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nº 103
Dezembro, 1997

Oficina do CES
Centro de Estudos Sociais
Coimbra

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PUBLICS, MEDIATIONS AND SITUATED CONSTRUCTIONS OF SCIENCE: THE CASE OF MICROSCOPY*

1. Introduction

The latest generation of studies of the public understanding of science has drawn attention to the heterogeneity of both "science" and its "publics". This paper offers a contribution to this body of work by focusing on a set of issues which have been dealt with, over the last two decades, by researchers in the sociology of scientific knowledge, the anthropology of situated learning and situated cognition and ethnomethodology, and which should be brought back to a prominent place in studies of the public understanding of science: how are scientific concepts, procedures and instruments reappropriated or reconstructed across a diversity of settings and practices which do not fit into conventional representations of "pure" science, and are generally associated with the "applied" pole of science or with expertise? These settings are recognizable, by and large, through forms of activity which, though drawing on science either as a source of legitimacy or as a source of knowledge, instruments and skills, respond to different "briefs". The languages, instruments and procedures of scientific disciplines are reappropriated and transformed in a situated way, as part of new configurations of language

* Paper delivered to the Conference "Ciência, Cultura Científica e Participação Pública", Lisbon, Fundação Calouste Gulbenkian, 20-21 November 1997. Research for this paper was funded by grants awarded by Junta Nacional de Investigação Científica e Tecnológica and by Programa Praxis XXI to the Centre for Social Studies of the University of Coimbra. I would like to thank the researchers, graduate students and staff at Centro de Investigação em Biopatologia e Oncobiologia/Instituto de Patologia e Imunologia Molecular da Universidade do Porto (CIBO/IPATIMUP) for their generous help and assistance.

games and forms of life. The articulation of continuities and discontinuities across settings constitute "trading zones" and boundary spaces where these different forms of knowledge and practice meet and mutually transform each other . For "lay" people, these activities are often important sources of scientific information and crucial mediations in the shaping of opinions and attitudes towards science, its production and its social uses.

Drawing on materials from research in progress, I shall examine several cases focusing on the topic of observation and visualization and on a set of procedures - subsumed in the expression "microscopy" - which, due to their accountable presence across a variety of work settings, makes an investigation of the respecifications or redefinitions of "seeing" and "observing" possible and provide a convenient point of entry for the study of the relationships and flows between forms of activity usually split along the basic/applied distinction. These, in turn, raise a number of questions on how "basic" or "originary" the settings usually identified as those where "pure" science is made are to the business of producing science, technology and expertise. Following the lead of other researchers in the social studies of science, I suggest that *all* forms of knowledge production and articulation, and particularly those commonly ascribed to either "basic" or "applied" science, to "science" or to "expertise" should be dealt with in a symmetrical way, without a prior commitment to a "diffusion" or "transfer" model of the relationships across settings. Paraphrasing Hutchins (1995), all settings where science is articulated - including the "basic" science laboratories - should be treated as instances of "science in the wild", of heterogeneous assemblages of actors, instruments, materials, spaces and practices or, in an alternative formulation, as ecologies of practices, of knowledge and of action.

2. Science in the wild

A growing body of work in the social studies of science has focused on the constitutive "disunity" of "science" as a set of historically emergent and heterogeneous "ecologies of practices", thus challenging the notion of "Science" as a unified or converging body of knowledge and methods (Lynch, 1993; Galison and Stump, 1996; Pickering, 1992; Stengers, 1993, 1996; Lenoir, 1997). Different approaches within science studies have explored other forms of "non-scientific knowledge" and how they relate to specific social settings and forms of learning, to "scientific" and "expert" knowledges, opening the way to a fundamental revision of the notion of a "public" to whom science and scientific information should be brought by scientists and experts in order to promote or advance "public understanding of science" or "scientific culture". Earlier - and still largely influential - definitions of the "public understanding of science" (PUS) were based on a deficit model of how the public relates to science, and on the supposed irrelevance of the "lay" knowledge configurations which should allegedly give way to scientific world views. Promoting PUS would thus entail more science education, more diffusion of science, a "percolation" of science to an undifferentiated public, understood as a sum of interchangeable, non-knowledgeable subjects. A variant of this approach acknowledges the importance of "lay" forms of knowledge as ways of relating to the world, but see them as illusory representations which should be replaced, through appropriate experiences and learning procedures involving "conceptual change", to adequate scientific understanding. In any case, "lay" forms of knowledge are taken to be obstacles to scientific culture[1].

Instead of a homogeneous or indifferentiated "public" whose members share a deficit of information on science, the new approaches have identified heterogeneous "publics" for science associated with a variety of local configurations of forms of knowledge and of skills, both "scientific" and "non-scientific" (Irwin, 1995; Irwin and Wynne, 1995; Martin, 1989, 1994; Stacey, 1997; Lave, 1988; Chaiklin and Lave, 1993). Rather than revisiting this body of research, I shall take for granted its findings concerning the heterogeneity of both "science" and its "publics" and the local configurations of knowledge and skills associated with it which have come to be described as "lay expertise" or "lay knowledge". Explorations have been undertaken of the active modes of appropriation of science by specific social actors in specific settings, and of their links to a more democratic and accountable relationship between "experts" and scientists, on the one-hand, and "lay-people" and citizens, on the other.

I shall focus here on what I feel is still a rather neglected theme in this debate. Let me start by formulating the issue in a vocabulary close to "conventional" understandings of science. We are all familiar with a range of forms of expert knowledge relying on science or invoking it to legitimate themselves and which are often identified by "lay" people as the "practical" and socially relevant face of science. I would include, here, all those "impure" or

[1]For a thoughtful discussion of "conceptual change" in science education, see Macbeth, 1997.

"hybrid" forms of activity like medicine, engineering, forensic expertise or science teaching, to name only a few. These are all activities conventionally ascribed to the "applied" pole of the "basic-applied" distinction which is still a common - even if contested - way of classifying scientific activities[2]. On the other hand, when dealing with the science-public or expert-lay relationships, these forms of "impure" activity are usually ascribed to the side of science or expertise. The basic-applied distinction, however, suggests that these activities somehow straddle the realm of "pure" science and the realm of "specialized" publics who develop the knowledge and skills necessary to deal with the various ways in which science is enacted in the world. This suggests that most forms of expertise relying on science could as well be described as constituting specific publics for science, or publics of science-users. Their labelling as experts would grant them an authority rooted in their skills in using science for practical purposes like diagnosing and treating people afflicted with diseases, developing new kinds of pest-resistant crops, building machines, buildings or bridges or bringing the knowledge produced by scientists to students through the use of appropriate procedures for teaching and learning. But they would still be dependent, for their activity, on the resources and on the legitimation provided by "basic" science.

It is true that this "basic-applied" distinction is increasingly being challenged within science worlds, and that expressions like "translational science", "regulatory science" or "citizen science" have been proposed to refer to the blurred boundaries between "basic" and "applied" science, to scientific activity responsive to social and political concerns while remaining answerable to the standards of research and to the agendas of scientific communities. There is a growing literature on the transformations of science emerging from this blurring of boundaries, particularly in fields like medicine and environmental issues[3]. This raises some interesting questions concerning the status of the already mentioned "impure" forms of science or science-related activity and of the place of "experts" within the science-public nexus. These questions, in turn, suggest that the notion of a "fundamental" or "originary" position of what is still largely referred to as "pure" science within the space of

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[2]The science/technology distinction is often used to describe this divide.
[3]See, for instance, Epstein (1996) and Bastos on AIDS, Proctor (1995) and Stacey (1997) on cancer, Irwin (1995), Wynne (1995) and Yearley (1996) on environmental issues, as well as the contributions to Irwin and Wynne (1995). For a more general discussion of the relationship between scientific and "lay" forms of knowledge and the prospect of a new common sense emerging from new configurations of these different forms of knowledge, see Santos, 1995.

the production, circulation, diffusion, promotion and social uses of scientific knowledge is problematic.

The basic/applied distinction is rooted in the notion of a one-directional flow or transfer between knowledge and skills generated in the settings where "basic" science is done to the settings where its "applications" are implemented. As science studies and the history of science and technology have shown, however, flows between settings are far more complex and multidirectional, and "basic" science itself is largely dependent on technological developments which often emerge in an autonomous way. On the other hand, some forms of expertise which are often thought to rely on a one-directional flow from "basic" to "applied" provide important inputs to "basic" science in the form of skills, technologies, instruments, materials or representations more responsive to the contingencies and uncertainties faced during work under conditions less controlled than those of research laboratories.

In order to explore these issues, it is necessary to go back to some early - and still current - concerns of the sociology of scientific knowledge. The learning and transfer of the skills required to do scientific work in specific settings were among the topics dealt with by Harry Collins in the 1970's (see e.g. Collins, 1975) and resumed in his more recent collaborative studies on the sociology of skills (Pinch *et al*, 1996; Collins *et al.* 1997). Callon, Latour and Law's notions of "translation" and the whole framework of actor-network theory also relies on the idea that knowledge, skills, procedures and inscriptions "travel" and are made part of networks through processes like "interessment" or recruitment. The associated notion of "centres of calculation" is crucial for the understanding of the early versions of this approach. It requires the identification of the "centre" from which translation and interessment may proceed in order to build networks (Latour, 1987). An interesting development of actor-network theory - which is not alien to the criticisms of its unidimensionality coming from feminist critics, in particular (Star, 1991; Singleton, 1995) - led to a more "decentered" version of it, acknowledging the possibility of a variety of "points of passage" for the networks (Callon and Law, 1997). Other approaches tried to come to terms with the problem of dealing with the circulation of science under the guise of knowledge, inscriptions or skills without the need to assume a single "centre" from which science is diffused or transfered. Star and Griesemer's and Löwy's "boundary objects" (Star and Griesemer, 1989 Löwy, 1996), Fujimura's "standardized packages"

(1996), Galison's "trading zones" (1997), Löwy's "pidgin" or "creole zones" and boundary concepts (1992) or Stenger's (1987) "nomadic concepts" were attempts at finding an appropriate way to deal with this issue. Other research traditions, like ethnomethodology and anthropological studies of situated action and situated learning and cognition started from the assumption that each setting of activity should be studied as a specific setting, without assuming either its "primary" and "originary" or its "derivative" and "secondary" condition (Lave, 1988 Lave and Wenger, 1991; Chaiklin and Lave; 1993, Lynch, 1995a). Forms of knowledge, skill and instruments and resources associated with science should be dealt with as part of what several authors called "ecologies of knowledge", "ecologies of practices" or "ecologies of action" (Star, 1995; Stengers, 1996; Fujimura, 1995), that is, as systems defined by an open interdependency of processes involving heterogeneous actors, resources, technologies, institutions and forms of knowledge, power and action (Nunes, 1996: 6). Issues like the transfer or diffusion of knowledge and skills across settings should be treated as research problems to be dealt with empirically, not as a general assumption or starting point of studies of situated activities.

Rather than providing a detailed discussion of this literature, I would just like to stress its importance to our understanding of the relationship between "science" and its "publics". What are the consequences of adopting a decentered approach to the relationship between the diverse settings where science is "done", "used", "reappropriated" or "transformed"? What does this mean for the way we deal with "diffusion" or "transfer"? If science (as a shorthand for knowledge, skills, procedures, inscriptions and resources) is not taken to be a "pure" version of something that can be transfered, diffused, applied, etc., but rather as something irremediably marked by *iterability* - ie, repetition with a difference/differance, but without any perceived "original" or "pure" version (Derrida, 1990) -, all settings relying on "science" for the definition of their identity or specificity should be treated symmetrically, all of them should be treated as instances of what I shall call, paraphrasing Hutchins (1995), *science in the wild*. This obviously raises some awkward questions for anyone trying to establish or hold a once-and-for-all, irreversible and "context-independent" distinction between science and its publics, between basic and applied science, between scientists and experts or even between experts and lay people and expert knowledge and lay knowledge. In no way should this be meant to endorse the idea that they are "all the same", but rather that these distinctions cut across a variety of settings, displacing or blurring their boundaries . The local, situated specificity of each setting has to be reckoned with, and identifying the continuities and discontinuities across settings is something to be established empirically.

There are obvious convergences between this approach and the "cognition in the wild" approach advocated and exemplified by Hutchins (1995) in his work on navigation - the study of cognition in its "natural" surroundings, and not just in the domesticated and controlled environment of the laboratory. Beyond these convergences, I would suggest that the study of "science in the wild" - which I would extend to the research laboratories themselves, as settings conditioned by their "surroundings" - and its constitutive "ecologies of practices" can be fruitfully extended to the discussion of the aforementioned distinctions between science, expertise and publics and of their blurrings and transgressions.

The exercise rehearsed in the remainder of this paper consists of examining the issue of how "science" as a set of practices is re-appropriated or redefined across a range of settings using what, at first sight, could be defined as the "same" set of procedures and instruments, and how foundational themes of science such as seeing, visualizing or observing are respecifyied across these settings as part of particular and unique ecologies of practices, of knowledge and of action. I am indebted, here, to Michael Lynch's ethnomethodologically inspired program of turning "foundational" issues in epistemology and scientific practice into topics for empirical investigation - what he calls "epistopics" (Lynch, 1993; Button, 1991).

3. All manners of microscopy

In order to locate this discussion in recognizable settings related to science, I chose to focus on an assemblage of practices organized around a particular instrument. Instruments provide convenient means of tracing the circulation of science-related phenomena, either through iterability or through autonomous reapropriation. Continuities and discontinuities are thus identifiable across settings and open to investigation. I shall focus here on one such instrument, the microscope - in this case, the more common light microscope[4]. Microscopes can be found across a variety of settings, as part of

[4]On the use of another kind of microscope, the electron microscope, and on the complex of practices involved in preparing, processing and interpreting the materials for electron microscopy in neurobiological research, see Lynch, 1985.

a diversity of configurations of language games and forms of life. The microscope is one of the most popular icons of science, of rigour, of precision and of what it means to "observe" as distinct from mere "seeing", as well as of *discovery*, of revealing what you cannot see with your bare eyes. Wherever a microscope is found, science under any of its incarnations - "basic" or "applied" - is assumed to inhabit the place.

Microscopy provides a suitable "anchor" or mediation - in Hennion's (1993) and Latour's (1991) sense - for the exploration of the continuities and discontinuities across settings, based on the material requirements of using a particular instrument linked to what Lynch (1995a) defines as a *topical contexture*. Lynch uses this notion to respond to the need for looking at "where the action is" in scientific work, that is, at the way actors, technologies, materials and skills are assembled in particular spatial and temporal orders to produce specific types of objects. These assemblages of heterogenous elements are constitutively linked to the organization of a "space of operations" and to a "grammar of spatial concepts". The resulting topical contextures are "local orderings of referential details exhibiting visible relations of above/below, next to/separate from, inside/outside, before/behind, aligned with/askew, and so on." (Lynch, 1995a: 229). Microscopy embodies a particular form of topical contexture refered to by Lynch as "opticism". It is worth quoting at length the features he ascribes to it:

> 1. Ocular vision provides the paradigm of perception and observation.
>
> 2. Visual field and viewer's image are clearly distinguished along Cartesian lines (external object-internal image).
>
> 3. The viewer's "eye" becomes a singular point of aperture toward which a field is oriented.
>
> 4. The field is framed by a window, often represented as the outer edge of the cone of rays linking the field to the eye.
>
> 5. The relationship between eye and object (or field) is transacted through a converging arrangement of linear rays. This arrangement integrates the limit forms and axioms of Euclidean geometry within the mechanisms of vision.
>
> 6. A transparent lens and/or reflective mirror mediates the linear transfer of rays into (or in some theories out of) the "eye's" image.
>
> 7. A point by point correspondence obtains between image and object. Note that this correspondence governs even the well-known "defects" of vision, since the biases and distortions are mapped out in reference to the refractory and reflective properties of the bodily instrument.

8. The model of vision supplies a vocabulary and a set of topics for a more general epistemology. Discussions and debates about the role of sense data, primary and secondary qualities, signifier-signified relations, and private experience partake of the orthodox theory's opticism (Lynch, 1995a: 235).

These features are "mutually supportive" and "can be viewed as `epistemic´ conditions of embodied action in particular technological complexes" (Lynch, 1995a: 234). Microscopy is one of these complexes, one for which these features seem to be particularly salient, and through which they become accountable features of "seeing", "visualizing" or "observing" as an activity constitutive of "science".

I would like to go one step further and examine the different vocabularies and "grammars of action" through which these shared features are enacted in a variety of settings. Is there some "originary" setting where "seeing with a microscope" is defined "in general", without bounds to any particular context of use, so that it can be transfered or replicated in other settings? Or does "seeing with a microscope" mean different things in different settings, depending on the particular complex of activities, actors and materials involved and on the particular vocabularies drawn upon to account for it? Do a biologist, a pathologist, a physicist, a secondary school science student or a forensic expert "see" the same thing when they look at a sample of human tissue? And how does one "learn" microscopy? Through "general" training aimed at developing what are presumably transferable skills, or through the situated engagement with specific practices? And if seeing with a microscope is a set of transferable skills, which way do these flow? From "basic" acquaintance with the (physical and optical) principles underlying microscopy to settings where it is "applied"? Or are there as many ways of learning microscopy as there are settings where the microscope is used?

Answering these questions requires the study of a variety of activities where microscopy is part of the day's work. I have chosen to focus on three of these in some detail[5].

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[5]Work in progress focuses on two additional settings: science education in secondary schools and forensic expertise. I shall not deal with them here, but a brief reference to some of their features may be useful to give a taste of the variety of ways "microscopy" is enacted.
In educational settings, students are oriented towards the "discovery" of previously unseen features of objects, whereby the objects themselves and their details are made relevant through *staged* observations, these features being previously known to the teacher. The microscope is treated as an instrument, that is, as a means of seeing what you cannot see with your naked eye. This association with "discovery" is further underlined in the language games

The first activity is post-graduate teaching of microscopy, organized by a scientific research lab, and involving different types of users of microscopes, ranging from lab technicians to pathologists, science teachers and researchers. The second and third activities are routine diagnosis in tumour pathology and research on cancer using immunochemical procedures, respectively. I shall deal with them jointly, since not only are they often performed by the same actors in the same settings, but also because of the way they provide a particularly apt illustration of the main arguments of this paper. I shall give a brief description of how "microscopy" is performed in each setting, and I shall then go back to the issues raised earlier in the paper. I relied on a variety of sources of information, ranging from observation and interviews, manuals, textbooks, protocols and other written materials to photographs and video.

i) Post-graduate teaching of microscopy

Some scientific research institutions offer courses to practictioners of microscopy aimed at helping them to "make the most of the microscope", through an understanding of how it works and what can be done with it (Evenett, 1996). These courses typically rely on a hands-on format, allowing students to get acquainted with the physical make-up of the microscope, with developments in its technology and with the optical principles on which microscopy is based. "Seeing with a microscope" means, in this case, orienting towards the physical and optical properties of the microscope and of the objects displayed, to the identification of the activities linked to the appropriate use of the microscope as an optical instrument, to the development of the skills needed to adjust the microscope and get the best possible image and to the different means of recording images with the help of a microscope. The relevant vocabulary is organized around terms from optics, a branch of physical science. This is assumed to be the most general and context-independent way of dealing with microscopy. Students are required to examine the physical make-up of the microscope, to identify its different parts (lenses, condenser, eyepiece, etc.) and functions and to perform a series of

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for learning with the microscope - detective work or travel, for instance (Lynch and Macbeth, 1996).

In forensic expertise, microscopy is part of the procedures aimed at either identifying clues which allow further investigation accountable as legal procedure, or to establish evidence answerable to the legal requirements of a court of law (Lynch, 1996).

manipulations required for the proper adjustment of the microscope. These involved getting the illumination, magnification and focus "right", that is, getting a clear and well-defined image. The properties of the objects "seen" with the microscope during these adjustments are relevant only in so far as they can be described using the vocabulary of optics.

"Seeing" and manipulating the microscope are mutually constitutive, so that the participants in the course may become proficient in setting up the microscope even if they come to "forget" the vocabulary of optics and the theory associated with it. The optical properties of microscopy become embodied in a technological complex and in a topical contexture. In the end, what have participants "learned"? The physical and optical principles of microscopy, or a set of instructions for getting their microscope adjusted through the use of eyes and hands? We shall come back to this issue later. In the meantime, let us look at activities where microscopy is part of a set of activities oriented towards specific aims and towards the production of specific types of objects which cannot be accounted for using the vocabulary of optics.

ii) Routine diagnosis in tumour pathology and research in oncobiology

Pathology is described by its practitioners as "the scientific study of the causes and effects of disease", disease, in turn, being defined as "an abnormal variation in the structure or function of any part of the body" (Anderson, 1985: 1.1). Tumour pathology deals with a specific type of diseases, those related to abnormal cell growth. In the course of their work, pathologists are oriented towards the features of samples of tissues, which have been processed, stained and subject to reactions with antibodies and fixed on slides which allow them to be inspected for the presence of "abnormal variations". Anatomical features of the specimens-on-slides - such as the morphology of tissues, the architecture of cell populations, intracellular characteristics, etc. - are the focus, and the microscope is used as an instrument allowing the specimens to be inspected. Optical properties discussed in the previous section are here made part of the slides themselves through staining techniques, which allow transparent fragments of tissues to be made visible. These staining techniques also incorporate biochemical properties which are routinely known and whose properties may be taken for granted during visual inspection of the samples, as long as the specific antigen-antibody reactions used have been identified and the way they work made part of routine procedures. The focus is on the optical identification of the features which allow, through an elaborate version of the documentary method of interpretation (Garfinkel, 1967), the distinction between "positives" and "negatives" as an accomplishment of the examination of the slides as problem solving in a heterogeneous field of practices articulating subspecialties of pathology like, among others, histology (the study of structural changes of tissues), cytology (the study of changes in cells), biochemistry or chemical pathology (the investigation of the metabolic disturbances of diseases by assays) or immunology (the identification of abnormal conditions in the immune system through specific antigen-antibody reactions), against a background of detailed anatomical and physiological knowledge of human organisms. Pathologists draw upon relevant competences in these subspecialties to perform systematic visual comparisons of new cases with previous cases and with a body of established knowledge, treating each new case both as an instance of more general categories of cases, while at the same time revising these categories, when needed, in order to accomodate new cases. The use of standard protocoles or reference manuals and textbooks is frequent during these visual inspections. Occasionally, cases considered as particularly interesting or rare may give rise to further study and to publications in medical journals. But this activity is mostly based on well-established and normalized routine procedures.

"Seeing with a microscope" stands, in this case, for the visual identification and description of the features of samples of tissues which provide information on the possible existence of tumour pathologies. This work depends crucially on a set of distributed activities involving the harvest, processing and staining of samples, these steps being usually performed by hospital staff and laboratory technicians. Where do the optical principles of microscopy show up in this setting? In fact, most of the laboratory technicians and pathologists display little or no knowledge of the optical principles involved in microscopy, or they simply admit that they have forgotten them. Seeing with the microscope is here an activity which is accounted for in the language of pathology and of its subspecialties. A sample is described in terms of the properties that are relevant for the tasks at hand. Learning how to see with a microscope in these settings requires, above all, learning the practical skills of identifying the features of the objects to be seen as objects of pathology, not as an application of a more general practice of microscopy rooted in knowledge of the physical and optical properties of the instrument. This does not mean, of course, that these properties of the microscope and of microscopy have no bearing on "seeing" as part of the work of pathologists. But these principles are embodied in a piece of equipment which, by ascribing specific tasks to its users - or, as Akrich (1992) put it, by defining *scripts* associated with the technology -, respecifies physics and optics in settings where they are not invoked as resources for accounting for the particular ecologies of practice defining the setting.

Pathology thus appears to be one of those "secondary", "derivative", "applied" or "impure" forms of scientific activity, relying heavily on inputs from "basic" disciplines like biology and biochemistry, and turning these inputs into routine procedures for the study of diseases as they appear in specific cases. But is that really so? A (necessarily brief) look at research in the biology of cancer - often assumed to be the "basic" foundation of tumour pathology - may well provide a different picture.

On a first approach, research on the biology of cancer using immunochemical procedures looks very much like routine diagnosis in tumour pathology. Samples of human tissues are processed and stained and made available for inspection with the microscope, and the distributed activities involved in this particular ecology of practices is very similar to the ones found in routine diagnosis. But what researchers see and how they see it is different. The microscope is used mostly for the identification of features of positive samples - that is, of samples exhibiting tumour pathologies, "normal" samples being used for contrast, comparison or control -, and seeing is "biased" (a native term) by the focus on specific questions and specific features of the sample. Cases are examined not as instances of what is already known, but as potential providers of new information and as ways of exploring new problematic areas.

A recently published article provides an interesting example of this just process (Reis *et al*, 1997). The article is based on research aiming at the development of a monoclonal antibody (MAb CLH2) allowing the identification of the expression of a specific protein in human gastric carcinomas - i.e., cancers of the stomach. The research was targeted towards the study of the specific reaction of an antibody developed in the laboratory against a synthetic peptide expressed in the normal gastric mucosa and in gastric carcinomas. Rather than getting into the details of the study, which are far away from the subject of this article, it is interesting to examine the illustrations included in the article, as well as their captions.

It would be possible, of course, to describe the figures using the vocabulary of optics, although the interest of such an exercise is doubtful. The figures are interesting, above all, as documents and objects of pathological and biological research and of how "seeing" is made accountable. They allow the anatomical, histological and cytological propeties of the samples to be examined, and the results of immunohistochemical essays to be visually depicted. A pathologist performing routine diagnosis could describe in a systematic way the features of the normal and tumourous tissues and cells displayed in the figures. The authors of the article, however, chose to focus on very specific features of the samples. The captions of the illustrations provide instructions on how to generate a relevant "reading" of the images: as representations of the immunohistochemical action of an antibody on normal and tumourous tissues ("MAb CLH2 in immunohistochemistry"), enhancing the characteristics and staining patterns of specific cells ("perinuclear staining of foveolar and mucopeptic neck cells using MAb CLH2"; "Carcinoma cells show diffuse cytoplasmic staining with MAb CLH2"; "The staining pattern of the adjacent gastric mucosa is similar to that of normal gastric mucosa"), their size (scale bar, 70µm") and location in the targeted organ, in some cases using specific graphical devices, like arrows or arrowheads ("Carcinoma cells are not immunoreactive with MAb CLH2, in contrast to adjacent gastric mucosa that shows perinuclear staining of foveolar cells"; "Carcinoma cells are immunoreactive in the isolated cells (diffuse type areas; arrows) and not immunoreactive in the glandular (intestinal) area (arrowheads)) (Reis et al, 1997, pp 118-119, Figures 6 and 7).

One would expect biology or biochemistry to provide the disciplinary background against which this type of "seeing" is performed, since these are disciplines usually ascribed to the "basic" side of the basic/applied pair. This does not seem to be the case, however. The different disciplinary backgrounds of researchers provide different orientations towards what there is to be seen in images like the ones dealt with above. Biologists will have a much more "locally" oriented approach to their samples, focusing on specific and partial features related to the cellular scale. Pathologists are more likely to have a more "holistic" approach, identifying features which require a precise knowledge of anatomical detail. Pathology is not a "derived" form of "impure" knowledge relying on the "basic" findings of biology, chemistry or biochemistry. It actually provides the frame and resources through which biological, biochemical and chemical research are respecified as part of medically-oriented research in the biology of cancer, or oncobiology. This area of research thus emerges as a "trading zone" where different forms of knowledge meet and are articulated around technological complexes which include microscopy (Galison, 1997). Which of these forms are "basic" and which are "applied" is irrelevant for all practical purposes.

4. Conclusion

Can any of the activities discussed above be identified as the "original" setting to which microscopy "belongs" and from which it is then "transfered" or "diffused" to other settings and activities? As Hacking (1983) noticed, the microscope arose from technical tinkering, and not from a technological "application" of scientific design. This raises the interesting question of how the material shape and characteristics of the microscope were relevant in defining the way it was to be used in different settings, including laboratory science, and how it was linked to specific "scripts", as any other technology (Akrich, 1992).

Even if some procedures are the "same" as observable features of these ecologies of practices, they are linked to different relevances that make them meaningful as part of different phenomena of order. Skills acquired in one setting may be "transfered", but they have to be made part of a different, specific and uniquely adequate set of procedures. The cases of tumour pathology and of cancer research suggest that the latter depends, to a large extent, on knowledge and skills developed through routine pathological work, and that the specific skills associated with "seeing with a microscope" in research are learned by pathologists through the discipline of diagnosing routine cases. Biologists learn to "see" in a different way, also linked to disciplinary training. No traces of the relevance of the "principled" and "general" teaching of microscopy are to be found in these cases. Microscopy seems to be a set of practices to be learned in ways uniquely adequate to the setting where they are to be used. This is, by the way, a familiar experience for computer users and, more generally, for users of technologies that become increasingly accessible to a variety of users.

A more general question arising from this exercise is that, as a lot of the experience of "science" the lay publics have is based on these forms of "impure" science, just how they relate to laboratory science as an idealized, "pure" form of science is a relevant issue for any attempt to deal with the relationship between a heterogeneous "science" and heterogeneous "publics". Once again, the iterability of microscopy makes it problematic to identify a setting which would be the originary, fundamental or basic one for microscopy, and thus also problematizes the very notion of transfer or diffusion of knowledge and skills associated with science, including the foundational themes evoked by terms like seeing, visualizing, observing, representing, exprimenting, etc. It also raises the issue of whether "applied" settings are less "basic", in any meaningful sense of the word, to how science is performed and understood by "publics", and how some settings come to be defined as "basic" and as "model" settings for the "correct" understanding and performance of science.

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