

## Medical Imaging: Pictures, “as if” and the Power of Evidence

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There is no doubt that we are living in a time of iconography. Pictures and images surround us from birth until death. Throughout our whole lives (and even before birth and after death), we are the product and the producer of a pure flood of images, which determine our thinking, wishes and imagination. The omnipresence of images is the result of a fundamental shift during modernity in both the status and modalities of presentation procedures. The concomitant increase in technical methods for image production resulted in a new kind of knowledge formation compared to premodern times. It is a specific element of these modern and postmodern processes of knowledge formation and dissemination that knowledge itself seems to be more dependent on the possibilities of its illustration, demonstration and presentation than on the matter or cause itself. Nevertheless, regarding the “claim for truth”, this practice is not less unproblematic than knowl-

edge that comes along without any form of representation.<sup>1</sup>

Contemporary medical practices are impossible without imaging techniques. Whereas in many disciplines, the history and philosophy of visual culture play an important role (Lynch 2006), in medicine only single aspects have been highlighted so far. One example is the practice of neuroimaging (cf. (Dijck 2005)). The “Gestaltsehen” perspective has been highlighted (Burri 2008, 214), and the process of creating visual evidence using complex combinations of numerical methods, statistical procedures and visualization-algorithms has been discussed previously (Schinzel 2006; Huber 2009). In line with this research, this special issue of Medicine Studies focuses on the specific use of visualizations, the transformation of observations and data into images, the shift in medical viewing patterns caused by new visualization techniques and the nomothetic function of visual discourse networks for distinguishing the normal and the pathological.<sup>2</sup>

This thematic issue of Medicine Studies also intends to stimulate further debates and research. For example, we lack systematic studies regarding the transformation

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<sup>1</sup> The body of literature regarding the practice of visualization is steadily increasing. An instructive bibliographical essay review is offered by Monika Dommann (2004).

<sup>2</sup> The articles of this special issue were presented and discussed during an interdisciplinary conference on Medical Imaging in Ulm, Germany organized among others by the radiologists Rethy Chhem (IAEA Vienna) and Shih-Chang Wang (Sydney), the philosopher Santiago Sia (Dublin) and the authors of this editorial.

and modelling of medical data by evaluation, selection and statistical processing, which are not only phenomena of the computer age but have existed long before. From the existing literature and papers in this issue, it is clear that questions regarding the validity of medical images are of special interest: many modern visualization techniques do not refer to observable correlates but to complex mathematical processing procedures, which have caused a paradoxical phenomenon, since they produce virtual images that do not exist as visible entities (Adelmann et al. 2009). In the history of medicine, analyses focusing on the epistemic status of a “reality” or “visibility” produced by measurement and evaluation are a desideratum along with studies on the evidentiary value of technically evoked images. Consequently, the topic of this editorial is the epistemological potential of images and artefacts in medicine. By providing two examples from the history of medicine, we will examine the claim of evidence put forward by scientists with the help of visualizations. These visualizations are scientific pictures, which are the result of the interaction of processing measured data, picture creation, amplification, reduction and human interpretation.

### Paul Ehrlich’s Images

The first example involves Paul Ehrlich’s central contribution to immunology—the side-chain theory. Cambrosio, Jacobi and Keating have shown that the development, reception and acceptance of Ehrlich’s side-chain theory, which explained the immune response as an antibody-receptor reaction, offers an illuminating example of the role and function of graphical images during the implementation of a medical theory (Cambrosio et al. 1993). Ehrlich based his side-chain theory on his earlier systematic studies on the relationship between the chemical structures of pharmaceuticals and their distribution in different organs (Ehrlich 1901) and on the research for his habilitation, in which he had examined the organism’s need for oxygen (Ehrlich 1885).<sup>3</sup> The underlying idea of his working hypothesis can be summarized as follows: living cells have side chains on their surfaces similar to those of the benzene ring, which can link with toxins (e.g., from bacteria) and make these toxins

innocuous. Since the receptiveness of an organism for toxins depended on these “protoplasm groups”, he named them receptors. Ehrlich imagined the process of “detoxification” as a chemical reaction similar to the neutralization of an acid by a base.

According to Ehrlich’s experimentally supported view, each receptor could only react with specific agents depending on its chemical structure. The toxins had to fit in the receptor like a key in a lock, an analogy that was coined by the chemist Emil Fischer in 1894 to describe the stereochemical anchoring of enzyme-substrate-binding (Fischer 1894). Ehrlich used this stereochemical conception as an explanation for the antitoxin doctrine he developed while studying diphtheria toxin and diphtheria antitoxin. He attributed specific groups of atoms to both reacting agents (toxin and antitoxin) in the process of detoxification. He assumed that the toxin consisted of two chemically different parts. One part of the toxin, which linked to the side-chain of the cell’s protoplasm,<sup>4</sup> was called the haptophore group, and the second part carrying the poison was called the toxophore group (Ehrlich 1904). If the haptophore group bound to the cell’s receptor, then the receptor switched off. Ehrlich theorized that the cell tried to repair this defect by regenerating and releasing the same specific group of molecules in excess to replenish their circulation in the blood. Now, the receptors as antibodies could intercept and render the intruding toxins harmless.

Ehrlich formulated this audacious and complex explanation of the mysterious processes of immunity in 1897 after performing experiments in animals with ricin and antiricin (Ehrlich 1897a, b). At first, his theory was disputed. Ehrlich himself encountered repeated difficulties because the results of his animal experiments were unstable. In a letter to his cousin Carl Weigert, a professor of pathology in Frankfurt, Ehrlich lamented at the end of December 1896: “Here everything is fluctuating and it is, as if one tried to build a palace in the swamps. After all it eventually works, but it costs a dreadful lot of animals, anger and boredom” (Heymann 1928).<sup>5</sup> In their correspondence,

<sup>3</sup> On the history of the side-chain theory cf. (Silverstein 1989; 2002).

<sup>4</sup> Ehrlich at first followed the terminology of benzole chemistry and called the binding groups of the cell protoplasmic “side chains”. Later he used the term “receptor”, because the term “side chain” insinuated far too simple concepts regarding their structure. Cf. (Ehrlich and Morgenroth 1904).

<sup>5</sup> This and all of the following translations from German by HF.

Ehrlich expressed admiration for Weigert for his mastery of staining techniques, and Weigert critically commented on Ehrlich's experiments. This correspondence also reveals the first graphical representation of the events Ehrlich assumed were taking place on the cellular level. In 1898, Ehrlich cursorily sketched the processes to foster understanding of his theory, and he commented on his picture not without self-mockery with the concomitant question "beautiful representations?" ("Schöne Figuren?") (Fig. 1).

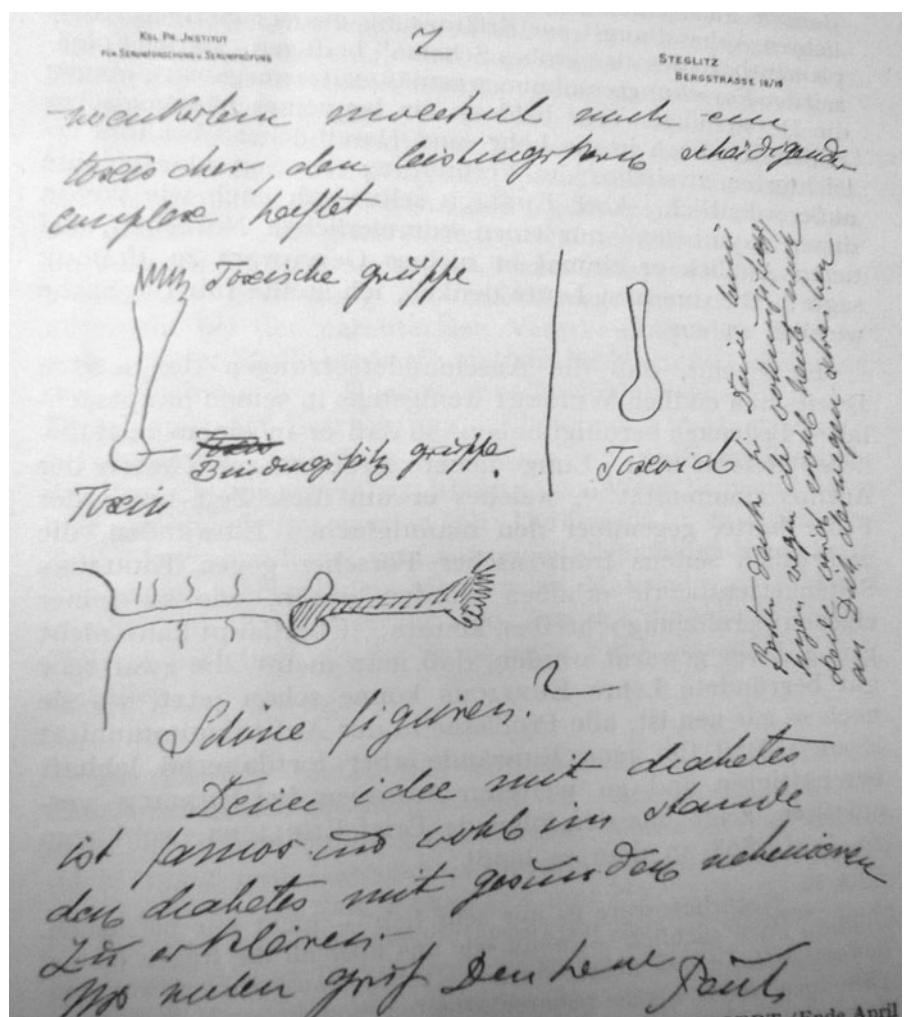
Ehrlich's sketch shows that he considered the binding of toxins by the cell's protoplasm as analogous to the physiological nutrition of the cell. Soon after, Ehrlich explicitly stated that there was a similarity between toxins and food molecules when he declared: "The toxins, as highly complicated products of herbal and animal cells, share certain

haptophore groups with food molecules and are consequently anchored by appropriate receptors of the protoplasm as well" (Ehrlich and Morgenroth 1904).

Ehrlich's ambiguous signature "beautiful representations" was chosen by Cambrosio, Jacobi and Keating in a similar translation as the title for their "beautiful pictures" essay mentioned above (Cambrosio et al. 1993). In this essay, they examined how Ehrlich developed diagrams from his first sketch to implement his hypothesis. Our following remarks are based on their findings.

Two years after his sketch of the "beautiful representations" in his letter to Weigert, Ehrlich published the first diagrams to depict his theory of immunity. These images were added to the printed version of an invited lecture Ehrlich gave in London

**Fig. 1** Letter of Paul Ehrlich with „Schönen Figuren“. First sketch of the side chain theory in a letter from Paul Ehrlich to Carl Weigert. In: Paul Heymann, Zur Geschichte der Seitenkettentheorie Paul Ehrlichs. Klinische Wochenschrift 7 (1928). p. 1307



for the Royal Society (Ehrlich 1900). In this paper, two images appeared for the first time, which in the following years were modified, refined and combined to larger complexes. As the levels of the single components' abstraction increased, the specificity of the functions they represented grew. When the side-chain theory was applied to explain haemolysis, both the receptor apparatuses and the number of assumed immune bodies were duplicated. Ehrlich conceptualized that an amboceptor circulated in the blood with two different haptophoric groups, which acted as an intermediate between the erythrocytes and complement (Ehrlich and Morgenroth 1900). Soon Ehrlich's scheme did not only operate with receptors of a first, second or third order, but it also included manifold complements, toxoids, toxonoids, toxons, complementoids, epitoxoids and nutriceptors.<sup>6</sup>

At first, Ehrlich abstained from giving chemical definitions or clear statements regarding the chemical existence or non-existence of these agents. In his London lecture, he emphasized that his figures were hypothetical in character. He explicitly declared that his diagrams should be looked at without any morphological considerations. Ehrlich emphasized that they were only a pictorial method of displaying and explaining his views about the metabolism of the cell and the way that toxins and antitoxins acted during immunization.

Despite of Ehrlich's introductory remarks concerning the visualization of his theory of immunization in which he saw nothing more than "the clearly arranged abstraction of an experience gained from an extraordinary large number of exact experiments" (Ehrlich 1904, V), his diagrams did not fail to have an impact. They suggested and provoked the impression of a real fact. In particular, the ostensive visualization of the single components, which resembled living organisms, seemed to confirm the belief that he had been able to unravel the mystery of life. Ehrlich presented structures with tentacles stemming from the protoplasm to represent the associations of polyps. His images resembled for example those of polyps and medusae published by Gegenbaur (Gegenbaur 1854). Later, Ehrlich also used analogies from botany. The visitors to his institute, who had wished to see cell receptors through his microscope, were

deeply disappointed when they were only shown these symbols instead of reality (Cambrosio et al. 1993).

Ehrlich's theory was rapidly disseminated not only because of the analogies in his graphical representations, but also due to his illustrative textual presentation. By extensively using metaphors and analogies, Ehrlich intensified the impression that he was describing reactions of real, existing chemical bodies, which anchored and captured toxins like fishing rods and snared poisonous elements up with the help of their tentacles.<sup>7</sup> Ehrlich received admiration, but also faced some severe criticism for his images. The French bacteriologist Jules Bordet vehemently attacked Ehrlich. Bordet had described non-specific serum components—the so called alexines, which correspond with today's complement system, and in 1919, Bordet received the Nobel Prize for his immunological research. Bordet accused Ehrlich of having achieved the acceptance of his theory only with the help of popular illustrations in the mould of children's' picture books (Christ and Tauber 1997). In Bordet's view, Ehrlich had put forward his theory only with visual definitions without caring for the ontological status of the assumed substances. Bordet himself strictly abstained from using any pictorial representation and advocated textual presentation. He considered textual presentation the more adequate and precise method of putting forward a theory. Similarly, other scientists argued that the diagrams were too imprecise to represent the complexity of the protoplasm and the reactions between protein

<sup>7</sup> As an example may serve Ehrlich's essay on the theory of lysin's actions, in which he described the assimilation of giant molecules in the cell (Ehrlich 1899): „In sehr zweckmässiger Weise wird solches erreicht werden können, wenn der Fangarm des Protoplasmas zu gleicher Zeit als Träger einer fermentativen Gruppe diese sofort in nahe räumliche Beziehung zu der zu verdauenden und zu assimilierenden Beute bringt. Derartige zweckmässige Einrichtungen, dass der Fangapparat zugleich verdauende Wirkung ausübt, finden wir ja in der ganzen Reihe der verdauenden höheren Pflanzen in der verschiedensten Art und Form. So sezernieren die Tentakeln der Drosera, also Fangarme im allergrößten Sinne, die das gefangene Object umgeben, eine Flüssigkeit, die stark verdauende Wirkung ausübt. [...] Wir nehmen also an, dass bei der Ergreifung dieser [Toxine] und anderer hochcomplicirter Körper Seitenketten besonderer Art vorhanden sind, die außer dem fangenden Complex noch einen anderen Complex enthalten, der durch Fixation geeigneter Fermente Verdauungswirkung auslösen kann. [...]”.

<sup>6</sup> See the compilation by Schatloff (Schatloff 1908, 9ff).

molecules and chemical atoms that were taking place on the invisible level.

Indeed, Ehrlich had aimed for this vagueness and indefiniteness in his representations. He was sure that the single components of his side-chain theory were not really existing entities. They were obviously unreal and could be identified only by their assumed effects. Their factual existence, however, was unproven and unprovable. The components could only be discerned through consistently repeated experimental events, which happened as if Ehrlich's assumptions were correct. Thus, the single components of the side-chain theory were scientific fiction, not a copy of reality (Dworetzky 1914).

Ehrlich treated his visual representations as if the assumed structures really existed, and he used them as heuristic tools to structure further experiments and to generate new knowledge. He did not use them as explications of causes or to make specific postulations regarding their appearance. For Ehrlich, the value of his images materialized in a constructive alternativism, in their status of images that represented his side-chain theory "as if" its postulated elements existed in real. Their power as a model was achieved through their plausibility and the sensation of evidence they emanated at first sight. However, the "epistemic power of representativeness", using Sybille Kraemer's (Krämer 2009, 12) terminology, turned out to be fallacious, since it did not lead to the actual chemical reality.<sup>8</sup>

Ehrlich's visualizations reminded his viewers of living organisms and could be related to well-known examples, such as the old conception of the body as an organism that is ready to battle hostile agents. This immediacy secured his pictures and the theory they represented a lasting impact, which was independent of their real ontological status. Ludwik Fleck coined the terms "collective thought style" and "thought coercion" to describe this type of directed perception, which goes hand in hand with an according theoretical and factual processing of what is perceived (Fleck

<sup>8</sup> Ehrlich himself closed his introduction into the side-chain theory stressing the heuristic power of the combination of single research results and the principles of his theory: „Die unübersehbare Fülle der Einzelthatsachen lässt sich ohne Zwang in die hier kurz dargestellten Prinzipien [der Seitenkettentheorie] einordnen, die zugleich heuristische Kraft genug bewähren, um ihrerseits wieder zur Auffindung zahlreicher neuer experimenteller Thatsachen zu führen”(Ehrlich and Morgenroth 1904).

1980). With regard to Ehrlich, one might postulate that "vision coercion" and diagrammatic coercion could explain the evidentiary power of his images.

A glance into a modern immunology textbook reveals that the immunological diagrams put forward by Ehrlich to visualize unknown immune system events still claim validity. Furthermore, they still appear to encapsulate and reproduce real structures (e.g. Murphy and Travers 2009).

## Imaging Sperms and Concepts of Embryological Development

A second illustrative example of this general principle of filtering an observer's perception is the debate that occurred during the 17th and 18th centuries among reproductive biologists. Here again, theoretical conceptions evoked observations and illustrations, which retroacted with the underlying idea. At the time, few questions preoccupied scientists as much as those involving human development, and few debates challenged the existing metaphysical world order to such an extent as these questions.

In 1651, William Harvey published his observation that embryonic development originated from the egg, which led to a scientific dispute (Harvey 1651). His dictum "omne vivum ex ovo" challenged the classic doctrine of spontaneous generation of living beings from inorganic material (Fig. 2). Since Harvey was unable to describe the role of sperm in generation, his dictum also challenged the validity of the theory that female and male sperm contributed equally to human development. No matter how hard Harvey tried, he could not detect any sperm in the uteri of his dissected research animals (Goltz 1986). He concluded that male sperm stimulated the egg through an immaterial "aura seminalis" (cf. Schurig 1720), a theory, which did not convince his contemporaries. Although Harvey was highly regarded as a scientific authority, since he had described the circulation of blood, his tenets on human development were severely criticized.

Scientists began intensive investigations into the field of human development. After 20 years of thorough research, it caused a sensation when the first spermatozoa were sighted under the microscope. The spermatozoa were pictured as small animalcula—real creatures with heads and tails. The paradox powers postulated by Harvey seemed to have materialized.



**Fig. 2** Detail of the frontispiece of: William Harvey, *Exercitationes de generatione animalium*. London 1651, Jupiter is holding a box with the inscription „Ex ovo omnia”. The picture demonstrates the programmatic direction of the book, in which Harvey tries to prove the development of every living creature from the egg (p. 409: „Ovum esse primordium commune omnibus animalibus“)

The first image of this mysterious animal appeared on the margins of a writing of the Dutch physicist Nicolas Hartsoeker (1656–1725) to Christian Huyghens (Huyghens 1899, 58–61). Hartsoeker reported in his letter and in print (Hartsoeker 1678, 355–366) that he had observed uncountable small creatures, which resembled small eels or tadpoles in a cockerel’s sperm under the microscope. Sixteen years later, he reprinted his spermatic animals in a book on optics with the remark that human sperm looked the same (Hartsoeker 1694, 227). He added that each sperm included a female and a male exemplar, which was inserted into the egg in order to grow and to be nurtured here. To emphasize this textually presented idea, he added a microscopic view showing a spermatic animal that appeared as a cowering homunculus. The long tail housed the allantoic vein to allow for placental nidation. However, Hartsoeker was very careful regarding the real existence of these embryological beings. Only later, when he copied this picture in other works, the original explanatory function of the image was blended with empirical observations. It became “real”.

Even more spectacular was the image of a spermatic animal published by the secretary of the Academy of Montpellier Francois Plantade under the anagram Dalenpatius. Dalenpatius claimed to have observed the moult of a spermatozoon under the microscope (Dalenpatius [=Francois Plantade] 1699–1700). As

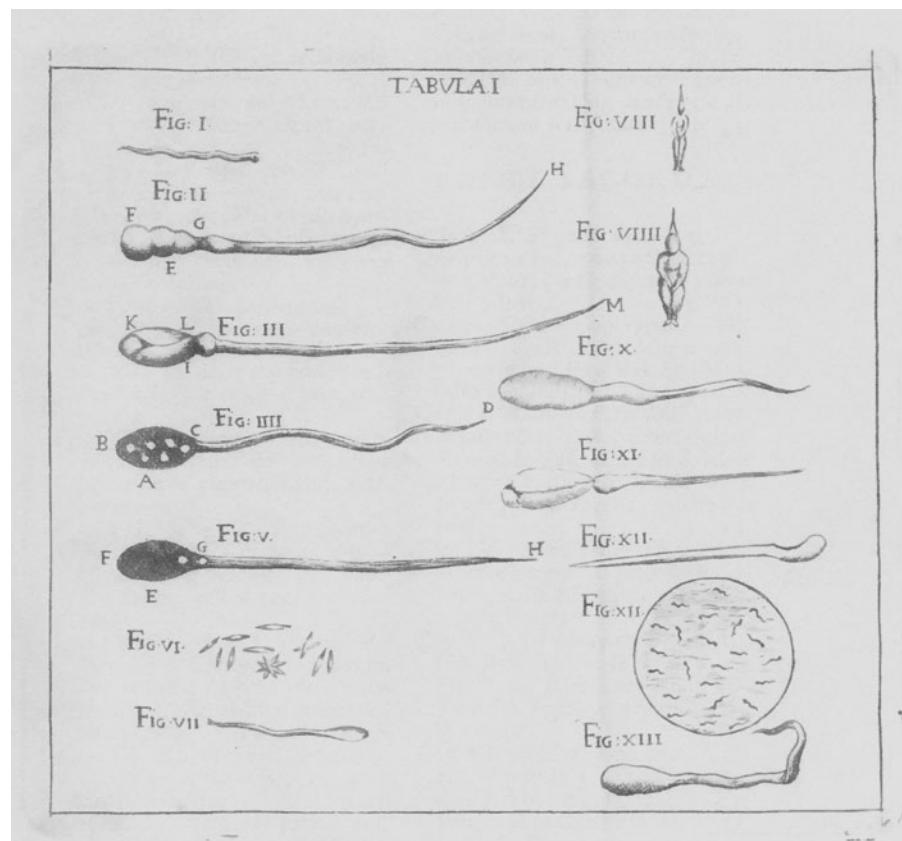
proof, he added an image of a moulting homunculus whose head, breast, arms and legs were still mantled with an outer skin. The credibility of this report was highly questioned. The French physician Jean Astruc could only interpret the image as a satire put forward by Dalenpatius to ridicule preformationists who believed that the forms of living beings preexisted in miniature versions (Astruc 1740, 1002f.). Nevertheless, the image had a lasting effect. It suited preformationism so perfectly that in 1721, the Italian biologist Antonio Vallisneri did not hesitate to include a reproduction of these animalcules in a table of known spermatozoons (Vallisneri 1721, Table I, Figure 7–9 and pp. 6–7), (Fig. 3).

No matter how unusual these fantastic images might appear to us today, when they were published in the 17th century they seemed to fit the expectations of biologists who were using microscopes to visualize the invisible. For instance, in Francesco Redi’s representations of fish worms, he attributed them with a human shape (Redi 1684, Table 23). Another example of this effect is Joblot’s descriptions of the organisms he observed in an extraction of anemones (Joblot 1718, p. 58, Table 56, Figure 12). He described that the back of one six-legged animal was covered with a mask resembling a human face (Fig. 4). Perhaps Joblot was ridiculing microscopic representation practices, but the basis of this image may have been more credible. Modern representations of hydrachnidia still have some similarities to Joblot’s image (Kaestner 1969, 777f.).

Although the pioneer of microscopic research and sperm visualization Antonj van Leeuwenhoek rejected and criticized these exaggerated visual interpretations (van Leeuwenhoek 1719, 82–94), he contributed his own interpretations of microscopic images. In many works, Leeuwenhoek described vivid, visible structures and vessels inside the animalcula (van Leeuwenhoek 1678, Table 13). He also promoted the idea that organisms and their body parts were preformed in the spermatic animals. His visualizations helped to fix and implement the preformistic ideas (Vallisneri 1721, Table I).<sup>9</sup> Leeuwenhoek’s

<sup>9</sup> Vallisneri combines images of spermatic animals following the descriptions of Leeuwenhoek, Nicolas Andry and Dalenpatius. He adds the comment that it is impossible to neglect the factual existence of the imaged animals (*una cosa di fatto*) facing so many prominent witnesses.

**Fig. 3** Plate displaying different spermatic animals (vermi spermatici): Fig. II, III, IV and V following A. van Leeuwenhoek;—Fig. VI (salt crystals in the spermatic animal), VII, VIII und IX following Dalenpatius;—Fig. X, XI and XII following N. Andry (De la génération des vers dans le corps de l'homme, 1701, Table 3, Fig. 12, 13, 14);—Fig. XIII Spermatic animals of a rabbit in motion, observed under the microscope by Vallisneri. Antonio Vallisneri: *Istoria della generazione dell'uomo, e degli animali, se sia da vermicelli spermatici, o dalle uova.* Venedig 1721, Plate I

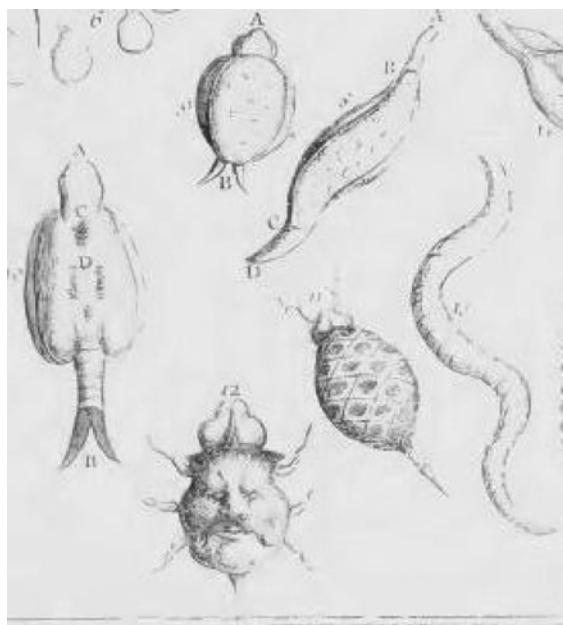


authority as the inventor of the microscope strengthened the validity of his exposures, and his less dramatic visualizations convinced with ostensive precision. These images were carried from handbook to handbook: Even 150 years later, the impact of Leeuwenhoek's images lasted on. In 1821, Prévost and Dumas described the origin of sperm in the testicles, which contradicted the prevailing idea that spermatozoa could be classified as independent organisms (Prévost and Dumas 1821–1822, Table 1–2). Nevertheless, their illustrations referred to Leuwenhoek. The idea that spermatozoa were organisms was bound to contemporary thinking to such an extent that in 1837, the physiologist Gustav Valentin described the mouth, anus, stomach and early stages of evolutionary development in bear sperm (Valentin 1837, Table 24).

After Leeuwenhoek's first description of sperm, spermatogenesis became an important field of research, and Harvey's observation that the egg was the starting point of reproduction was more or less

neglected. Only a few ovulists challenged the tenets of the animalculists. It might be argued that Harvey's abandonment of images hindered the reception of his findings. Except for its allegoric frontispiece, Harvey's work did not contain any figures. Harvey intentionally had abstained from using visualizations as stated in his foreword (Harvey 1651, 10). He distrusted images of any kind because he believed they abstracted, generalized and distorted in contrast to precise observations. Any image could only be a false representation of its object. Harvey believed that only own immediate observations were credible and reliable.

Nevertheless, even if scientists of the 17th and 18th century agreed with Harvey's statement regarding images, they still used visual representations. Their critical use constituted a theory that was then again backed by images. Last but not least, the ovulists and animalculists agreed on one point. Both followed the preformist tradition. Therefore, they both tended to display homunculi in their respective



**Fig. 4** Organisms found in an infusion of anemones described by Joblot. „Tout le dessus de son corps est couvert d'un beau masque bien formé, de figure humaine, parfaitement bien fait; comme on en peut juger par ce dessin, où l'on voit six pattes et une queue, sortant de dessous ce masque, qui est couronné d'une coiffure singulière“ (Part II, p. 57). Joblot, L.: Descriptions et usages de plusieurs nouveaux microscopes, tant simples que composez. Paris 1718, Taf. 6, Fig. 12

microscopic images, as can be viewed in a 1729 figure by the Dutch scientists Thomas Kerckring (Kerckring 1729).

## Conclusion

What can be concluded from these examples about the practice of medical imaging and the evidentiary power of pictures? Both examples show that scientific images cannot only be seen as illustrations of experimentally induced or morphological facts. They are bound to scientific practice, the thought styles of a thought collective, the cultures of popularizing knowledge and the cultures of the public understanding of science. Additionally, they are of course constituted by preexisting concepts. They represent the observed objects as if they existed in reality—a practice Immanuel Kant had considered to be not only possible but theoretically and practically necessary when the existing concepts do not suffice to provide explanation and understanding of the

unknown (kant 1783, §57, 58; Vaihinger 1911). On this basis, the philosopher Hans Vaihinger established his philosophy of “as if”, a fictionalism, which would see the aspect of “as if” in the two examples above instead of empty fiction. As our examples reveal, the “as if” in these cases has its own theoretical and practical value, which leads to theoretical and practical consequences (Vaihinger 1911). Thus, the evidence of “as if” images also lies in their power to produce plausible consequences. In a Festschrift for Vaihinger, the system biologist Ludwig von Bertalanffy commented on the meaning of Vaihinger’s analogical fictionalism stating that every interpretation of reality remains a “risky adventure of reason”. Either one should generally abstain from interpreting the entity of any object or one should be aware of the fact that these interpretations have the characteristics of an analogy. There is no proof that the “real” world has the same structure, as it is attributed by our own experience, analogies and metaphors (Bertalanffy 1986, 86–87).

Established patterns and conventions of perception shape the representation of these analogies in images. They constitute on the one hand how knowledge is displayed and on the other hand direct the formulation and presentation of new knowledge. Only images fitting these traditions can be trusted, and only these images are attributed with some evidentiary power. They are consciously false assumptions put forward for the sake of their functional results. Whoever accepts this character would agree with revisions. As the philosopher Arnold Kowalewski argued, none of these fictions would be privileged, and these (scientific) assumptions—and thus their visual representations—followed the “law of shifting ideas”. Whenever the philosophy of “as if” fictionalized certain ideas after critical inquiry, it weakened its impact, but attracted new followers. Consequently, it founded an “image collective” (“Ideengemeinschaft”), a concept later taken up by Ludwik Fleck as the “thought collective” (Kowalewski 1986, 230).

For the history of medical imaging, this theory means that any illustrator has to adapt his visualizations to the vision coercions of the respective thought collective. When illustrations are produced or signed by authorities, this increases their evidentiary power. Citations of these illustrations and re-citations of patterns introduced by these authorities increase the credibility of the respective images. Finally, by

reiteration and the solidification of a theory, the original explanatory function of an image can be transformed into an empirical observation. As a consequence, the former “as if” status transcends into an “it is” status, which might be deceptive but is taken for reality. The image itself has become the proof. There is no evidentiary power *per se*; there is only a power of evidence, which is constituted by those who produce medical images and negotiate them with their recipients. Thus, the evidentiary power of medical imaging depends on how convincingly the borderline between “as if” and “it is” is transcended. The transition of this borderline is the underlying story of the following papers, which hopefully lead to fruitful further discussions in this journal and beyond.

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