Do We See Through a Social Microscope?: Credibility as a Vicarious Selector

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Credibility in a scientific community (sensu Shapin) is a vicarious selector (sensu Campbell) for the reliability of reports by individual scientists or institutions. Similarly, images from a microscope (sensu Hacking) are vicarious selectors for studying specimens. Working at different levels, the process of indirect reasoning and checking indicates a unity to experimentalist and sociological perspectives, along with a resonance of strategies for assessing reliability. The perspective sketched here can open dialogue between philosophical and sociological interpretations of science and resolves at least one tension regarding the "primary" factors by which scientists evaluate claims.

1. Introduction. In 1981, Ian Hacking asked, "Do we see through a microscope?" The question embodied central concerns about realism—especially about entities we cannot see with the unaided eye and about the reliability of instruments in helping us to gain indirect access to phenomena of the "real" world. Hacking answered: yes, we see *with* a microscope when "an image is a map of interactions between the specimen and the image of radiation, and the map is a good one" (1981, 320). Moreover, we are convinced of the reality of what we see, not by the image itself, but by various forms of interacting, interfering, and intersecting with the specimen so observed (321; also see Hacking 1983, 207–209; Rothbart and Slayden 1994).

Over a decade later, Steve Shapin (1994) conveyed his conclusions on a parallel exploration of "the bases upon which factual scientific knowledge is held" (xv, xxv). Shapin posed similar questions about trustworthiness and reliability—but framed in the context of social interactions, testimony and "credibility"—of persons, as well as of ob-

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servations and knowledge claims (xv, 238–242). Shapin claims that no knowledge—at least at the level of a culture—can exist without a social system of trust (xxv, 417).

At first blush, Hacking's and Shapin's analyses may seem worlds apart—one dealing with experimentalism, instruments, and the philosophy of practice in the laboratory, the other with "moral economies," scientists, and the sociology of scientific culture. I claim, however, that both describe parallel processes at different levels, or scales, of scientific reasoning. In this paper, I use Hacking's and Shapin's works as benchmarks to link the maps of philosophical and sociological terrain and help unify their domain.

Integral to my linkage is Donald Campbell's notion of a *vicarious selector*. Vicarious selectors are indirect, or secondary—but not necessarily unreliable—means of probing phenomena that are otherwise difficult to observe (either by expense, time, risk, or availability of means). Vicarious selectors function as "short-cuts," or heuristics, in a process of variation and selection, whereby one set of criteria substitutes "vicariously" for another, more direct form of selection (Campbell 1974, 419–421, 423–451 passim). A blind man's cane, for example, is part of a vicarious search process, with the cane's movement substituting, or acting vicariously, for actual movement of the body (424). "Observation" with a cane is clearly indirect and fallible, yet still serves to guide the blind person, often more quickly or safely than without. A ship's radar, likewise, serves as a surrogate for actual locomotory search in determining the location of the ocean floor, enabling a ship to negotiate efficiently with less risk of damage. In the same way, Hacking notes (1981, 319–320), pilots of some high-tech bombers "see" the underlying terrain with radar data projected onto a screen, though perception of the "real" landscape is mediated.

As I shall argue more fully below, the notion of a vicarious selector shows the resonance between Hacking's and Shapin's central claims: the microscopic image is a vicarious selector of a specimen (§2), a scientific report is a vicarious selector of an observation or experiment (§3), while the "credibility" of a scientist is, in turn, a vicarious selector for the "credibility" of his or her reports (§4). Ultimately, I claim, the scientific culture is an *instrument* or apparatus, not unlike a microscope, with which individuals view the world through the testimony of others. Do we see with a social microscope? Following Hacking's lead and using Shapin's account, I will argue that yes, we do. Like any scientific instrument, however, the scientific culture of reporting must be carefully constructed, tested, calibrated, maintained, and regularly checked and retuned to support its intended function. The methods of validation at this social and linguistic level (as profiled in Shapin's analysis, for example) resonate strongly with those in the laboratory (as profiled in Hacking's analysis)—leading to some important general lessons (§5). In thus linking experimentalist and sociological approaches, I hope in part to pay homage to the late Donald Campbell, by contributing to an enterprise he pursued and promoted: a sociology of scientific validity.

2. Microscopic Images as Vicarious Selectors. As introduced above (§1), vicarious selectors are indirect means of detecting, and sometimes recording, the "reality" of an object or phenomenon. This was essentially Hacking's message: we do not see *through* a microscope, because the light rays are not reflected directly from the specimen. We "see" by virtue of diffraction (Hacking 1981, 306, 312–314). Nevertheless, Hacking notes, the radiation conveys "a good map" of the specimen: "After discarding or disregarding aberrations or artefacts, the map should represent some structure in the specimen in essentially the same two- or three-dimensional set of relationships as are actually present in the specimen" (320). Hence, we see *with* a microscope. In Campbell's terminology, the images from the microscope enable, by virtue of their surrogate structure, vicarious selection on the specimen itself (Campbell lists the microscope among several scientific instruments that function so; 1974, 435). That is, the biologist can "learn to move around in the microscopic world" (Hacking 1981, 321) by virtue of the images, rather than the specimen itself.

Hacking's analysis might not have stopped with the visual image, however. What is our knowledge of this observation biologically, or cognitively? The cells of the retina, for example, respond to different intensities and wavelengths of light, summed over short intervals of time. Nerve impulses substitute (vicariously) for the pattern of radiation striking the retina. Indeed, the pattern is "dismantled" into "on-centers" and "off-centers"; it is not transmitted "pixel by pixel." As the nerves converge, more synthesis and processing occurs, conveying the "image" further as a series of overlapping lines, edges, corners, etc. Ultimately, highly derived activity of cells distributed across the brain serves (vicariously) for the image, which was itself an indirect mapping of the specimen. Given all these substitutes for the "real" thing, it is a wonder we see at all. But of course—in accord with Hacking's maxim—the mapping is generally a good one and we *do* "see": we learn to move around even in a macroscopic world.

The concept that perhaps all observations, perceptions, and scientific data are mediated is not new. Hacking's ultimate concern, however, was the reliability, or the "goodness," of our mediated, vicarious maps (see §5 for fuller discussion). Here, one may note simply that vicarious selectors can fail. They indeed are surrogates, not the "real" thing—

though we employ them for good reasons. Typically, vicarious selectors fail in predictable ways, corresponding to how they work, or how they "read" the map. For example, given certain microscope lenses or sources of light, microscopists know (now) to expect spherical or chromatic aberration (Hacking 1981, 310). Isolating and identifying these failures allows scientists to correct for them, sometimes by redesigning the instrument. Even in mid-twentieth century, elements of the electron microscope's mapping process have been identified and excluded as artifacts (see Culp 1994 on the case of the bacterial mesosome). Vicarious selection, such as with the microscope, need not be perfect to work reliably. Fallibility can often be traced and flagged, or corrective systems developed. Hence, understanding the concept and role of vicarious selectors is important in getting us beyond merely bemoaning our epistemological handicaps. It helps us epistemically develop strategies or processes for regulating, modifying, or interpreting our mediated observations, where appropriate.

3. Scientist's Reports as Vicarious Selectors. As important as a simple observation by a single observer can be, science also functions with combined observations within a community of scientists. In this context, one observer might well be able to observe "remotely," albeit vicariously, through various documents and the personal testimony of another observer (Campbell's level #7; 1974, 431–432). This introduces further layers of vicarious selectors, discussed in this section. Each layer adds further challenges about how to transmit the original "map" reliably in all its critical dimensions. And, of course, the challenge of assessing the reliability of the transmission persists. This is Shapin's central concern.

Consider first the apparently simple problem of recording an observation for later use. The transfer of a microscopic image to photographic film (and then to exposed print) or to the photoreceptors of a video camera (and thence to an electronic medium) involves (as in the visual processing of the nervous system) successive remappings, each enlisting a new vicarious selector. The "simple" act of an investigator drawing or describing the observation in a laboratory notebook is also a compound process, including short-term memory (Campbell's level #6; 1974, 427–431), a specific pattern of coordinated muscular contractions (in drawing or writing) and possible translation into words (which may substitute for the visual image). Each step contributes in part to whether the image or information is transfered faithfully as it gets more and more derived from the original "reality." The individual scientist is an "instrument," like the microscope. Developing skills in making these transformations more precise or more reliable is like honing an instrument, the human body.

Similar challenges exist in conveying an image to others in a scientific community. And the challenges exist equally for constellations of observations (namely, results of experimental investigations) and their interpretations. The construction of a scientific report, such as might appear as a journal article or conference presentation (or even as a more informal personal communication), involves numerous transformations that presumably preserve some essential dimensions of the phenomena being reported. The surrogate experience, often highly consolidated and synthesized—and certainly highly derived—involves many components in its transmission: the language itself (Campbell's level #8; 1974, 432–434), graphs, publication practice, perhaps even peer review, etc. Each structure that transmits results within a scientific community (including conferences, telephones, e-mail, faxes, shipment of specimens, etc.), I contend, is thus a scientific instrument, too. Accordingly, scientists mindful of reliability need to learn, too, how to use their culture's reporting instruments—and consider how to keep them in good working order.

Vicarious selection through the scientific literature and/or the professional grapevine is valuable for individual researchers because they can have a much broader scope of experience. They may efficiently consolidate vast amounts of observations and thereby make deeper selective judgments concerning their own investigations or technological work (also see Latour 1987 on "centers of calculation"). The vicarious mappings from remote sources enable scientists to negotiate more effectively among the phenomena they study "locally" and to probe their nature more deeply.

4. Scientist's Credibility as a Vicarious Selector. Success with scientific reports as vicarious selectors depends, of course (recalling Hacking's maxim), on the reliability of the mapping. Scientific reports or testimony vary in quality. Some may even be wholly fraudulent. How does one know? Here, finally, we reach Shapin's central concern in *A Social History of Truth* (1994). In this section, then, I discuss the epistemic *structure* of the reasoning behind such judgments (leaving discussion of their *warrant* to §5).

Ultimately, the reliability of vicarious reports can only be "seen" directly in retrospect: how well did they they "map" the world for the recipient? Conceivably, then, one might check firsthand each secondhand report—say, by traveling to a field site or by conducting one's own parallel investigation. This would recreate the direct experience or observation, essentially dissolving reliance on the vicarious, or mediated, nature of the report. Under some circumstances—in the wake of reports of cold fusion or cloning, for example—efforts to replicate findings may indeed be warranted. Even as a "last resort," appeal to direct observation (without intermediate testimony) is an essential epistemic benchmark.

Still, a strategy of direct checking is not very economical, either in time or expense. Ideally, the scientist would like an indicator (much like a color indicator in chemistry) with which one could vicariously select reliable reports. Even if fallible or prone to periodic failure, the method might prove warranted epistemically if it significantly reduced the number of cases of checking, while allowing productive research based on other reports deemed reliable by the same method. What a valuable tool, or instrument, this heuristic would be!

Here, one can conceive many plausible criteria, or markers, for assessing reports prospectively—and vicariously.[1] Shapin vividly documents one community's efforts to work out such principles for themselves. Bacon, Locke, Boyle, and other seventeenth-century English gentlemen prescribed several "maxims of prudence" for assessing testimony, such as plausibility, immediacy, consistency, and disinterested sources (Shapin 1994, 212). But any such maxim or indicator will depend in part on the structure of the scientific community, its members, and reporting practices (that is, its design as a social instrument; §3). Hence "what indicator, if any, will effectively reflect reliability?" is an empirical question, contingent upon a specific scientific culture's organization.

Shapin's study is significant, though, in highlighting one particular element of the vicarious observation process: personal testimony. In a scientific community, Shapin notes, observations are unavoidably mediated through persons. Hence, one cannot escape assessing the prospective reliability, or *credibility*, of the person who gives testimony. The primary question becomes for Shapin not *what* to trust, but *whom* to trust. Shapin thus posits an important link between the credibility *of an observation or knowledge claim* (ostensibly an epistemological question) and the credibility *of the person* who makes it (by contrast, an apparently sociological or political question).[2] In Campbell's frame-

1. A vicarious selector yields propensity, not actual performance. Thus the relation of vicarious selector to actual "reality" is similar to the relationship, well discussed among philosophers of evolutionary biology, between fitness (a propensity, or prospective performance) and reproductive success (actual performance, measured retrospectively). Here, one would distinguish similarly between credibility and reliability.

2. One may note the equivocal nature of the term 'credibility'. Error can emerge from moving from one context of credibility to the other without appropriate argument. Credibility of the person is established through historical assessment of that person's

work, *personal credibility* is a vicarious selector for the *epistemic credibility* of mediated reports.

Shapin shows that in seventeenth-century English practice, the credibility of a report, knowledge claim or observation was intimately tied to trust in the person or persons who mediated that report, claim or observation. Such habits persist among scientists today (e.g., Latour and Woolgar 1979). How should we interpret the use of this vicarious selector epistemically?

The link between personal credibility and epistemic credibility makes sense epistemically if a person's reporting behavior is viewed as an instrument (§3) and personal credibility refers to the "track record" of that behavior. That is, scientists might infer that if a person has been reliable in the past, he or she will continue to be reliable. Assessments of personal credibility would thus be grounded *empirically* in a history of reliable reports from a single individual. (I contend that this expresses the core aim of current practice.) In this view, credibility represents simple induction. Moreover, the use of such induction might be supported by a meta-induction of the persistence over time of truth-telling behavior among persons more generally. This would be a contingent fact—but possibly one worth endorsing in certain domains with sufficient evidence.

As a product of induction, personal credibility would be vulnerable to all the known dangers of induction. How would we know, for instance, that credibility is not a property like 'grue' that will change suddenly at time t (Goodman 1954)? Individual conclusions might also be fallible, while not always invalidating the assessment: personal credibility could be a probabilistic judgment (also see fn. 1). If scientists exhibit substantial trust in persons (as emphasized by Shapin), it might well rest partly on mere faith in induction.

In close circles, scientists may well be familiar enough with the reliability of their peers' past performance to make such inductive inferences effectively. But scientists more remote from the field may likely encounter problems. Hence, they may rely on yet other layers of vicarious indicators to assess past performance and, thereby, expected future reliability. Some judgments of personal credibility, then, might result from *compound induction*. For example, when one trusts someone that apprenticed in the lab of a credible person (as scientists now often do), one makes an assumption—or a conclusion induced from experience—that more often than not, credible persons instill their skills in

testimony; credibility of claims can be determined independently. For clarity, I refer explicitly to *personal credibility* and *epistemic credibility* as distinct (though related) species.

their students. Similarly, when one uses institutional affiliation to judge the personal credibility of an otherwise unknown individual, one induces over cases of prestigious institutions able to hire, ceteris paribus, credible scientists.

Vicarious selectors, of course, may always fail, simply because they are secondary indicators. One can be wrong. That is the risk of vicarious selection. But exercising these vicarious selectors at the outset, even as a "first cut," is a matter of heuristic economy. One trusts that one can identify and remediate the periodic error. Proximal and ultimate selectors interact. Noting that there are two levels (or scales) of selectors and that they are linked is important for the naive observer who may first intepret them as conflicting norms (see §6).

In practice, judgments of personal credibility or authority may reflect other factors, such as assurance or quality of voice, personality or, in Shapin's case, civility, manners, Christian faith and "virtue." Whether these other factors warrant epistemic credibility is another question, only answered empirically. In many cases, our intuitions and unregulated cognitive apparatus do not yield the most reasonable judgments (see, e.g., Bechtel and Richardson 1993). The potential problem with indicators is not only that they might miselad us, but that they can be used independently to promote unsubstantiated reports. Hence, as Toumey (1997) dramatically shows, even non-scientists can "conjure" science in the public arena by deploying the symbols of science in the absence of any sound science.

For scientists *personal* credibility as a vicarious selector is a tool for interpreting the *epistemic* credibility of scientific reports (§3). What remains yet to be addressed is how one investigates whether this tool is warranted or effective.

5. Don't Just Hear: Interfere. Ultimately, how does one assess the reliability of instruments, scientists' reports or other vicarious selectors? Here, Hacking's and Shapin's analyses of different levels of science complement each other in striking ways.

First, from the foregoing analysis, one might wonder whether science can achieve any reliability at all given the lengthy chains of transformations that must preserve the original mapping and the layers upon layers of vicarious selectors, each susceptible to failure. After all, the failure of any one link in the chain potentially cascades through the entire chain, threatening the reliability of the entire series. Flaws are compounded. Shapin's English gentlemen, however, found a remedy in contemporary legal practice: corroboration (or testimony from 'multiple' sources, in Shapin's terminology; 1994, 212–215). Hacking identifies the very same principle in microscopy. In addition, he notes how images from *different* instruments can converge: "We are convinced because instruments using entirely different physical principles lead us to observe pretty much the same structures in the same specimen. . . . We are more convinced by the admirable intersections with biochemistry, which confirm that the structures we discern with the microscope are individuated by distinct chemical properties too." (1981, 321; also see 315, 317). Here, observations *in parallel* (versus observations in series) lead to more reliable interpretations: they are *robust* (see the in-depth discussion in Wimsatt 1981). Robustness, then, is a prime strategy for dealing with the uncertainty of vicarious selectors. Indeed, robustness of evidence persuaded electron microscopists that the vicarious image of the bacterial mesosome was an artifact of preparation techniques, not a "real" structure of living cells (Culp 1994). What is especially worth noting, here, is that as a principle of reliability, robustness applies equally at the levels of instrumentation in the laboratory and social testimony in scientific communities. Robustness is a "deep" epistemic principle.

Hacking also offers a second strategy for ensuring the reliability of instruments: intervention, or interacting with the instrument and the specimen. Essentially, one problem with vicarious selectors is that the final image is an effect whose origin, or cause, is uncertain (possibly artifactual). Hacking thus recommends inserting known causes, transforming the line of uncertain origin into a loop of known cause, originating with the experimenter. One affects the specimen "upstream" of the signal in question and observes its effect. "Don't just peer," Hacking advises (1981, 308), "interfere." And indeed, this is a standard method for calibrating instruments (Franklin 1997). Through interaction, one can assess whether a vicarious selector is mapping relevant properties reliably.

Hacking's recommendation has overtones for social discourse. By comparison, one ought not to take personal testimony or read the scientific literature as a "spectator" sport any more than one subscribes to a spectator theory of knowledge of human observation (see Hacking's comments, 1981, 308–309). Testimony should thus be assessed dynamically. The complementary maxim might be: "*Don't just hear: interfere*." Indeed, I believe that scientists do just this. For example, when they assemble at conferences, they do not just listen to presentations. They ask questions. They gather in corners and coffeeshops to discuss discrepancies and uncertainties. When separated, they e-mail one another with queries about controls, etc. They thus assess the reliability of mediated claims by actively situating them in unreported background knowledge or samples of reagents or tissue cultures, etc. Moreover, in some circumstances, as noted above (§4), they may return to the unmediated observation to explore a questionable report and its phenomenon more fully.

When one views the scientific community as a social microscope for sharing observations, one can see more clearly the need to understand its design as an instrument for reliable reporting. Hull (1988), for example, has advanced some strong claims about systems of rewards and sanctions that might shape truth-telling behavior. Do scientists "calibrate" their colleagues? I suspect that, unconsciously, they do. When introduced to new peers, they often discuss familiar topics informally: a sample by which to gauge responses against a "known" standard. Shapin's account models how one can integrate philosophical and sociological approaches in investigating the *epistemic* structure of scientific societies. Scientific *society* and its mapping system are socially constructed (literally). Scientists might herefore consider (with the possible assistance of philosophers and sociologists of science) how to build a better instrument—and how to keep it well-tuned and calibrated.

Finally, Shapin highlights the role of trust in testimony in holding the fabric of scientific communities together. Does this have import for scientists in the laboratory working with microscopes and other instruments? Hacking frames his argument in terms of truth and being convinced by microscopic images, yet his tone certainly implies concerns about trust. While Shapin discusses trust as a very personal dimension, one might need to interpret trust more broadly to include instruments. Are instruments also members of the scientific "community"? Instruments may give testimony. Issues of credibility apply equally to instruments and humans. Here, analysis of vicarious selectors shows vividly how persons and instruments are threaded together epistemically. Hence, one may begin to blur the distinction between actor and actant (Latour 1987; also see Pickering 1995). The scientific community may be more inclusive.

6. Unifying Philosophical and Sociological Interpretations of Scientific Judgment. The use of personal credibility as a vicarious selector can potentially lead to confusion about the foundations of scientific judgment. Scientists often contend that they focus exclusively on empirical evidence for evaluating the reliability of claims. Yet ethnographers observe that scientists typically apply personal credibility as the single most important standard in such assessments (e.g., Latour and Woolgar 1979). For sociologists, credibility and politics appear primary. Philosophers bristle. Articulating the role of credibility as a vicarious selector clarifies this apparent discrepancy and helps to resolve philosophical and sociological accounts by distinguishing between proximal and ultimate selectors (detailed more extensively in the literature on philosophy of evolutionary biology). Credibility is a proximal measure. It functions as a vicarious selector, or heuristic, for an ultimate, more foundational aim—namely, empirical reliability. Scientists thus apply the heuristic *first* as a prospective "short-cut" to a longer process of validation. Credibility thus appears primary. But following scientists' reasoning and their behavior on a larger time-scale reveals that credibility is merely an indirect, hopefully efficient and effective, gauge. What scientists report and what they do ultimately agree. Both sociological and philosophical claims are each partly warranted. Personal credibility is primary, in the sense of proximal, while empirical reliability is foundational, or ultimate. The analysis of credibility as a vicarious selector thus points to an important link, or bridge, for unifying philosophical and sociological analyses.

Moreover, a focus on vicarious selectors highlights the uniformity of methods in assessing the reliability of the transformations or "mappings" at various levels of scientific analysis, or at various stages along a series of transformations from phenomenon to the sometimes remote "observer." Do we see through a social microscope? In Hacking's sense of perceiving through a traceable series of transformations that preserve an original structure, yes: we see *with* a social microscope when the reports or testimony (the subject of Shapin's analysis) map the observation, and the mapping is a good one. The challenge, of course, is knowing when the mapping is good and, when it is not, applying strategies to isolate and correct errors.

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