of these concepts are treated here. The present selection could have been infinitely larger than it is, but the topics are central and important to empirical researchers, and they straddle the infamous qualitative-quantitative distinction. The topics included here are partly meant to be tools for critical analysis, both of everyday belief constructions and scientific claims; and partly to reflect at least some of the classical topics with which all researchers are expected to be familiar. I shall begin by laying out central concepts that will be much employed in my subsequent discussion, namely the so-called observation/theory distinction and induction related to inference and interpretation.

The O/T distinction

The centrality of this distinction between observation and theory becomes evident when we recognize its close connection to questions of construct validity, operationalisation, inferences and interpretations. The main purpose of the distinction is to separate the empirical from the non-empirical, which in turn is important because they enjoy a different epistemic status. The empirical has what we call epistemic priority: data can falsify theory, but not vice versa – a principle utilized by philosopher of science Karl Popper in his falsificationism, as we shall soon see. This epistemic priority is also recognizable from everyday life: if we have a choice of what to believe, theory or data, we generally choose to believe in the data (the observation). But why do we think observation is more trustworthy than theory?

The problem of epistemic priority made it imperative to find a sound criterion for the distinction. Historically, positivists put a great deal of energy into this question. Rudolf Carnap (1936) made a sharp division between observable and non-observable attributes or properties. Observational terms, henceforth called O-terms, are terms that refer to directly observable entities, for example objects (chairs, cups), properties (blue, heavy) and relations (warmer than). In passing, it should be noted here that by "observational" is meant not only that which can be seen, but also in any sense experience. The meaning of O-terms was, according to positivists, unproblematic, as it was determined directly through sensations or experiences and therefore enjoyed a very high degree of

intersubjective agreement and certainty – two observers could easily agree on whether something is a cup and whether it is red.

Theoretical terms, henceforth called T-terms, are more difficult to handle. There seems to be two ways of understanding T-terms that exist side by side; I am going to call them the strong and weak sense, respectively.

- Strong sense: genuine T-terms refer to non-observable entities and belong to one or more scientific theory. For example, electrons, positive reinforcement or gravity.
- Weak sense: T-terms are all terms that denote non-observable entities, whether they belong to a scientific theory or not. For example, personality, boredom and thinking. It does seem that this has become the established use, a fact of some importance for the relation between theory and observation, a topic to which I will return.

Examples of typical T-terms are gravity, electron, and cause. In the social and educational sciences all our interesting phenomena are of this kind: understanding, intrinsic motivation, meaning, learning strategy, intention, self, etc. The philosophical questions concerning T-terms have always included the following: Since we cannot access them directly through sensation or experience, how do we know they exist? How can we study them, assuming they do exist? And how do the T-terms cover their meaning, since it cannot occur directly from experience?

The fate of the distinction is clear: While it cannot be drawn universally, as Carnap (1936) had envisioned, it can be drawn contextually, e.g. between observation and interpretation. This recognition changes with knowledge and technological development in a field; the tendency is that terms which used to be T-terms become O-terms. That is, the view of what is *empirical* may change. However, even if the distinction itself is problematic, the epistemic priority of data and observations remains both in science and everyday life. We tend to trust data over theory.

Induction: inferences, interpretations

Induction is a principle for making inferences. In inductive reasoning we arrive at conclusions that are more or less probable. We reason from the known to the unknown, from the seen to the unseen. Such reasoning is of course much used in both science and everyday life. Many inductive inferences may be recognized by such linguistic formulations as “in general”, “for the most part”, “most often”, “regularly”, etc. Below are examples of inductive reasoning. All

inductive conclusions merit inquiry or mild criticism; they may be wrong even if the premises are correct.

- From particular to general (generalizations). In commonsensical belief formation such inferences can be hasty or unrestrained, maybe based on one or two examples: Having met one dour Norwegian, one can inductively infer that all Norwegians are dour. In science, methodology helps harness such inferences
- From sample to population (a subcategory of generalization)
- From particular to particular. For example, one has met a child and inductively infers that the mother must be….
- Future. This strategy worked well in 5th grade this year, so it will work next year, too
- From known correlations to causal connections
- From O-terms to T-terms. One has observed behaviour x, y, z in a student and infers that the student is hyper-motivated (or whatever). This is an example of a single person's interpretation involving an attribution of an unobservable trait. The attribution may be wrong even if the observations are correct. Measurement is another version of this kind of inference, addressing as it does the problem of which indicators we should use to tap the concept we are investigating. The problem of construct validity concerns how we justify that our indicators are adequate.

Common to all forms of inductive reasoning is that they are connected to probability, not certainty. All inductive conclusions must therefore be justified and argued for.

Categorization

Categorization is an important ingredient in theorizing and treatment of data. No phenomena ever come labelled, especially not in research on complex social and educational phenomena.

A category is a grouping of things, phenomena or entities that are somehow considered to be equivalent. Everyday categorization often proceeds on two presuppositions: some *similarity* between the things that are grouped together and some properties that form *discontinuities* that we perceive as natural (e.g. the difference between cats and dogs). The *similarity* in question may be observable or wholly abstract – note the importance of a theoretical background to decide what the basis for the equivalence is to be.

Categories are constructed for several reasons. We use categorization to organize data; to partition large phenomena into more finely grained ones; and to gain overview, structure and coherence. Categorization allows the researcher to simplify things and thereby be able to handle masses of data. There is disagreement among philosophers whether categories can be true or false or whether we can only assess them in terms of their adequacy for our purpose (see e.g. Suppe, 1989, ch. 7, for discussion and historical overview).

Categories are generally organized in systems (taxonomies). Often, but not always, they are connected by class inclusion. This way of thinking is very old, coming as it does from Aristotle. Such taxonomies have become part of everyday thinking and are easily recognized: Fifi (a particular dog with a pink collar) is a member of the class of greyhounds; greyhounds are members of the class of dogs; dogs belong to the class of canines; canines are mammals; mammals are living creatures. Such systems proceed from the concrete to the more general and inclusive. They aptly illustrate the fact that concepts have different levels of generality: canine is a more general concept than dog, dog is more general than greyhound. The more general the concept is, the more individuals are subsumed under it. Researchers are well advised to be clear about which level of generality at which they wish to operate and discuss.

Aristotle (384–322 B.C.) has provided us with what has become known as the classical theory of categorization (Aristotle, 1972). He tried to distinguish "natural" from "artificial" categories, and much philosophical work has since then been spent on determining what is natural (the nature of natural kinds). But not even natural kinds are given; sometimes re-classifications happen (we thought x was an A, but it turned out to be a B).

If a taxonomy is not natural, then it is artificial. Artificial taxonomies are constrained by their usefulness in relation to some purpose. But the same requirements hold for artificial as for natural taxonomies, according to Aristotle:

- Taxonomies should be *exhaustive*: All objects in a main category must be placed in one of the subcategories. For example, all canines must be placed in the subcategories of dogs, wolves, foxes. If there should be a canine animal that does not fit into one of the subcategories, the taxonomy would be criticized for failing
- *Mutual exclusiveness*: All objects should belong to *one* category only. Thus a canine is either a dog or a wolf or a fox, as the same animal cannot be viewed as belonging to two or more categories at the same time (which may make hybrids tough cases)

- *Criterion*: The basis for dividing objects must be clear (e.g. colour, size, shape, function) with respect to *what* makes the objects similar. It can of course be a combination of criteria, and not just one. For example, if we categorize on the basis of colour, all green things are placed into one category, all red things in another, etc. If our criterion is shape, we carve up the world in a different way and a different pattern emerges; there are circles in one group, triangles in another, etc. Thus, the choice of criterion is important and researchers would do well to be highly aware of this

Needless to say, Aristotle's requirements are very strict and few if any taxonomies in the social sciences satisfy them. Nevertheless, he reminds us of the importance of justifying why we group things (and data) the way we do, and that category systems, or taxonomies, can be made in many different ways.

As suggested above, Aristotle maintains that only a limited number of classes or categories are natural. Natural classes have a form, and essential nature, an essence – artificial classes do not. This form, or essence, is eternal and unchanging, according to Aristotle. Thinking in terms of essences is interesting for many reasons, not least to criticize cases of misuse or avoid misusing it oneself. An instructive example is Rousseau's description of Sophie in *Emile* (1762/1984), where he states that the essence of woman is to be man's delight – it is the law of nature, as he puts it, and so it cannot be changed.

But another reason is its connection to modern definition theory (e.g. Popper, 2007; Scheffler, 1974). Essences are specified in terms of necessary and sufficient conditions. The necessary conditions make up the definition of something; they are necessary for something's being what it is. Such conditions are individually necessary, and together they are sufficient for something's being what it is. For example, we observe a living creature and in order to define it as, say, a bird, we look at the necessary conditions for being a bird: having feathers, laying eggs, and flying. While colour, number of eyes, shape of beak, etc. are also properties of birds, they do not make a bird what it is.

Stating that a property is necessary is to say that a living creature *must* have it in order to be considered a bird. If it lacks this one property, it cannot be defined as a bird. This is a philosophical approach to categorization with a strong normative touch to it. It is very precise, but also problematic. Many items and objects may fall outside a category. For example, we see that neither ostriches nor penguins count as birds according to this approach. Being flightless, they fail to satisfy one of the necessary properties of "birdhood".

At the same time, a selection of properties that are to be viewed as necessary

is vital. Not all properties of an object can be necessary, because if they were, then every single object would be a category of its own and no simplification, organization, overview or easy handling can be obtained. This is why a criterion for categorization is needed in order to help us make reasonable arguments about the properties that should be regarded as necessary. But needless to say, there is hardly one correct or self-evident answer to this question.

While Aristotle's theory of categorization is normative – worldly materials simply do not satisfy the ideals of mutual exclusiveness and exhaustiveness – the American psychologist Eleanor Rosch (1978) has conducted a number of empirical inquiries into what people *actually* do when they categorize, suggesting that in a fundamental sense categorization is done on the basis of psychological principles:

- To gather the most possible information with the least possible cognitive effort. That is, we reduce differences to manageable proportions; a principle we also recognize as originating in Aristotle's theory
- The world is perceived as structured or ordered at the outset, not as random or unpredictable. That is, categories are applied already when we perceive the world. This allows us to recognize patterns, or sometimes even "see" patterns where none exist.

Categories, Rosch says, are defined by a prototype: the most typical one. People tend to view sparrows as more typical birds than hens, and ostriches are atypical. But they are still birds!

Like Aristotle, Rosch points out that concepts or classes have different levels of generality. The level that we usually refer to is called the *basic level*. This notion may be combined with an Aristotelian way of thinking; for example, dog is the basic category, with subcategories of poodles, German shepherds and cocker spaniels, and a larger category of dog is canines. Chair is a basic category, subcategories are kitchen chairs and barstools, and the larger category is furniture. What is important for any researcher to consider here is the level of generality and precision: What does my project need or desire? Such choices need to be consciously made and maintained, because if Rosch is right, we will automatically slide into the basic category level unless we are conscious of what we are doing.

The main difference from Aristotle to be noted here is that Rosch's mapping indicates that categories have no clear, fixed boundaries. On the contrary, we group objects by typicality and their contrast with other objects, and the result

is that we have no exhaustive categories. It is a more flexible way of thinking, although not as precise as the Aristotelian system.

Interestingly, in Rosch's way of thinking, it becomes clear how categories are connected to induction. It is of course much easier to generalize if a phenomenon is typical or representative. Nevertheless, there is a pitfall lurking here, because research also shows that we tend to believe that phenomena, situations, individuals or behaviours are more representative than they actually are – another point of which researchers need to be aware.

Category systems are not theory-exclusive. That means that the same system can be used with different theories. Categorization is an important tool in theory construction, in domains where there is little theory as well as in theory testing. But one should be aware that categories may have a difficult epistemic status: Do they have an empirical basis or not? How should we judge their adequacy?

Justification

Justification is one of the most central concepts of epistemology, and it lies at the heart of all scientific activity. Justification is concerned with our understanding of truth; how we support our claims and how we evaluate the reasons or the evidence we present to support our claims and theories.

Knowledge and evidence

I shall begin by presenting the standard definition of the term *knowledge*. This definition dates back to one of Plato's dialogues in *Theaetetus*, and has withstood most onslaughts to the degree that it has passed into our everyday understanding of what it means to know something as opposed to believe something (Plato, 1987). The classical definition concerns propositional knowledge, that is *knowledge that*, not knowledge *how* (Dancy, 1994).

Plato defines knowledge as *justified true belief*. This is called a tripartite definition, since it contains three items. This may seem relatively simple, but when unpacked it reveals several complex assumptions about truth, evidence and the certainty of our claims and representations.

Basically, the definition says that person A knows something (x) if and only if the following conditions are met:

- X is true
- A believes that X
- A is justified (has good reasons or evidence) in believing X

All three conditions are necessary. If one of them is not satisfied, we cannot say that we know x, but we may say that we believe it. Condition 3, the evidence condition, is there for at least two reasons. First, it was important for Plato to distinguish between knowledge and belief; second and it was important to nail down the principle that a belief is not justified simply by being true (that would make a lucky guess count as knowledge, and Plato wanted to rule that out). Hence, we have a condition that requires evidence, reasons, data, and arguments.

In science, this condition is to be taken much more seriously than in everyday life. Scientific claims to knowledge require much higher standards than do common sense. This is also an ethical point: Researchers should not deceive their audiences. When researchers claim to know something, they are implicitly saying: "Trust me that this is so, the world is like this".

The truth condition states that in order for us to know something, for example X, then X must be true. If X should turn out to be false, we can no longer claim to know, but we can say that we *thought* we knew but were mistaken. The truth condition makes knowledge incompatible with mistakes, thus setting a high standard indeed. It commits us to the existence of a given state of affairs in the world, the something that we claim to know ("this is how it is"). However, truth and absolute certainty is not the same thing. Science no longer deals in certainty, but in probabilities. Believing that a theory is true is not the same as believing that we can be certain that we have found the truth. Truth and fallibility are therefore nicely compatible entities (Scheffler, 1983). There is always the possibility that we might be wrong.

What does it mean to say of a claim that it is true? That depends on which theory of truth one employs. There are at least 6 or 7 such theories. However, the correspondence theory of truth is frequently simply assumed. According to this theory, truth is a kind of relationship between (linguistic) claims and some aspect of the world. A claim is true if it describes a certain state of affairs the way this state of affairs actually is (Kirkham, 1997), meaning a claim is true if it corresponds to some fact in the world. So the claim "there is a cup on my desk" is made true by the fact that there actually is a cup on my desk. The world itself makes our beliefs true or false, and presumably also constrains the beliefs that we construct about it. I think the correspondence theory is the everyday

theory of truth; this is how we learn to think about truth and falsity when growing up. Of course, much philosophical criticism has been levelled at this theory. For example, how do we know there is a correspondence between belief and fact? This requires making a comparison between them, which in turn demands access to both sides. However, we only have access to the fact (the world) through the belief that the fact is supposed to correspond with – and thus we end up in a vicious circle. Nevertheless, I believe that the correspondence theory should not be discarded for the reason that it captures what researchers try to do, namely talk about how real phenomena are, behave or change (see Kvernbekk, 2007, for a discussion).

For many years, the coherence theory of truth has been hailed as the most sensible theory of truth in the social sciences. This theory states that a belief is true if it is part of a coherent system of beliefs. There is no correspondence with any phenomenon involved, but rather the internal state of a belief system (Kirkham, 1997). It is important to note that while this theory defines truth for the individual parts in a system, it says nothing about the truth value of the system as a whole. Nor is it entirely clear what *coherence* means, except that it should not be identified with truth, since that would render even this theory viciously circular (a belief is true because it is true). Coherence theorists differ in their claims as to how strong and strict the coherence must be (see Dancy, 1994, for an overview).

One final theory of truth to be mentioned here is the instrumental theory of truth, also called the pragmatist theory of truth. According to this theory, a belief is true if it "works"; that is, if it is useful and effective in our interactions with the material and social world. Objections have been raised regarding both this theory and the coherence theory, as it has been pointed out that swindlers' stories and lies may be beautifully coherent and work nicely to deceive people – and yet simultaneously be untrue. It should be noted that this objection presupposes the correspondence theory of truth, claiming that lies are untrue because they do *not* describe the world as it actually is.

We see already that even the first condition of the tripartite definition of knowledge causes us problems. Some philosophers have given up the truth condition and settled for the evidence condition instead – this is in reality what e.g. John Dewey (e.g. 1929/1990) did. But let us look more closely at this condition.

Evidence and justification are intimately linked, since we justify claims by providing evidence for them. Questions in the form of "how do you know this" and "why should I believe this theory" are requirements for evidence. As sug-

gested above, this condition is at least partly based on the idea that knowledge should be more than just true belief, since that would make even lucky guesses count as knowledge. Versions of this are well known from everyday life, as when we take our ailments to a medical doctor and want her diagnosis of us to be based on knowledge and reliable tests rather than on guesses that just happen to be true. But it is not only a matter of providing evidence or reasons, either. It is equally important to evaluate both the quality and the degree of evidence provided for a claim; this is especially important in scientific contexts where people are generally expected to be critical thinkers. Not just anything may be accepted as evidence and one must be able to distinguish between good and bad reasons for a claim.

In science, evidence mostly comes in the form of empirical data, reasons, and arguments. Some ideas about evidence are very old, such as evidence given by humans in the form of witnesses, testimony or authority. There has been an interesting historical change here: nowadays, arguments from sources of authority are considered a fallacy. In the course of history ideas were introduced about evidence provided by objects; evidence that came from signs or indications (Hacking, 1975). Indications tie in nicely with O-terms: they indicate something else, they point beyond themselves. They are not private experiences, but publicly or intersubjectively accessible. And, as we can see, in pointing beyond themselves indications form the basis of inductive inferences.

It is important to be precise about *what* one wants evidence for, since the *what* largely determines what can count as evidence. Do I want evidence for a correlation? A causal connection? A generalization? A certain interpretation of some philosophical doctrine? Support for a normative conclusion? What sort of data or arguments is needed? Will anecdotal evidence do? Must I look for textual evidence? It is sometimes hard to say what evidence is required, especially when non-occurrences are vital evidence, as is the case with for example causal inferences. Good research designs and methodological awareness may help us here.

What about the belief condition? According to Jonathan Dancy (1994), this condition is minimal; it states that if we know something, we thereby also believe it. But not the other way around! Beliefs have no inherent truth condition, and one may suspect that we nowadays make a less defined separation between knowledge and belief, although we still find the distinction an integral element of our everyday language. However, constructivists such as e.g. Ernst von Glasersfeld (1984) hardly make the distinction anymore and call "every-

thing" knowledge. Any combination or re-combination of concepts constitutes knowledge, he says, and no evidence or justification is needed to adopt one such combination over another. There is no correct, no incorrect, no right, no wrong. This view is interesting to juxtapose to Plato's original definition: only the belief condition is left to define knowledge, as both truth and evidence conditions have disappeared. If this is the case, why do we accept one "knowledge combination" and not the other? According to von Glasersfeld, this is a matter for social negotiations among researchers (and perhaps other stakeholders). This move effectively undermines the role of evidence and reasons in scientific activity, and should in my opinion be resisted. Acceptance of theories should be more than a question of power and negotiations.

Foundationalism and non-foundationalism

One way of answering the question "how do you know that" is called foundationalism. It is mainly designed to solve the problem of infinite regress. The concept regress is famously expressed by among others postmodernist Jean-François Lyotard, paraphrased here as: "How do know that? By this proof. And how do you prove the proof? By another proof. And how do you prove that…?" (Lyotard, 1984). Infinite regresses and vicious circles are generally disliked by philosophers, since they both fail to justify a conclusion. Foundationalism is a way of stopping the infinite regress and, hence, of providing an answer to the question: "How do you know that?"

Foundationalism is an epistemological doctrine that categorizes all beliefs into two groups: those that need support from other beliefs and those that do not (Dancy, 1994). There is, in other words, a fundamental asymmetry between types of beliefs; a distinction between basic and non-basic beliefs, those that need justification and those that provide it.

So, what kind of beliefs does it take to stop the regress?

- Beliefs that are justified by something other than beliefs, e.g. by sense experiences
- Self-justifying beliefs
- Beliefs that need no justification

All these belief types are foundational. They comprise the "bedrock" of our belief systems, the ground upon which all other beliefs are built, and these other beliefs are justified because the "bedrock" provides the justification. Founda-

tionalism comes in different versions, the best known of these being the empiricist. This is also the most interesting version because it is so strongly similar to the commonsensical way of thinking; that is, the commonsensical way of thinking is empiricist in this particular respect, working in the following manner: After hearing a number of questions such as "How do you know that…?", one finally says: "Because I saw it with my own eyes". This is sense experience as bedrock, either one's own senses or those of other witnesses. There is a great deal of social-psychological research demonstrating that this is generally how we reason in our daily lives, and that it generally does not make much sense for us to problematize what people claim to have seen with their own eyes. There are no more "How do you know that's" after someone has declared himself an eyewitness to some event.

Sense experiences are not themselves beliefs, but a point of departure for the reports that constitute a foundation. One cannot doubt what one has seen with one's own eyes, and this stops the regress. The empiricists believed that we cannot be mistaken about our own sense experiences. True enough, we may *describe* them incorrectly, but we cannot be mistaken with regard to the experiences themselves.

Two brief notes concerning the O/T distinction should be interjected at this point:

- The distinction is involved in foundationalism, since O-terms were thought to acquire their meaning directly from experience. O-terms were therefore assumed to have a certain, trustworthy, intersubjective content.
- Foundationalism also plays a part in the difference in epistemic status of O-terms and T-terms, a difference that makes observation capable of falsifying or confirming (or confirm) theory – but not vice versa. It is generally an accepted view in science that data in this sense has epistemic priority.

Foundationalism may for the above reasons be a tempting perspective to adopt. Some people, however, are self-confessed non-foundationalists, and their views are also well worth considering.

The renowned pragmatist John Dewey (1929/1990) is quite adamant in his belief that there is no certain, firm or secure basis for belief. Conditional justification (belief A is justified *if* belief B is justified, B is justified *if* C, etc. – the regress alluded to above) is sufficient. It is simply all we have, because we have no access to correspondence truth. We use ideas in interaction with the material and social world; some ideas are useful and adequate, others brush up against

experience and do not bring us the results we want. This is the instrumental theory of truth: ideas work or they do not work. Dewey is a wonderfully stark consequentialist here. *No* ideas are immune to this kind of testing, he claims, not even his own pragmatism. We test pragmatism as we test other ideas, and if it proves useful we can keep it; otherwise, we may throw it out!

While experience is a central concept for Dewey, his conception of it differs from that of the empiricists (which is sense experience). Dewey is an experimentalist thinker; he needed a concept of experience for his theory, and he spent much time developing one. He went back to the common sense use of the word: Experience is to be acquainted with practical things based on previous behaviour – this concept is broader than sense experience or cognitive experience. Moreover, researchers' experience is also of this practical nature! Things generally are what we experience them to be, according to Dewey. For instance, we all have experience with umbrellas, bruised knees, forks, spoons and staircases. We *do* something with things rather than *know* them; use, enjoy, trade, treat, etc. Secondary experience is reflective; its objects are not things but theoretical entities. The individual's reflective experience is supposed to explain their primary experience; and this experience, too, shall return to interaction with the world. But Dewey does not quite agree with himself on this point, as he makes different claims in different places about whether *all* reflection should eventually feed into action.

Dewey is a Darwinist. That means that he is preoccupied with *change*; that something is *becoming* rather than *being*. This is the basis for his unrelenting criticism of Greek ideas and of what he calls the spectator theory of knowledge. Dewey is thus deeply critical of anything that tastes of essentialism in the Aristotelian sense which, as we have seen, is static, eternal and unchanging. Learning demands participation, Dewey says, not watching.

Another non-foundationalist is Karl Popper (1959/1992). This may be somewhat surprising, since Popper also insists that data can falsify theory but not the other way round. Falsification is based on an asymmetry between data (O) and theory (T). It is thus incumbent upon Popper to ground, or to justify, the epistemic status of data in order that they will be able to perform this function.

The mechanism of falsification is *incompatibility*: when an accepted observation, called a basic statement, is incompatible with a theoretical claim, we conclude that the claim must be rejected as false – and this is a deductive inference. The most famous example is that of the white swans. Our theory is that all swans are white; then we have an accepted observation of a black swan, and we deduce

that our theory has been falsified. It cannot be true that all swans are white if we have a black one. Two points must be noted here. First, the observation must be *accepted*. That is, a random sighting of a black swan by one person is not enough. Second, following from the first point, an accepted basic statement is only a necessary condition for falsification. It is not a sufficient condition for falsification, precisely because there can be random results. Additionally, the observation must be replicable or reproducible.

Furthermore, a theory is in Popper's view scientific only if it is falsifiable by experience. Falsification is his criterion of demarcation, as it separates the scientific from the non-scientific. Theories are representations; they tell us what the world is like, and they admit of truth and falsity. Popper is a strong defender of the correspondence theory of truth; indeed, he believes it is the only theory of truth worth having. Yet, while truth is the aim of all research, Popper also says that we can never attain it. We can never know if a theory is true, but we can know if it is false. This view of the aim of science has drawn a lot of criticism – it is not rational, critics say, to have an aim that you in principle can never reach (e.g. Newton-Smith, 1981).

We are going to inquire a bit further into the nature of basic statements. A basic statement is defined by Popper as *an interpretation in the light of theory*. Such statements are about observable events or phenomena, which must be intersubjectively accessible and testable (observable event x happened at time t at place y). Observations are (often) connected to perceptual experiences, but are not justified by them. The relation between perception and belief is a *causal* one. Your perceptions (or experiences) may therefore *explain* why you have belief X, but not *justify* it. Importantly, there is a major difference between explanation and justification. It is precisely at this point that Popper disagrees with the empiricists and their version of foundationalism. As we have seen, they believe that (sense) experience can justify claims or beliefs. Claims, according to Popper, can only be justified by other claims – a view which, as we have seen, leads to an infinite regress if we demand that all claims must be justified. It is not clear to me just how Popper deals with this particular problem, but justification is certainly necessary in Popper's view. If we do not justify our theories, acceptance of them becomes a question of dogmatism and power rather than evidence and argument.

So, Popper is not a foundationalist. Foundations are not really interesting, he claims, since science is to test our theories intersubjectively. Basic statements can be further refined into "smaller" observations. While this process may yield

an infinite regress as well, Popper maintains that it is harmless because one does not try to show or establish or confirm anything, only to falsify something. But, eventually all tests come to an end; not as a matter of principle, but rather as a convention or for practical reasons.

As a result, Popper concludes that the empirical basis of science is not absolute, foundational or firm. If this is the case, then how can it be used to falsify theory? This is indeed a problem for Popper. Basic statements are interpretations in the light of theory, and since theories may be false, the observation may be incorrect. So, how can theory-impregnated observations have an epistemic status that allows them to falsify theory? The overall conclusion of Popper's critics is that he does not justify the epistemic status of observations that his falsificationism needs because he is a non-foundationalist and rejects the O/T distinction that could have helped him ground it. Furthermore, at the same time he insists that only data can be appealed to for acceptance or falsification of theory. As for observations, not even "this is a glass of milk" is an unproblematic observation according to Popper!

What conclusions can we make, then, concerning evidence, knowledge and justification? I suggest only the following: 1) Present available evidence in an honest way 2) Produce the best arguments that we can and 3) Assume an overall attitude of fallibility due to the fact that all claims may in time prove to be wrong, including our own. That also holds true for our observations, as it will be argued for in the next section.

Observation and theory

No matter what their epistemic status may be, observations have always been a primary source of scientific data. On the other hand, there are diverging views of what scientific observation really is and how important it actually is; views that most likely vary from discipline to discipline.

In this section we will meet theory in both its strong and weak sense, quite possibly mostly the latter. The problem of the relationship between theory and observation is of course related to problems of the relationship between theory and experience, theory and practice – the well-known problem of "what comes first".

Conceptions of scientific observation

As indicated above, there are diverging views of scientific observation. I have purposefully selected two examples of definitions that differ substantially from one another.

The first view is relatively recent, namely Liv Vedeler's definition (Vedeler, 2000) in which she defines observation (specifically addressing the discipline of education) as a systematic collection of information about the physical and the social world, as it appears to us directly through our senses and not indirectly, e.g. via witnesses. Once the information is gathered, it must be categorized, and only then does theory enter the picture. This definition should be easily recognizable as being both inductivist and empiricist in nature. First, we make our observations, and then we use theory – observations have no theory involved in this definition. In fact, I find it astoundingly empiricist, and I hasten to add that the book subsequently becomes much more sophisticated, and that Vedeler does not truly treat observation in accordance with her own definition of it, which I find to be positive. If all we can have are descriptions of directly observable entities, we will have meagre data indeed.

Now, let us contrast Vedeler's definition with that of Peter Achinstein (1968). This definition, although it was developed some 35 years before Vedeler's, is much more complex. According to Achinstein, scientific observation 1) involves attending to something in a way which is influenced by the observer's knowledge and intentions 2) does not require recognition of what is observed 3) may involve seeing intermediary images 4) allows seeing what is hidden from view and 5) allows different, but equally correct, descriptions of what is observed. Whereas Vedeler's definition entails that what we observe must be directly accessible to the senses (especially eyesight), Achinstein's definition goes well beyond direct perception. It is important that Achinstein allows for indirect observations; that is observations via indications or signs. Merely seeing something as a visual sense experience is not sufficient for observation. Observation is essentially *seeing-that*, a linguistic formulation which expresses the intimate relationship between seeing and knowledge.

Let us look at some implications of Achinstein's view.

1) A somewhat minor implication, namely that it is a mistake to make principal and necessary connections between the human sensory apparatus and scientific observation. It would seem that Vedeler makes such a connection, although it must be remembered that she is speaking about the educational

sciences. But for that matter, even psychological research occasionally uses instruments to measure heart rate or eye movements. The point is that use of instruments allows scientists to make highly complex observations that humans cannot make, such as magnetism on the sea floor, the behaviour of neutrinos, or solar storms.

2) Observations may be placed on a continuum from simple to highly complex. Examples of simple observations are; we see a book falling off a shelf, or we see that two children are fighting (even this is assuming that we know what it means to fight). Examples of complex observations may be about children's social skills, or, as I once heard a teacher say: "I saw immediately that he (a pupil) was a potential welfare client". Needless to say, observations about potential are exceedingly complex (and rather dubious).
3) When indirect observations are allowed, the boundary between observation and interpretation becomes blurred. It certainly cannot be upheld universally, but contextually. However, even that may be difficult at times. Consider the following example: "The student teacher was trying to teach the children norms for good behaviour". Is this a description of an action or an interpretation? It is difficult to say. But the statement obviously has some distinctively interpretative qualities about it, since it largely refers to an intention behind an action, the intention of teaching children good behaviour.
4) Achinstein's definition of observation brings us much richer forms of data than does Vedeler's definition. What is it that appears directly before our senses? What data does it yield? Certainly nothing about what people try to do, since that implicitly refers to an intention and intentions are not directly observable. Empiricist observations are, strictly speaking, restricted to sensory experience, and are therefore of limited use in educational research, I venture to say.
5) As suggested above, Achinstein's definition opens up for the legitimate use of indications in observations – this is in fact what indirect observation consists of: "Observations O1… O4 indicate T". This is how we "see" a diagnosis, for example. But it presupposes, of course, that the indications are actually indications of some theoretical terms; and if the theory behind it is well argued, then we have may believe that our indications are justified.
6) Closely related to the previous point, this form of indirect perception is very common in daily life. Almost all of our everyday observations go well beyond what our senses provide. Following epistemologist Fred Dretske

(1990), I would like to introduce the concept of fact perception. Many of the entities educationalists (including teachers, special needs educators and researchers) see are facts expressed in terms of seeing-that. For instance, we see that students are writing, that three students are making a drawing together and that the curtains have not been ironed. The facts that we observe are the facts that students are writing or drawing, or the fact that the curtains have not been ironed. But we also say that we see that people take pride in their work, that somebody is in deep thought, that a student is poorly motivated for doing schoolwork or an audience is bored. Although none of the above facts are directly observable, we nonetheless claim that we see them. In his explication of how it is that we see such facts, Dretske basically makes the same distinction that has been alluded to above, namely a distinction between direct and indirect fact perception. We see whatever is indirect by seeing something else; for example, we see that somebody has excellent social competence by seeing that she asks other students how they are doing, etc. Again, this is an inference, and it may be wrong even if the initial direct perceptions are correct. But whereas scientists are required to be clear about what they see and what they infer from what they see, in everyday life we often conflate the two. We tend to believe that we see directly what we actually only see indirectly, because the inferences are so fast. This is potentially dangerous, because if we believe that we have seen something with our own eyes, we also believe that our perception is true – it generally does not make sense for people to problematize what they and others claim to have seen for themselves. But there is no way that we can see directly that people are deep in thought! In everyday life we do not bother to worry about the connection between our direct and indirect fact perceptions. The connection comes from common sense, and is usually not justified at all (although it may of course be adequate). However, the danger lies in the merging of direct and indirect, when we think that we have observed directly what we in fact have only observed indirectly.

The above considerations also point to my penultimate point, which is that the more knowledge we have, the more observations we are able to make. By acquiring theoretical knowledge, our ability to make especially indirect fact perceptions increases dramatically.

My final point is that the above considerations are of great importance to educational researchers, since social phenomena are not directly accessible for observation, but rather are of the indirect kind.

Hanson's thesis

Hanson's thesis, named after the philosopher Norwood Russell Hanson (1924–1967), states that all observation is theory-laden. It may seem somewhat unfair that Hanson's name should be so closely connected with this doctrine, as the idea itself has been around much longer. But Hanson (1958) gave it a thorough and detailed description and a philosophical justification. It should be noted that the doctrine also has plenty of empirical backing; in fact, it is one of psychology's best documented empirical findings. So Hanson's thesis is well justified.

Like Peter Achinstein (1968), Hanson maintains that seeing is essentially seeing-that. Moreover, it is so because seeing is shaped by knowledge and thus is an epistemic achievement. Whatever else is involved – seeing pencils, ironed curtains and people who are in deep in thoughts, etc., is to have knowledge of certain sorts. It is easily seen, then, that Hanson's thesis is a criticism of empiricism; both of the doctrine that all knowledge begins with sensations or experiences and of the foundational doctrine that all justification must be empirical. It follows that Hanson's thesis also questions the O/T distinction, at least in its universal version.

To repeat, seeing-that expresses the relationship between seeing and knowing. It is not the case, Hanson says, that we see the same thing but interpret it differently. Having a different interpretation is simply seeing something different. Among Hanson's stock of examples are the drawings (probably originating in Gestalt theory) that can be seen as two different pictures; duck or rabbit, young or old woman. Whether we see the young or the old woman is not a question of superimposing an interpretation, but of the organization of what we see; that is, of the way in which the elements of the visual field are appreciated. There is a sense in which we are visually aware of the same thing. However, visual stimulus of the retina is a physical event and not the same as a scientific observation. The *ways* in which we are visually aware are profoundly different, and they are so because the observers bring different knowledge, experience and theories to the seeing: "… the physicist sees an X-ray tube, the child sees a complicated lamp bulb; the microscopist sees a coelenterate mesoglea, his new student sees only a formless, gooey stuff" (Hanson, 1958:17).

Another of Hanson's examples has achieved classical status and is only for this reason worth presenting. Let us assume, he says, that the two astronomers Tycho Brahe (1546–1601) and Johannes Kepler (1571–1630) are admiring the sunrise together. But they do not make the same observation while doing so, since their theoretical background is different. Tycho Brahe employed the

geocentric theory, believing that the sun orbited around the earth. He would therefore see the sun rising and moving across the sky. Kepler subscribed to the heliocentric view, believing that the planets orbit elliptically around the sun. He would therefore see the earth move to such a degree that the sun would come into view. But here we may encounter a problem: Do researchers (and others) fall victim to their own theoretical frameworks and/or their own background knowledge? Can we only see what we have concepts to see? Would Brahe and Kepler ever have been able to discuss their different observations, let alone reach an agreement?

To add further to this problem, let me quote Howard Becker on educational researchers:

> I have not had the experience of observing in elementary and high school classrooms myself, but I have in college classrooms and it takes a tremendous effort of will and imagination to stop seeing the things that are conventionally 'there' to be seen. I have talked to a couple of teams and research people who have sat around in classrooms trying to observe and it is like pulling teeth to get them to see or write anything beyond what 'everyone' knows (cited in Buchmann, 1989: 1–2).

If Becker is right, this is bad news for educational researchers. I do not think the picture is as bleak as all that, but Becker surely has a point. Much of education is commonsensical given that the domain for various reasons is so close to practice. And besides, we have all been raised, and we have all been exposed to a number of teachers and have thus been socialized into our cultural understanding of upbringing, teaching, and education. For this reason alone, it is easy to see what everybody else sees.

While Becker's point may be understood as a reminder that researchers (and perhaps other professionals in the educational realm) should be able to see something more and something different from what everybody else sees, the philosophical implication is somewhat different. The question is, does our theoretical framework *determine* what we are able to see? Again, certain implications need to be pointed out.

1) It is important to make clear that we are faced with the same unclarity concerning the concept of theory as we have met before. What does "theory" in theory-laden mean? Both the strong and the weak version of theory are applicable here, but Hanson mainly seems to have the weak version in mind. If so, "theory" means roughly the same as background knowledge. This view we also find in Popper, when he argues that no research ever

begins with data – it always begins with theory, in the sense of a theme, an idea or a problem.

2) While it is widely agreed that Hanson's thesis is right, there is considerable disagreement about its significance; that is, about how strongly it should be interpreted. The problem arises when theoretical background is said to *determine* our observations rather than just *influence* them (notice the importance of precision here!).
   - If background determines observations, then relativism reigns supreme, as Denis Phillips (1992) puts it. Truth, then, becomes relative to a certain world view or context, and no common ground between the contexts can be found to adjudicate between them – truth is local, and disagreement between contexts becomes impossible. Even worse, it may apply to individual rather than group; in which case we call it subjectivism – the view that truth varies from person to person. It is important to note that variation in beliefs is not the same as relativism. It is unproblematic that people have different beliefs. Relativism or subjectivism says that truth is relative to context or person, and that no common standards exist to help compare the two views with one another. Thus, according to subjectivism, all views are true because they are true in accordance with our subjective standards. The point of doing research thus largely disappears, one might want to argue. So, with this interpretation of Hanson's thesis, researchers indeed see only what they have concepts and theories to see. We are well advised to remember Howard Becker's lament!
   - Expanding on the previous point: Are we then trapped in our own theoretical frameworks, each and every one of us, since no two people can be assumed to have exactly the same knowledge backgrounds? A possible example of someone trapped in his own framework is the Italian explorer Marco Polo (Eco, 1998). Like all Europeans of his time, Polo (1254–1324) firmly believed in the existence of unicorns – white horses with a single horn on their forehead. On one of his travels, Umberto Eco tells us, Marco Polo came to the (now) Indonesian island of Java, and there he saw animals with horns on their forehead. He categorized them as unicorns despite having some misgivings about doing so: they were not quite what he had expected. These animals were greyish brown, not white, they did not have fur but a leathery hide, and they were not elegant but rather big and chunky. What he had seen, of course, was a rhino. But Marco Polo,

argues Eco, could not conceive of the idea that he had seen a new kind of animal. He referred to things he knew and expected to encounter, and adjusted his own categories to make the new observation fit his system of thought. Once again Becker's complaint comes to mind.

- If a theory determines its own facts, then no theory can ever be tested for truth (in the correspondence sense), because the O-terms will not be neutral but rather belong exclusively to one theory. Any testing will show the theory to be correct – you will look for the facts that the theory says are there, and those facts are the only ones you will be able to detect.

3) If all this is true, it is indeed a bleak picture of science. But are we really unable to see or accept evidence that goes against our beliefs? No, Israel Scheffler says, we are not so blinded by our own knowledge:

> It is undeniable that our beliefs greatly influence our perceptions, but neither psychology nor philosophy offers any proof of a pre-established harmony between what we believe and what we see (Scheffler, 1982:151).

The history of science is full of surprised researchers. Surprise, as Scheffler points out, is an epistemically important emotion. It occurs when our observations do not match what we believed or expected to see. Surprise thus indicates that we are not trapped by our frameworks, but are capable of noticing that which is different from or incoherent with our belief systems.

4) O-terms, observations or sets of data are not exclusive to any theory. Rather, they may be used with several theories in order to test, justify or compare them. It is important to have a philosophy that allows comparison of theories against each other. Such uses of O-terms and data are possible, even if one does not accept the empiricist distinction between the observational and the theoretical. One does not have to think that O-terms are totally independent of theory.

Finally, science is full of important pre-theoretical observations and data (Hacking, 1995). Both Röntgen and Fleming happened to notice something that was randomly there: They had no idea what it was, how or why it had occurred – but they both pursued it and made significant discoveries. As Hacking puts it,

> Davy's [physicist Humphrey Davy] noticing the bubble of air over the algae is one of these [counterexamples to Popper]. It was not 'an interpretation in the light of theory', for Davy had initially no theory (Hacking, 1995:155).

This does not mean that Davy's observation was completely theory-free. It was theory-laden, but not with a fully fledged scientific theory, because at that point Davy had no such theory. Nevertheless, it was theory-laden in the weak sense of theory, probably in this particular case a whole arsenal of physical and commonsensical concepts.

A concluding remark

The present text is a brief journey through some of the topics which the philosophy of science deals with. I would like to underscore the brevity of it – the number of possible topics to cover is endless. On the other hand, I also think that the topics covered here are important ones, and that they straddle the notorious quantitative-qualitative divide. No matter what philosophical preferences an educational researcher may have, these topics will be of (some) relevance. It may be that the demands of philosophy seem so strict that one wonders if it is at all possible to claim to know anything. Philosophers problematize everything, they turn views upside down, and they make commonsensical notions dissolve into thin air. They may very well make empirical researchers wonder if research is possible or worthwhile at all. And yes, there is a fine trade-off to be negotiated between the universal, ideal and the practically possible. In the end, if educational researchers do their best to present their claims as accurately as possible and take care to back up their views with evidence and arguments, then no one can expect them to do anything more.

But of course: If this brief journey kindles the reader's interest in philosophy, nothing would be better than that!

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