



Errors in imaging reading and reporting

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In a previous Editorial for this journal, we proposed an epistemological analysis of imaging [1]. Epistemology asks the question: in this area, at what conditions can we claim that we know something? We assessed image reporting and indicated possible epistemic pitfalls of each. Here, we will consider image reading in more detail. The framework we adopt, as in our previous contribution, is called “reliabilism” in contemporary epistemology. It is the view that something counts as knowledge if it is the output of a relatively error-free process. Until AI-based systems for image analysis are not ready for use, medical images need to be read by a specialized physician. Reading a medical image can be described as a conversion of visual information to clinically relevant information (the term “conversion” is intentionally vague at this stage). A possible option is to adopt process reliabilism as an epistemic framework and explore the view that image reading is knowledge-conducive (it makes good evidence), when it is the output of a reliable process, that is, a process that it is relatively error-free.

Unfortunately, image reading and reporting are far from being error-free: radiological errors are a huge problem in contemporary medicine. Recent studies quantify them up to 30% of reported findings, with variations depending on imaging modality, task, and location [2]. If we only consider the reading stage at this point of our discussion (or the so-called pre-reporting errors), the data are still impressive. Of course, not all imaging reading errors have an impact on patients’ management—on their final diagnosis, intervention, and eventually on their health outcomes—but some do. Moreover, radiologists are increasingly held responsible for misdiagnoses and negative outcomes and sued

for malpractice [3]. Therefore, it is not surprising that the medical literature on the topic is vast, that is, the fear of malpractice suits. The most common cause of malpractice suits against radiologists is failure to diagnose, that is, an error in reading. Taking errors apart—that is, assuming a good quality image and a good reading—the second cause of malpractice suits is failure to communicate. In these cases, it is claimed that a defective (even if accurate) radiological report caused the diagnosis to be delayed (a typical example is mammography for breast cancer).

It is worth reminding here that the epistemology of image reading is not primarily concerned with finding solutions to avoid errors—just like the epistemology or testimony (for one) is not primarily focused on how not to be fooled by liars, impostors, or fake news. What counts as error, though, is a conceptual question worth addressing, together with what the different kinds of errors are, and which competencies or skills they count as failures of. On the first question, what is medical error, there is an ongoing discussion in the scientific literature [4–6]. Here are some of the requirements and difficulties that have been presented. First of all, errors should be distinguished from malpractices, that is, cases in which blame can be attributed to the agent. There should also be a difference in principle between errors and variations in interpretation, but the possibility of operationalizing this difference depends on whether there is a consensus of experts on interpretation issues, which is not always the case [7]. Moreover, if something counts as a medical error only if it impacts on clinically relevant outcomes, we are trumping the epistemic goal of medicine (knowing and explaining diseases) in favor of the practical goals (curing and caring) [8]. On the other hand, in many cases—and in most cases in diagnostic medicine—errors are epistemically accessible and quantifiable only from their clinical effects. There is room for suggesting that the definition of error in medicine is a genuinely philosophical problem, that is, one of those cases in which no additional amount of evidence can settle the issue.

Arguably, so is the problem of the classification of errors. At the most general level, imaging errors in reading can

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be of two kinds, not detecting an anomaly when there is one (false negative finding) and detecting an anomaly when there is none (false positive finding). In addition to these so-called detection errors, a further distinction that can be found within the medical literature is between interpretation errors, which concern how the anomaly is categorized (pathologic vs physiologic), and threshold errors (as when an increased uptake is interpreted as cancer in a PET scan). This classification of errors reflects a view of what are the components of the process of image reading, that is, perception (for detection), medical knowledge of normal structures and functions (for detection and interpretation), and knowledge of the specific imaging modality and its semantics (for threshold setting). Other authors propose different subclassifications of errors, for example, a distinction among different kinds of perceptual errors in image reading based on their cause (fatigue, cognitive biases such as inattentive blindness and satisfaction for search, etc.) [8]. From a non-systematic recognition of the literature, it appears that there is no agreed upon classification principle for errors—cause, etiology, and effect are equally employed and mixed up—and this indicates a possible area for philosophical inquiry.

In addition to the problem posed by the notion and varieties of errors, the reliabilist framework proposed so far for the epistemology of image reading is further complicated by what has come to be accepted as consensus in phenomenological and ethnocognitive studies of imaging, that is, that image reading is a kind of seeing-as, or Gestalt perception [9, 10]. In seeing-as, what is seen emerges out of a specific but unconscious spatial organization of the parts of a scene—as when, suddenly, one sees a smiling face when looking at three dried leaves on the ground. Seeing-as is a holistic process, defined as perceiving more than the elements of the observed scene (that is, perceiving them also as organized in a meaningful way). Philosophers of perception and psychologists of vision have claimed that in some fields, including radiology, seeing-as correlates with expertise and may even be taken as a defining feature of expertise [11, 12]. The bottom line is that expert radiologists do not read images by recalling and applying conversion rules from visual to clinical information.

If reading images is a kind of seeing-as, it makes little sense to distinguish between perception, knowledge, and threshold errors in radiological reading, as one holistic competence is supposed to be in place. Therefore, it makes little sense to reflect on separate correctness conditions relative to those components, for a good epistemic standing of radiological reading. A recent discussion of seeing-as in reading images suggests that radiological seeing-as depends on the individual's "horizon"—a sort of paradigm in Thomas Kuhn's sense [13]—defined as "the total experience a person has accumulated during his or hers lifetime, which includes personal social experience, education, rules and laws, family

values, politics, religious standing, and professional expertise" [14, 15]. The suggestion is that the horizons of different people can be incommensurable, that is, what they bring about cannot meaningfully be compared; this is the case when radiologists do not belong to the same group and thus do not share the same type of education, professional experiences, and culture [14].

These considerations about the thesis that radiological reading is a kind of seeing-as point to a difficulty for the epistemology of medical imaging. Arguably, seeing-as is an epistemically opaque process, that is, a process such that we do not really know how, and why, it works; with another metaphor, it is a black-box process, which can be assessed by its outputs only, but not by inspecting the methods, mechanisms, or rules that produce them. Even if we adopt an externalist epistemology, that is, we do not require that agents are reflective on their methods and on the validity of such methods, for them to count as knowledgeable (we do not require that the knowing agents are reflective on their methods and aware of the validity of such methods), still there is the intuition that medical knowledge and medical evidence need some kind of accountability. Indeed, that it is not a really black box, but a box we can at least partially see through, or that someone can see through. This is the case of the complicated models for assessing image quality, or, in a different area, the complicated statistical rules for the meta-analyses of studies—image quality measurement and meta-analysis are not epistemically opaque processes, they are just complicated processes, knowledge of which is deferred to experts. This accountability requirement for processes involved in medical knowledge, as well as the epistemic opacity allegation, are central also to arguments against replacing human image readers (radiologists) with artificial intelligence software—the problem with AI reading software is that it can be blamed as epistemically opaque [16]. And we could even question: who will ever trust an opaque system?

Is the seeing-as account of image reading incompatible with an epistemology of imaging that preserves the intuition of the accountability of medical knowledge? There are some ways to support a negative answer. A first one may be that epistemic transparency versus opacity is an underspecified requirement, with fuzzy boundaries, and context-dependence; a further one could be that seeing-as is not opaque, but rather it is a perfectly well understood cognitive capacity, and the fact that it is not analyzable into discrete components, such as propositional knowledge and perception, is not relevant; in fact, there are well-known principles of Gestalt perception [17]. On a different vein, it could be argued that seeing-as pertains to the psychology and phenomenology of reading images, and those are relatively irrelevant to the epistemology of reading images (just like, for example, it can be argued that the epistemology of logic

can be kept separate from accounts of how people reason, or the psychology of reasoning). Finally, a radical externalist approach would consist in biting the bullet, abandon the accountability requirement for an epistemology of radiological reading, and allow for seeing-as (and AI) processes as providing good evidence, insofar as they are relatively error-free. Each of these strategies stands in need of further development and clarification; the sketchy list above is just meant to signal another area for work in the epistemology of imaging procedures.

Declarations

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