The first paper below is published in Niklas Juth and Gert Helgesson (eds.),
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After that follows chapter 5 ("Knowing How and Knowing That") from my and Niels Lynøe's book *Medicine & Philosophy* (2008).

Tacit knowledge revisited

Ingvar Johansson

On Niels Lynøe's initiatives, he and I have together written three book introductions to problems where medicine and philosophy overlap. Naturally, the books have grown in content and complexity. The first one, *Medicin och filosofi – en introduktion* (1992, 134 p, only in Swedish), contains nothing about tacit knowledge, but in the second enlarged edition, *Medicin & filosofi – en introduktion* (1997, 218 p, in Swedish; in Danish 1999), a chapter about the distinction between knowing-how and knowing-that was added. It very much took its departures from the writings of the man who coined the term tacit knowledge, Michael Polanyi (1958, 1967, 1969). As I remember our discussions, we had come to the conclusion that a philosophy book concerned with medicine for two reasons had to say something about know-how.

One of the reasons was stated in the book in these words. The purpose of basic research is to obtain knowing-that; this goes also for basic medical research. But the overarching knowledge purpose of the whole healthcare system, of which much of the medical research is a part, is to develop know-how. It shall embody knowledge about *how* to prevent diseases and illnesses, *how* to diagnose diseases and illnesses, *how* to treat diseases and illnesses, *how* to alleviate pain, and *how* to comfort a patient (repeated in: Johansson and Lynøe 2008: 163).

The other reason was that we thought that we had to say something that reflects the fact that Swedish medical students (like most medical students) have to do a long practical period together with supervisors ("allmäntjänstgöring") before they can become licensed as medical doctors. There is a kind of important medical knowledge that cannot possibly be acquired by merely reading books. Because of the mainstream philosophy of science's extreme focusing on the conceptual-logical structure of theories and on a very abstract view of the testing of them, most introductions to philosophy of science did not at all – and do not! – mention the tacit knowledge and know-how that is an important part of all laboratory work and experimental set-ups.

Our third book, *Medicine & Philosophy. A Twenty-First Century Introduction* (2008, 475 p, only in English), can be regarded as a wholly new book; in what follows I will simply call it "our book". The old chapter "Knowing How and Knowing That" ("Kunnande och vetande") is expanded on. Among other things, a brief section called "Tacit knowledge and computer science" is added. This topic will also be one of the things that I will comment on when now, almost seven years after the publishing, I am going to relate the chapter mentioned to some recent books and papers. First of all, however, a very brief recapitulation of the views in our book.

1. Tacit knowledge in the 2008-book

The essence of our view is not that there is an important distinction between knowing-that and knowing-how to be made, but rather, taking the distinction for granted, that there are four different ways in which know-how can be improved on without any pre-existing improvement of some knowing-that. They are: (1) by simply practicing on one's own; (2) by the direct imitating of others, be it short-term or long-term role models; (3) by practicing together with some kind of a tutor; and (4) by means of creative proficiency. In order to improve a skill, one may sometimes use one of these ways and sometimes another.

The term "creative proficiency" (in Swedish: "färdighetskreativitet") is meant to be an analog of the term "creative thinking" that is used in relation to knowing that. If there are two kinds of knowledge, it seems natural to think that there are two kinds of knowledge creativity, too. Let it be noted, though, that whereas it is *logically impossible* to explain all radically new thoughts by means of a prior thought about the new thought (that would imply an infinite regress backwards in time), it is logically possible that all radically new actions are preceded by a creative thought. Our claim is that this mere logical possibility is simply contradicted by empirical observations. Completely new kind of actions and know-how can arise without any prior thought about them; they can arise spontaneously. Of course, after the event, even such actions can normally be talked about, and so later be put forward *also* as a rule of thumb (i.e., a knowing-that) for a good performance. One and the same kind of action may arise spontaneously in one person but in another only after a prior thought and intention to perform it.

Our view of creative proficieny distances our conception of tacit knowledge from the conservative aura that earlier has surrounded this notion (i.e., imitating *others* and learning from a *tutor*). Even if an expert sometimes has to say to a novice "I cannot tell you why, but this is simply the way we have to act!", it may turn out that the latter because of creative proficieny was right and the expert wrong (Johansson and Lynøe 2008: 169). On my understanding, there is a modern view of tacit knowledge that can be contrasted with the classical mainstream reception of Polanyi. In retrospect, I regret that we didn't stress this contrast more in our book. It can be summarized as in the table below.

The Classical View	**The Modern View**
The expert always knows best when it comes to tacit knowledge.	Tacit expert knowledge is fallible and might be overruled by non-expert tacit knowledge (J&L 2008: 169−71).
Advanced tacit knowledge cannot possibly be substituted by technological artifacts.	Even advanced tacit knowledge may be substituted by robots (J&L 2008: 169−70).
Tacit knowledge is a kind of connection between a person and his body or between a person and some tool/machine.	Tacit knowledge can also be a kind of connection between a person and other humans, and even some animals (J&L 2008: 155, 157).
The existence of tacit knowledge is an inexplicable fact about human beings.	Tacit knowledge can be scientifically investigated (J&L 2008: 164).

The first row in the table makes it clear that a reasonable conception of tacit knowledge does not imply that a presumed master always knows best (as in classical conservatism); the second that the modern conception does not imply a negative attitude towards new technology (as it has often been interpreted); the third that it does not imply any extreme individualism (Polanyi's magnum opus has the title *Personal Knowledge*); and the fourth that a belief in tacit knowledge has nothing whatsoever with a belief in some mystical supernatural faculty to do (as was often believed in the New Age movement).

The classical view of tacit knowledge saw itself as a criticism of the Enlightenment tradition. Our modern view does not. We claim: "Both epistemological fallibilism (Chapter 3.5) and an acceptance of tacit knowledge (Chapter 5) have to be injected in the Enlightenment position in order to enlighten this position even more" (2008: 4).

2. Tacit knowledge in the light of computer science and robotics

The remarkable developments that over the last decades have taken place within computer science and robotics, have to make everyone very cautious when talking about what may be accomplished in these areas in the future. In our book we state:

> The proof of the pudding is in the eating. The limits of the artificial chess players, of the medical expert systems, and of what actions robots can perform are probably to be found empirically. […] Simulators and computerized programs may probably in the future be fruitful means when medical novices develop into medical experts; they are already used in certain specialties such as anesthesia and surgery. Also, simulators and computerized programs may be used as time saving tools for the experts. But so far we have not seen any computers that can replace medical experts, be these clinicians or researchers. (Johansson and Lynøe 2008: 169-70)

When thinking about tacit knowledge in medicine, I have always thought mainly about surgery and diagnostics, and in what follows I will do so again; first surgery. The robots used in surgery have beside their physical structure, a power source, a sensor system, and a "computer brain" that controls the activities. However, there is still a surgeon needed. Images on a viewfinder, sent by a camera inside the patient, show the surgical site and the surgical instruments. Controls comparable to joysticks are used by the surgeons to handle the instruments and do the actual surgery. In my opinion, even such robot using surgeons need tacit knowledge when skillfully combining what they are seeing with what they are doing with their hands.

When, second, it comes to diagnostics, I will rely on a recent bestseller: Erik Brynjolfsson and Andrew McAfee, *The Second Machine Age* (2014). The authors, active at the forefront of artificial intelligence, say:

> Now comes the second machine age. Computers and other digital advances are doing for mental power—the ability to use our brains to understand and shape our environments—what the steam engine and its descendants did for muscle power. (Brynjolfsson and McAfee 2014: 7–8)

The central artifacts of the first and second industrial revolutions (i.e., the steam engine of the first and the electric engine and the internal combustion engine of the second) created powers that by far outrun human muscle capabilities of moving fast and of lifting and handling big and heavy tools. What happens now – probably as an essential part of an already ongoing

third industrial revolution – is that many human mental intellectual powers are becoming outrun by *thinking machines*, i.e. by computers and robots.

The authors' primary examples of already existing artifacts in the presumed second machine age are "cars that drive themselves, useful humanoid robots, speech recognition and synthesis systems, 3D printers, *Jeopardy!*-champion computers" (Brynjolfsson and McAfee 2014: 90). But, of course, also the legendary chess computer Deep Blue is mentioned; in 1997 it beat the then world chess champion Kasparov. Many deeds that by many as late as the 1990s were thought to be impossible for computers and robots to do, have already been done. The *Jeopardy!*-winning computer was called Watson, and now artificial intelligence teams are working on constructing a medical Dr. Watson-computer. About the prospects for such an invention, the authors write:

> Here again, it [Dr. Watson] will be limited by its frame. Make no mistake: we believe that Watson will ultimately make an excellent doctor. Right now human diagnosticians reign supreme, but just as Watson soon got good enough to beat Ken Jennings, Brad Rutter, and all other human *Jeopardy!* players, we predict that Dr. Watson will soon be able to beat Dr. Welby, Dr. House, and real human doctors at their own game. (Brynjolfsson and McAfee 2014: 192)

The authors do not, however, think that there are no limits at all. Here is another quote:

> We don't project that computers and robots are going to acquire the general skills of ideation, large-frame pattern recognition, and highly complex communication any time soon, and we don't think that Moravec's paradox [high-level abstract human reasoning is easier to substitute than low-level concrete human sensorimotor skills] is about to be fully resolved. But one thing we learned about digital progress is *never say never*. [---] Maybe we'll see an automatic medical diagnostician with all the different kinds of knowledge and awareness of a human doctor. And maybe we'll see a computer that can walk up the stairs to an elderly woman's apartment, take her blood pressure, draw blood, and ask if she's being taking her medication, all while putting her at ease instead of terrifying her. We don't think any of these advances is likely to come any time soon, but we've also learned that it's very easy to underestimate the power of digital, exponential, and combinatorial innovation. So never say never. (Brynjolfsson and McAfee 2014: 202–4)

This being stated and accepted, a threatening fallacy must be avoided. The fact that a robot is constructed that can substitute a certain activity formerly performed only by humans, does *not* imply that the notion of tacit knowledge has there become superfluous. It is still applicable to the *humans* who continue to perform the activity. Even if the notion of tacit knowledge is superfluous for robots, is not superfluous in relation to humans; not even if they are doing the same things as robots.

A classic in the philosophical discussion around know-how is Gilbert Ryle's *The Concept of Mind* (1963 [1949]); the second chapter is called "Knowing How and Knowing That". The main purpose of the book is to demolish the Cartesian view that there is an ontological gap between mental and physical existence. As part of this enterprise he says: "it is important to correct from the start the intellectualist doctrine which tries to define intelligence in terms of the apprehension of truths" (Ryle 1963: 27). As I see it, artificial intelligence, robotics, and cognitive science (see next section) have now in their own non-philosophical way proven Ryle to be right. What literally can be called thinking need not take place in a non-material Cartesian substance. In a way, neither predicted nor argued for by Ryle, our very everyday concept of

thinking has changed, too. In everyday discourse, the expression "thinking machines" seems no longer to be understood metaphorically.

I will not, however, here dwell on the mind-body problem. I will only claim that the development presented does *not* in itself imply that *everything* is material, i.e., it does not imply a so-called reductive materialism. Pains are definitely mental; to describe the bodily causes of a pain is not to describe the pain itself. And, surely, pains are central to medicine; otherwise anesthesia would not be as crucial to medicine as it is. With respect to thinking, I am of the opinion that there are two kinds of thinking, pure machine thinking and person-with-consciousness thinking. Even if a computer or robot passes the Turing Test, this does not imply that it has consciousness.

As a transition bridge to the next section about cognitive science, I will a last time quote *The Second Machine Age*:

> Our brains are extraordinarily good at taking in information via our senses and examining them for patterns, but we're quite bad at describing or figuring out *how* we are doing it, especially when a large volume of fast-changing information arrives at a rapid pace. As the philosopher Michael Polanyi famously observed, "We know more than we can tell" (Brynjolfsson and McAfee 2014: 18).

3. Tacit knowledge in the light of cognitive science

According to Polanyi, all perceptions and actions have a from-to structure. In perception we cognitively attend *from* some kinds of parts *to* the whole perceptual object; and in activities we act from some kinds of part-actions to the whole action. Often, Polanyi writes as if both the parts and the corresponding whole exist wholly in the realm of consciousness, but he nonetheless makes it explicitly clear that within his framework he accepts as parts subliminal states and processes, too (Polanyi 1967: 13–15). That is, even though he never stresses the fruitfulness of carefully studying subliminal cognitive processes, he quite clearly would have welcomed most of the investigations that nowadays are done in the name of the umbrella term cognitive science. Therefore, despite having only superficial knowledge of this area, I need to say some words about cognitive science.

The first fact I will point at is that in cognitive-scientific discussions about how our memory functions, there is very often a distinction made between *declarative* and *procedural* memory. In my opinion, this distinction presupposes a logically prior distinction between knowing-that and knowing-how. That is, the memories are of different kinds because what is remembered are of different kinds. Here is a quotation:

> Declarative memory encompasses the acquisition, retention, and retrieval of knowledge that can be consciously and intentionally recollected . . . Such knowledge includes memory for events (episodic memory) or facts (semantic memory) . . . In contrast, nondeclarative or procedural kinds of memory encompass the acquisition, retention, and retrieval of knowledge expressed through experience-induced changes in performance. These kinds of memory are measured by indirect or implicit tests where no reference is made to that experience. Skill learning, repetition priming, and conditioning are classes of implicit tests that often reveal procedural memory processes dissociable from declarative memory. (J.D.E. Gabrieli, 1998, "Cognitive Neuroscience of Human Memory"; quoted from (Stanley 2011: 154))

The second fact I want to highlight is that cognitive science contains quite a number of eye tracking studies. It is investigated how the eyes of persons unconsciously move when the persons are performing various activities. These studies very much underline and broaden this paragraph of our book:

> Tacit knowledge is firmly anchored in the body and the brain. We know that the movement of the eyes of a radiologist that looks at an X-ray differs from those of a layperson looking at the same picture. The brain of an expert is probably able to receive and adapt to certain kinds of perceptual data which the novice's brain is not yet able to deal with. Therefore, the brain of an expert can send signals to the muscles that the brain of the novice cannot yet send. Such signals move extremely fast – in a billionth of a second – and without any awareness on our part. It is this fact that might have misled some thinkers to *identify* tacit knowledge with the bodily automatics that this knowledge is dependent on. (Johansson and Lynøe 2008: 162).

The last sentence is important. It is meant to remind us of the from-to structure of tacit knowledge. Tacit knowledge must not be wholly identified with the parts we attend from. There is in tacit knowledge still something in consciousness that we attend *to*, and it must not be forgotten.

Third and last remark. Talk about mirror neurons has the last decade become popular far outside of cognitive science. There seems to be evidence in favor of the view that in some animals and humans there is a kind of neuron that fires both when a certain kind of action is performed, and when the same kind of action is merely observed in someone else. Some researchers in neuroscience argue that understanding the function of mirror neurons is the key to understand how both animals and humans learn and improve new skills by automatic imitation. If true, this would supply us with a small piece of knowing-that about this way (our second way) of improving know-how.

4. Tacit knowledge in the light of Kahneman's system theory

I have already (sect. 2) mentioned one recent cultural bestseller that is of relevance for the notion of tacit knowledge. Now I will say some words about another, Daniel Kahneman's *Thinking, Fast and Slow* (2011). Kahneman is a psychologist who in the 1980s made himself famous in behavioral economics by (together with A. Tversky) proposing the so-called prospect theory of behavior; in 2002 he received the Nobel Memorial Prize in Economics. The book mentioned summarizes and popularizes all his research about how people think.

Below come two quotations from Kahneman's introduction; both would fit well into Polanyi's books.

> Most impressions and thoughts arise in your conscious experience without your knowing how they got there. You cannot trace how you came to the belief that there is a lamp on the desk in front of you, or how you detected a hint of irritation in your spouse's voice on the telephone, or how you managed to avoid a threat on the road before you became consciously aware of it. The mental work that produces impressions, intuitions, and many decisions goes on in silence in our mind. (Kahneman 2011: 4)

> Expert intuition strikes us as magical, but it is not. Indeed, each of us performs feats of intuitive expertise many times each day. Most of us are pitch-perfect in detecting anger in the first word of a telephone call, recognize as we enter a room that we were the subject of the conversation, and quickly react to subtle signs that the driver of the car in the next lane is dangerous. Our everyday intuitive abilities are no less marvelous than the striking insights of an experienced firefighter or physician–only more common. (Kahneman 2011: 11)

A large part of the book is concerned with the question why, and in what way, we often make wrong inferences. A simple way, he claims, to understand many of our fallacies is to look upon our cognitive capability *as if* it consists of two different systems. System 1 works fast and uncritically; often it gets things quite right, as in the quotations above, but it is nonetheless the source of fallacies. It works with various kinds of simplifications. System 2 is systematically reflective, critical-logical, and needs more time; Kahneman seems to regard it as a non-fallible system. It is mostly at rest, but can be triggered to save situations where System 1 has got lost; even though this by no means always happens. One peculiarity of the human mind, according to Kahneman, is that a hard problem that really requires System 2 for a solution, is often exchanged for a simpler problem that System 1 quickly finds a solution to; and then the mind take the answer to the simpler problem to be an answer to the hard problem.

It might be easy to read Kahneman as if System 1 is just another label for tacit knowledge, but such a temptation must be resisted. Even if, as the introductory quotations show, there are affinities, the differences make an identification impossible. There are at least three differences. If Kahneman's two systems are regarded as real systems existing in the brain, then (a) the notion of System 1 has a narrower set of referents than the notion of tacit knowledge has, but (b) System 1 has a wider range of presumed explanatory functions than tacit knowledge has. The central point, however, is (c) that Kahneman regards his systems as being fictions. Let me present the three points in turn.

(a)

The notion of tacit knowledge applies to both manual, perceptual, and intellectual abilities, but the notion of System 1 is applied only to perceptual and intellectual abilities. In our book we do stress that there is tacit knowledge in intellectual matters, too:

> There is even know-how in relation to intellectual skills. Reading, writing, and performing mathematical calculations cannot be efficiently done without tacit knowledge. Normally, when reading and writing, we are not aware of anything that has to do with grammatical, semantic, and pragmatic language rules, not to speak about being aware of how the eyes and the hands are moving. We simply read and write. Similarly, without bothering about axioms and theorems in number theory, we simply add, subtract, multiply, and divide numbers with each other. (Johansson and Lynøe 2008: 157).

(b)

The distinction between knowing-that and knowing-how cannot be used for explaining why something goes wrong. It is a distinction between two kinds of knowledge or presumed knowledge. But to be able to explain mistakes in reasoning lies at the heart of Kahneman's distinction between System 1 and System 2. In our book, on the other hand, we are stressing the fact that an interaction between knowing-that and knowing how can improve both kinds of knowledge (sect. 5.3).

(c)

When the human body is divided into different functional systems (the muscular, the respiratory, the cardiovascular, etc.), the systems are regarded as being spatiotemporally real; be they spatially overlapping or not, and be they interacting or not. Now, Kahneman says that "there is no one part of the brain that either of the system would call home" (Kahneman 2011: 29). Saying this could be a claim merely to the effect that the systems very much overlap in the brain, but this is not the view of Kahneman. He regards the systems as fictions. Early in the book, he explicitly states:

> System 1 and System 2 are so central to the story I tell in this book that I must make it absolutely clear that they are fictitious characters. System 1 and 2 are not systems in the standard sense of entities with interacting aspects or parts. (Kahneman 2011: 29)

This declaration is later repeated three times: (i) "The system and the machine are fictions" (2011: 77); (ii) "the list of traits will help you develop an intuitive sense of the 'personality' of the fictitious System 1" (2011: 105); and (iii) "This book has described the workings of the mind as an uneasy interaction between two fictitious characters: the automatic System 1 and the effortful System 2" (2011: 415). Readers who merely skim this 500 pages book, may, I guess, easily miss this only four times mentioned aspect of the book.

In other words, Kahneman's all explanations of mistaken thinking in terms of System 1 and System 2 are explicitly *as if*-explanations. I do not, to make this perfectly clear, regard the distinction between knowing-that and knowing-how as a distinction between two kinds of fictions.

5. Tacit knowledge in today's philosophy

In philosophical journals there still appear papers both that deny and that defend the very distinction between knowing-that and knowing-how; sometimes it is done in terms of *knowledge*-that and *knowledge*-how, sometimes knowledge-that is shortened to knowledge-wh (where, when, what, why, etc.). I have in these found nothing that has made me revise any of my 2008-views. Here I will only comment on a book that has received quite an amount of attention, and which claims to give a new analysis of knowing-how, Jason Stanley's *Know How* (2011).

As I value things, persons who in their work primarily rely only on know-how have since long had an unduly low social status compared with persons working with knowing-that. As is quite clear from some interviews, but not from the book, Stanley is of the same opinion. Indirectly, he regards his analysis as a way of also making theoretical and practical knowledge more status-like. His two purposes run for himself smoothly together, since his basic claim is that know-how more closely seen in fact *is* a kind of knowing-that. I think his analysis is wrong, and I will briefly state why I am confident about this.

Our book says: "Knowing-that can by definition only exist in symbol systems; of course, mostly, this is a natural language. Therefore, knowing-that might also be called 'spoken (or non-tacit) knowledge'" (Johansson and Lynøe 2008: 156). We consciously avoided the philosophers' technical term "proposition", but it cannot be avoided when discussing Stanley's book. Traditionally, having knowing-that is more or less the same as knowing a true proposition. But what, then, is a proposition?

The recent dictionary *Metaphysics. The Key Concepts* states: "One way of thinking about propositions is as the things that are true or false (what are called **truthbearers**) [---]

Propositions are usually thought of as **necessarily** existing **abstract** objects" (Beebee et al. 2011: 196). And *The Stanford Encyclopedia of Philosophy* says under the entry propositions: "Propositions, we shall say, are the sharable objects of the attitudes and the primary bearers of truth and falsity. This stipulation rules out certain candidates for propositions, including thought- and utterance-tokens, which presumably are not sharable, and concrete events or facts, which presumably cannot be false" (McGrath 2012). This is what our book would have had to relate itself to, had we used the term proposition. On neither definition can tacit knowledge be a species of the genus knowing-that, i.e., be a specific way of knowing a true proposition, because tacit knowledge is neither true nor false. Stanley starts his book as follows:

> A fact, as I shall use the term, is a *true proposition*. A proposition is the sort of thing that is capable of being believed or asserted. A proposition is also something that is characteristically the kind of thing that is true or false […]. The thesis of this book is that knowing how to do something is the same thing as knowing a fact. It follows that learning how to do something is learning a fact. (Stanley 2011: vii)

Question: how to reconcile these assertions from Stanley with the earlier quoted definitions of proposition? Answer: it is impossible. Consequently (but, to my mind, by no means stressed enough in the book), Stanley also says: "I [shall] show that a more sophisticated notion of proposition (and hence a more sophisticated notion of fact) is required for a full account of knowledge-wh [S:s term for knowing-that]" (Stanley 2011: viii). According to the traditional definitions of proposition, propositions are not spatiotemporally localizable and are causally inefficacious. Stanley's "more sophisticated notion" denies both these desiderata.

Stanley does not, be it again said, try to conjure away the important commonsensical features of know-how. Therefore, in my much considered opinion, instead of saying (a) that he accepts the existence of a quite specific species of knowledge called know-how, but wants to give it a new and intellectualist analysis, an analysis that proves it to be a species of knowing-that; he should have said (b) that he accepts know-how but wants to give *propositions* a radically new analysis, an analysis that makes it possible to connect even know-how to propositions.

Mostly, Stanley calls his analysis of propositions "Fregean", but once he calls it "quasi-Fregean" (Stanley 2011: 73); it is only the latter epithet that is adequate. Frege is a Platonist who takes his "Thoughts" (propositions) to be abstract objects; and as such they are not action inducing entities. But Stanley's so-called propositions can be action inducing. Stanley's arguments are very much centered round the syntax and semantics of linguistic ascriptions of knowing-how. The book is mainly a book in the philosophy of language.

Stanley defines *facts* as being *identical to true propositions*. In our book, empirical facts are treated as being obtaining spatiotemporal states of affairs. As such, facts may make assertions with propositions partly or wholly true (Johansson and Lynøe 2008: 78), but they cannot possibly be identical to the propositions they make true. Propositions contain only concepts and conceptual structures, but most basic empirical facts contain things or thing-like entities. False empirical assertions/propositions (truthbearers), on the other hand, simply lack a corresponding fact (truthmaker). The problem with Stanley's conception of facts as true propositions is, that it makes him unable to explain what a false proposition is. If, as he claims, spatiotemporal facts are true propositions, then, seemingly, spatiotemporal non-facts would be called upon to define empirically false propositions. But there are no spatiotemporal non-facts; even the so-called "negative facts" of some philosophers' are facts.

Summary, I can't find anything in Stanley's book that repudiates the view of tacit knowledge put forward in our book. I do, however, find it quite possible that taking the existence of knowing-how seriously may require a rethinking of how propositions ought to be understood. Perhaps a notion of proposition that can be tied to the notion of knowing as it appears *both* in

knowing-that and in knowing-how ought to be substituted for the present mainstream notion. Such a problem, however, is a problem for the philosophy of language, not for the philosophy of science.

6. Tacit knowledge and the dual use of proficiency creativity

Since this paper of mine (for the surprise aim of the Festschrift) had to be written without any consultations with Niels, I cannot for sure tell whether or not he will agree with the views I have put forward, but I don't know anything that indicates that he will not. Now, as our lives have turned out, a couple of years ago Niels was in the same situation vis-à-vis me when he gave tacit knowledge some second thoughts. In a Festschrift to me, he published a paper called "Does Dual Use of Johansson's Proficiency Creativity Benefit Patients of Physicians?" (Lynøe 2013), which I will now briefly comment on. As far as I can see, we are still thinking about tacit knowledge along the same lines.

I will leave aside the issue whether or not the notion of proficiency creativity should be called Johansson's (as Niels does) or Johansson&Lynøe's. Perhaps I was the one first to propose it, but without Niels' acceptance I would probably never have tried to elaborate on it.

When I have thought about know-how in relation to medicine, my two paradigmatic examples have been, as earlier said, the surgeon performing an operation and the GP making a diagnosis. In both cases, the analogies with old handicraft skill is easily visible. The surgeon may without reflective thinking perform an operation, i.e., the knowledge is in a sense situated in his/her hands; and the GP may without reflective thinking simply see what disease the symptoms are symptoms of, i.e., the knowledge is in a sense situated in his/her mere look. Of course, both the hands and the eyes are connected to the brains in question. Tacit knowledge is brain dependent.

In his paper, Niels brings in other but equally relevant kinds of cases of tacit knowledge and accompanying proficiency creativity among GPs. Some of the cases (2.1 and 2.2) concern the face-to-face doctor–patient relationship, and can from a broader perspective be regarded as tacit knowledge and proficiency creativity in social relations; remember that our notion allows tacit knowledge between persons. I have here nothing to add to Niels' views and narratives.

Some other cases (3.1−3.5) concern the relationship between a GP and the Penal Code. Here, as Niels shows, GPs who want to be law-abiding can in situations where many people should on a superficial description see a conflict between the law and the GP's actions, by means of proficiency creativity act in the interest of the patient without even consciously thinking that there might be a legal issue to consider. In such situations, it would, as Niels also points out, be good if the tacit knowledge involved became partly turned into knowing-that, and then some revisions of the Penal Code asked for (Lynøe 2013: 368). By definition, as long as it is *only* a matter of tacit knowledge, it cannot be discussed and set in contrast to what the law states. Again, I have nothing to add to Niels' views and narratives.

In all the examples hinted at so far, the tacit knowledge and creative proficiency involved are to the benefit of the patients. I can now, after having read Niels' paper, see that unintendedly and unfortunately our book easily gives the impression that all tacit knowledge among physicians must be good for the patients. On reflection, however, it is quite clear that if there is a physician who, contrary to his duty, wants to support values of his own to the detriment of a patient, then his/her tacit knowledge and creative proficiency can be put in the service even of such a cause. Moreover, be so used without the physician noticing it, since the knowledge is tacit.

It is by two cases of the last-mentioned kind that Niels ends his paper (4.1 and 4.2). The first of these is about restrictive provisions of abortion (Sweden 1946–1965), and the second about

restrictive offerings of sedation therapy. Both cases are seen in the light of some physicians' views on the sanctity of life. Because of the possibility of creative proficiency such physicians may *without noticing it* take actions that are not in the best interest of the patients in question, but in the interest of the physicians own overarching values. The fact that proficiency creativity in medicine need not necessarily be in the interest of the patient, but instead in the interest of the physician, is what Niels means by the expression "the dual use of proficiency creativity".

He ends his paper by saying: "I believe that Ingvar Johansson has not considered the dual use of proficiency creativity and I therefore hand over this issue to Ingvar for further consideration and solution" (Lynøe 2013: 377). Well, right, I had not before reading Niels' paper really thought about it. Now, having thought about it for a year and a half, I say as follows.

There is no general knowing-that solution to the problem of the dual use of proficiency creativity. There is no other way out but to act on case-by-case investigations in the way Niels Lynøe and his collaborators have for quite a time done; see the references in (Lynøe 2013).

7. Tacit knowledge in the year 2015

In my opinion, the chapter on tacit knowledge in our 2008-book fares quite well even with seven years of hindsight. The defects are that we should have spoken about the dual use of proficiency creativity, and much more stressed the difference between the classical and the modern view of tacit knowledge. On the other hand, I am very pleased that our views conform so well to results obtained in artificial intelligence, robotics, and cognitive science.

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5. Knowing How and Knowing That

Chapter 5 in Ingvar Johansson and Niels Lynøe, *Medicine & Philosophy* (2008).

In contrast to some other languages, English mirrors immediately the fact that *knowing how* (to do something) and *knowing that* (something is the case) have, despite their differences, something in common; both are forms of knowledge. In this chapter, we will present what is peculiar to know-how and argue that optimal knowledge growth in medicine requires much interaction between knowing-how and knowing-that. Note that to 'know how a thing functions' is to know *that* it functions in a certain way, i.e., this kind of knowledge is a form of knowing-that (something is the case); what might be called *knowing-why* – i.e., a knowledge of explanations why something happened, why something exists, and why something stopped functioning – is also a form of knowing-that. *Knowing-what* (kind of thing something is) may be both knowing-that and know-how. When it is the latter, it is an ability to identify in perception something as being of a certain kind.

5.1 Tacit knowledge

Most of us have much know-how without much of a corresponding knowing-that. We can make phone calls, but we do not know much about how telephones work; we can write, but we do not know in detail how we hold the pen and how we move our hand when writing; we can talk, but we hardly know anything at all about how we move our mouth and our tongue. Examples can be multiplied almost to infinity; even though, of course, the list differs a little from person to person. There are know-hows that concern only the body, some that concern the use of tools, and others that concern the use of machines and computers; there are also know-hows that are very important in interactions with animals and persons. In medicine, the last kind of know-how is important when one tries to understand and/or improve doctor-patient and nurse-patient relations.

Michael Polanyi (1891-1976), the scientist and philosopher who has coined the term 'tacit knowledge', has an illustrative example of what a discrepancy between know-how and knowing-that can look like. Most of the people are able to ride a bike, but very few are able (a) to correctly describe how they move their body when biking and (b) to correctly explain why humans can bike at all. Most people think falsely that they do not move their arms and hands when they are biking without turning, and that biking should primarily be explained by our sense of balance. In fact, when biking we rely only to a small extent on this sensory system. Biking is in the main made possible by centrifugal forces. When we turn to the left, a centrifugal force arises that will tilt us to the right; we then move our hands and make a turn to the right, whereby a force arises that will tilt us to the left. We then make a new little turn to the left, and so on. Tiny movements of the hands enable us to keep the bike upright by creating centrifugal forces of opposite directions. The bike is actually tottering from left to right, even though we may think that the bike is continuously in a stable upright position. Even when we are biking straight ahead, we are unconsciously making small turns; and we have to do these turns. The reader who does not believe in this explanation can easily test it. Weld the handlebars and the frame of your bike together, and try to ride in a straight line by means of your sense of balance. After a few meters you will inevitably fall to one side. That is, having know-how about

bicycling not only goes well together with a complete lack of a corresponding knowing-that; it often even lives in peaceful co-existence with false knowing-that.

Knowing-that can by definition only exist in symbol systems; of course, mostly, this is a natural language. Therefore, knowing-that might also be called 'spoken (or non-tacit) knowledge'. Know-how, on the other hand, can exist both with and without symbol systems. Children can learn many skills such as walking, tying shoes, sawing, sewing, and biking before they learn to speak properly. This is one reason why know-how deserves to be called tacit knowledge. Another reason is that even if language and knowing-that have in fact been useful when a non-language skill has been acquired, such a skill can later be put to work 'tacitly'. Adults, let it be said, mostly have some knowing-that about each of their skills. But they must stop thinking about this knowledge when actually using their know-how. Because if one concentrates on the knowing-that aspect of a know-how when using the latter, one is often thereby obstructing or getting in the way of this skill. For instance, if when riding a bike one starts to think of how to move the handlebars in order to create good centrifugal forces, then one will impair one's actual biking. Similarly, orators should not think when speaking.

As know-how can exist without any knowing-that about this very know-how, conversely, one might know-that about a certain know-how without being able to do anything at all in this respect. One can read much about how to perform heart operations without becoming able to perform one – not even a relatively bad one.

Know-how is not restricted to knowledge about how to use our body and how to use tools. This fact has to be stressed because some older literature on tacit knowledge gives the contrary and false impression. First, as we said at once, there is tacit knowledge in relation to the use of machines and interactions with computers, and there is such knowledge in our interactions with other human beings and animals. There is even know-how in relation to intellectual skills. Reading, writing, and performing mathematical calculations cannot be efficiently done without tacit knowledge. Normally, when reading and writing, we are not aware of anything that has to do with grammatical, semantic, and pragmatic language rules, not to speak about being aware of how the eyes and the hands are moving. We simply read and write. Similarly, without bothering about axioms and theorems in number theory, we simply add, subtract, multiply, and divide numbers with each other.

Sometimes inventions based on new knowing-that make old know-how superfluous. But then some new know-how has arisen instead. When old-fashioned handicraft based production was replaced by machines and industrial production, tool skills were replaced by machine-managing skills. One kind of know-how was replaced by another.

Tacit knowledge is action-related knowledge. Therefore, despite some similarities, tacit knowledge must not be put on a par with completely automatic reactions, adaptations, and behaviors of the body. Even though tacit knowledge is tacit, it has a connection to consciousness and agency. A necessary condition for an action (activity, behavior, or process) to be an expression of know-how is that its overarching pattern is governed by the person's will. This fact is reflected in ordinary talk about abilities and skills. It makes good sense to ask whether a certain person is able to ride a bike, cook a meal, play tennis, make diagnoses, or perform surgical operations, but it makes no sense to ask whether a person's heart is able to beat, or whether the person is able to make his heart beat – the heart beats independently of our will. Nonetheless, the heart's pulse, just like many other bodily processes, adapts to new conditions; in a sense, the heart can learn how to beat under various conditions, but it has no tacit knowledge.

A last warning, nor must the concept of tacit knowledge presented be conflated with any psychoanalytic or otherwise psychological concept of 'the unconsciously known'. What in this sense is said to be unconscious are memories and desires that are assumed to be actively 'repressed', since they are assumed to fill the mind with agony if they were suddenly to become conscious. Also, in psychoanalytic theory, they are supposed to be reflected in dreams and be responsible for neurotic behavior. Tacit knowledge is by no means identical with 'repressed knowledge', be such knowledge existent or not.

The fact that a person has good tacit knowledge is in non-philosophical discourses expressed by sentences such as 'he has it in his fingers', 'he has a good feeling for it', and 'he has a good clinical glance'.

5.2 Improving know-how

Those who have developed a skill to a very high degree are sometimes said to have developed their skill into an art. Physicians of all kinds may well in this sense try to develop their specific skills into arts. But then they have better to learn (as knowing-that) that know-how is not just a special form of knowledge, it has its own methods of improvement, too. Even though new knowing-that can be used to introduce and to improve an already existing know-how, we want to emphasize the fact that know-how can also be improved independently. Becoming proficient at handicrafts, sports and music requires years of practice and personal experience; the same goes for proficient handling of some machines and computers; and it is also true of conducting good laboratory experiments, making good diagnoses, and performing good operations. There are four general ways in which know-how can be improved:

1. practicing on one's own
2. imitation
3. practicing with a tutor
4. creative proficiency.

In cases 1, 2, and 4, know-how is improved independently of any reading of manuals or other kind of apprehension of relevant knowing-that. Now some words of explanation.

1. Practicing on one's own. The more we practice an activity, the more we improve the corresponding skill. As the old adage says: 'practice makes perfect'. Or, more moderately: 'practice greatly improves proficiency'. Obviously, the human body and the human brain have an in-built capacity of self-learning through trial and error. It functions in relation to kids (that for instance learn to ride a bike) as well as in relation to adults (e.g., medical students who train clinical skills). A remarkable fact is that this kind of tacit learning by repetition also can function across the gap between real activities and simulations of these activities. Since long, pilots are trained in simulator cockpits. The computer revolution may in the future make physicians train many things on computer simulations, which is actually already the fact within some areas such as anesthesia, internal medicine, and surgery.

2. Imitation. Simply looking at and/or listening to other people performing a certain activity, can improve one's own skill in this respect. Small children's ability to imitate is remarkable. But even adults can learn new activities and improve previously acquired skills by means of imitation. In cases where one can learn an activity both by imitating and by reading a manual, it is often easier to learn it by imitation. It is against this background that the cry for 'positive role models' should be understood. The fact that know-how can be improved by

imitating shows that there is a close connection between our ability to perceive and our ability to act. Our perceptual system does not exclusively process information; by means of this information, it also improves our actions. Imitation and practice on one's own can be fused in a peculiar way that has been developed by sports psychologists. Some kinds of know-how can be improved on by imitating a repeatedly created mental picture of oneself performing very successfully the activity in question. For instance, if you are a basketball player, you may improve your penalty shooting by visualizing yourself – over and over again – making perfect penalty scores.

3. Practicing with a tutor. Neither practicing on one's own, nor imitating, nor creative proficiency requires language to describe the new know-how in question. But when a tutor (includes teachers, supervisors, trainers, coaches, and masters of all kinds) enters the scene, language and knowing-that are also brought in. When a driving instructor teaches a novice to drive a car, he begins by describing how the steering wheel, the pedals, and the stick-shift should be used. Thus he first gives some knowing-that of the know-how that the pupil shall learn. Then the pupil tries to follow this oral instruction and practice begins. But even later in the process the driving instructor uses his knowing-that. He makes remarks like 'relax your hands on the steering wheel', 'listen to the sound of the motor before you change gears', 'press the gas pedal more slowly', and so on. Common to all these knowing-that transfers is their approximate character. They are very abstract in relation to the wished for performance that constitutes 'flow'; they might be said to supply necessary but by no means sufficient descriptions of good know-how. However, despite being only rules of thumb, they can function well in interaction with the practitioner's own practice. And what in these respects goes for learning how to drive goes for most know-how learning.

4. Creative proficiency. Independently of all imitation and all prior pictures of an activity, a person may start to perform an already known activity in a completely new way. He so to speak 'creates in action'. We have chosen to call this phenomenon 'creative proficiency'. There is and has been much literature about 'creative thinking'. Sometimes this talk gives the false impression that creativity is an exclusively intellectual thinking-phenomenon; one consequence being that all *radical* know-how improvements have to come about indirectly via radically new knowing-that. But just as there are two forms of knowing, knowing-that and know-how, there are two forms of radical creativity, 'creative thinking' and 'creative proficiency'. For example, Jimi Hendrix did not create his new way of playing guitar by first creating a mental picture of how to play guitar his own way. Here is an example of clinical proficiency. A mother with her four year old boy is consulting a general practitioner (GP). The boy is suffering from an ear disease that makes an examination of the internal part of the ear (an otoscopy) necessary. GPs know that it is difficult to have the child's permission to examine his ear, and the present GP suddenly on impulse asks whether the child is able 'to hear the light' when the doctor looks into the ear. The boy becomes curious and asks the doctor to perform the examination in order to see whether he can hear the light.

In most actions one can discern part-actions. That is, when we act we concentrate on an overarching goal even though we are in some sense aware of the part-actions. With Polanyi one might say that we act *from* the parts *to* the whole action. This from-to structure is important in some learning situations. It is sometimes possible, but not always, first to learn the part movements of an activity and then integrate these into a homogeneous 'Gestalt', as when learning to drive a car. Sometimes, when we already can perform a certain activity, we can improve on it by first repeating merely a detail many times, and then try to let the consciousness of the detail disappear in the consciousness of the larger integrated whole that constitutes the activity in question. Polanyi exemplifies with a piano teacher that interrupts his sonata playing

pupil in order to make him touch a key slightly more softly in a certain passage. The pupil, under strong concentration, is forced to touch the key repeatedly in order to obtain the right softness of touch. Later on, when the whole sonata is to be played, concentration and consciousness has to be directed towards the whole. If this does not happen the transitions between the different keys will be incorrect. A particular note sounds right, but the music sounds wrong.

Tacit knowledge is also present in what we earlier have called 'perceptual structuring' (Chapter 3.2). When we concentrate on something in perception, we experience this something as having parts even if we cannot in detail see what the parts are like and describe them. We might say that we perceive *from* the parts of a percept *to* the whole percept. What part actions are to a whole action, perceptual details are to a perceived whole. One of Polanyi's examples comes from radiology. When a layperson looks at an X-ray, it is usually impossible for him to differentiate between different anatomical details. The radiologist, on the other hand, immediately observes theses details in the same way as the layperson sees details in an ordinary photo. It is even as hard for the radiologist *not* to see anatomical details in the X-ray as it is for him and the layman *not* to see ordinary things in an ordinary picture. The radiologist possesses skilled perception.

A person at the outset of his education is a layperson. In the beginning of his studies, the radiology student only saw black and white spots on radiographies. When children learn their first language, initially they understand nothing; they only hear sounds. Nevertheless, they eventually become able to speak fluently and to understand immediately what other persons are saying.

Tacit knowledge is firmly anchored in the body and the brain. We know that the movement of the eyes of a radiologist that looks at an X-ray differs from those of a layperson looking at the same picture. The brain of an expert is probably able to receive and adapt to certain kinds of perceptual data which the novice's brain is not yet able to deal with. Therefore, the brain of an expert can send signals to the muscles that the brain of the novice cannot yet send. Such signals move extremely fast – in a billionth of a second – and without any awareness on our part. It is this fact that might have misled some thinkers to *identify* tacit knowledge with the bodily automatics that this knowledge is dependent on.

5.3 Interaction between knowing-how and knowing-that

In one specific sense, some kinds of scientific knowing-that are disconnected from all knowing-how: they completely lack practical application. A good example is cosmogony, the theory of the genesis of the universe. However, even such knowing-that is for its existence dependent on know-how – other than that which is always required by language itself. The theory is based on observations with instruments; hence all the skills and structured perceptions necessary for handling the instruments are necessary for the theory. No knowing-that concerned with the world in space and time can exist without many different types of know-how. Improved know-how can be a necessary requirement for new knowing-that. Lens grinding in relation to the microbiological paradigm (Chapter 2.5) is merely one of a huge number of examples in the history of science. Conversely, new knowing-that can lead to improved know-how. The relation between lens grinding and microbiological discoveries is obvious, but so is the relation between new knowing-that about how systems and organs in the body functions and improved know-how about how to cure and prevent various diseases and illnesses. For instance, without detailed knowledge about how the heart and the blood system works, bypass operations would be

impossible. Often, to see how something functions in detail (knowing-that) is enough for receiving cues about how to improves one's ability to repair it (know-how).

The purpose of basic research is to obtain knowing-that; this goes also for basic medical research. But the overarching knowledge purpose of the whole healthcare system, of which much of the medical research is a part, is to develop know-how. It shall embody knowledge about *how* to prevent diseases and illnesses, *how* to diagnose diseases and illnesses, *how* to treat diseases and illnesses, *how* to alleviate pain, and *how* to comfort a patient. From what has been said and indicated above, it ought to be clear how the general relationship and interaction between new knowing-that and improved know-how can look like – and that such an interaction is important. Below, we will show how the interaction between knowing-that and know-how can look like in a special case of 'practicing with a tutor'; one in which the practitioner so to speak becomes his own tutor. It concerns medical consultation.

As stated by Hippocrates, "Life is short, art long; the crisis fleeting; experience perilous, and decision difficult", and the GP is probably the first to recognize this. Since the GP is supposed to deal with numerous unselected patients per day, in many situations his skill requires quick adaptation, improvisation, and vigilance. Consultations have to be optimally efficient in relation to the problems for which the patients consult the doctor. This requires, apart from medical knowledge, communication skills and empathy. Not only the novice has to try to develop his consultation skills, now and then even the expert clinician has.

In a typical GP consultation there is only the doctor and one patient. A newly licensed doctor may have a senior colleague with him, but his work is mostly done alone. Our own performance of know-how is hard and often impossible to observe. One may be acutely aware that one is performing poorly, but one can nonetheless not see exactly what goes wrong. Accordingly it is difficult to correct such sub-optimal or counterproductive actions. But videotapes have radically changed this predicament. Now, it is sometimes possible to observe one's performance in retrospect.

Medical consultations can be videotaped and the doctor (or other health care providers) can afterwards reflect on it, i.e., acquire knowing-that about his own know-how or about others. He can do it alone and try to be his own tutor, or he can do it together with colleagues or a senior tutor. The latter may then make various apt comments from which the former can benefit. Such video studies by novices as well as experts have given rise to some rules of thumb for GPs. There exist many different lists of such rules and relevant questions, and the subsequent list (developed by GP Charlotte Hedberg) is a model used in some continuing professional development programs in Sweden. It is called 'the Prismatic Model'.

As a piano pupil can be requested to play and concentrate on just one key at a time, the participants (students, nurses, or physicians) of prismatic-model-training are requested to concentrate on merely one aspect of a videotaped medical consultation at a time. Each aspect is named by a color and is associated with a corresponding pair of colored glasses.

1. The white glasses focus, to start with, on the health care provider's general perspective. Before the video is being played he is asked questions such as 'Had you seen the patient before or was it the first visit?', 'Was it a planned or unplanned consultation?', 'Did workload, work condition, and schedules for the day influence the actual consultation?' After having seen the video, the health care provider at hand is supposed to make some comments of his own and to say something about his feelings; then the tutors (or some colleagues) are giving their comments. Later on, all participants are asked to focus on the patient's perspective and try to imagine themselves as being the patient. They should think of themselves as having the same

kind of body, and they shall describe the patient's life situation and physical illnesses/symptoms as comprehensibly and vividly as possible in sentences such as '*I* feel …' and '*My* illness make *my* life troublesome because …'.

2. The red perspective focuses on the conversation between the health care provider and the patient and, e.g., on who dominated the conversation. The participants are asked to pay particular attention to the first three minutes of the consultation. Special focus is on the health care provider's questions. Do they open up for real discussion or are they leading questions? How does he react to the patient's answers? For instance, is he often 'humming' and/or often saying 'yes, I understand'. Does he ever say, e.g., 'Tell me more'? One also focuses on facts such as whether the health care provider summarized the conversation and whether he interrupted the patient. Also pauses and their importance for the conversation are discussed among the participants.

3. The pink glasses deal with the patient's and the provider's agenda, respectively. Relevant questions are: 'What is the patient's/provider's problem?', 'What are the patient's/provider's expectations?', and 'Do provider and patient agree on the actual problem and is there a common basis to the conversation?'

4. The orange perspective is concerned with explanations. Did the patient receive any explanations at all? If not – is there an explanation?; if yes – what did it look like and was it comprehensible? Did the patient receive information about diagnosis, prognosis, preventive measures, and treatments? If not – was it possible and relevant to provide such information?

5. The yellow color represents the body language between the two actors. What is the position of the provider and the patient, respectively? The participants are asked to describe the distance between the provider and patient, the latter's mimics and eye contact, as well as whether or not they copy each other's movements during the conversation. Questions about possible inconsistency between the body language and the spoken language are also relevant.

6. The green color represents emotional aspects. Is there a tension in the conversation? Has the provider given any emotional response to the patient's problem? Are there any key replies? Do we observe any 'laden' or 'golden' moments during the conversation?

7. The turquoise color focuses on the medical content of the conversation and how the doctor understood the medical task, the physical examination included. The participants are asked to focus on the description of the medical complexity of the case history rather than on a possible right answer.

8. The blue aspects concern gender, social issues, and taboos. Did the provider's/patient's gender or social background influence the content and development of the consultation? Would the consultation have been different if the provider and/or patient had been male/female, or vice versa? Did the provider or patient avoid certain topics such as sexuality, drinking habits, smoking habits, and death?

9. The violet color deals with the ethical aspects of the consultation. Was it a fair negotiation? Did the provider patronize the patient or did the patient patronize the provider? Did the provider respect the patient's autonomy and integrity? Did the patient respect the provider's professional autonomy?

10. The purple color deals with the time aspects. How did doctor and patient use the time? Was there a correspondence between clock-time and attention-time?

As a piano pupil is expected to have only background awareness, if any awareness at all, about the specific keys when he is playing in public, the practitioners that take a consultation course are expected later in their actual work to have at most background awareness of the ten consultation aspects listed. The pianist should when not training give the melodies played a good Gestalt, and the health provider should give all real consultations a good Gestalt. Know-how should be exercised with flow.

5.4 Tacit knowledge and computer science

The computer revolution has affected the discussion of tacit knowledge. On the one side we find determinist philosophers and (many) computer scientists who think that human beings are just a very complex kind of machine-with-computers that we ourselves have not yet been able to build. For these people, to create a man is only a matter of implementing the right kind of software in a hardware that is capable of processing this software. On the other side we find philosophers and (a few) computer scientists who think that there is something special about human beings that never can be mirrored by any machine or computer whatsoever. That is, to them it is certain that there will never ever be expert systems, artificial intelligences, and robots that will be able to perform exactly like human experts. The main argument of these humans-are-unique defenders can be schematized as follows, using artificial intelligence (AI) as our example:

premise 1: all artifical intelligencies perform only by means of rule following

premise 2: expert tacit knowledge cannot be reduced to rule following

premise 3: human beings can acquire expert tacit knowledge

hence: ---

conclusion 1: human beings have a capacity that cannot be reduced to rule following

conclusion 2: human beings cannot be wholly substituted by robots

Before we make some brief remarks on the debate, let us say some words about experts and stages of know-how. In Chapter 5.2, we presented four different *ways* in which know-how can be improved. Now we will present five *stages* of know-how. At most stages, all the four ways of improving discerned can be useful, but, by definition, there are two exceptions. When someone is the number one expert, he does not need to imitate anyone; and if somebody has reached the absolutely highest possible level, he can't improve at all. However, the different ways may have a more or less prominent role to play at various stages. According to the American philosophers and AI researchers Hubert and Stuart Dreyfus, skill acquisition relies much on rules (knowing-that) in the lowest stage but not at all on rules in the highest stage. According to the Dreyfus brothers, when adults develop skillful behavior there are five possible emerging stages that ought to be distinguished:

1. novice stage
2. advanced beginner stage
3. competence stage
4. proficiency stage
5. expertise stage.

1. Novice. The novice is instructed by means of strict rules about what to do. Persons that act only by applying such rules work rather slowly; and in many situations their strict rule-following leads to bad or very inefficient actions.

2. Advanced beginner. As the novice gains experience by trying to cope with real situations, he either notes himself or is told by his instructor about various aspects of the situations. The strict rules become transformed into maxims or rules of thumb that the advanced beginner knows how and when to apply. Nonetheless, the actions are performed in a detached analytic frame of mind where the individual thinks about rules and examples.

3. Competence. In this stage the individual is able to note an overwhelmingly number of potentially relevant aspects of various situations. Therefore, apart from the strict rules and the maxims, he starts in many situations to devise plans and perspectives that can determine what aspects are important. He becomes *as a person* involved in his activity. When something goes bad or well he can no longer blame or praise only the rules and maxims, he feels personal responsibility. He can feel remorse for mistakes, and he can experience a kind of elation when being successful. To quote H. Dreyfus (2006): "And, as the competent student becomes more and more emotionally involved in his task, it becomes increasingly difficult for him to draw back and adopt the detached maxim-following stance of the beginner. Only at the level of competence is there an emotional investment in the *choice of action*."

4. Proficiency. The emotional involvement that comes about in the former stage causes an automatic strengthening of successful responses and an inhibition of unsuccessful ones. Thereby, the rules, maxims, and plans will: "gradually be replaced by situational discriminations, accompanied by associated response. Only if experience is assimilated in this embodied, atheoretical way do intuitive reactions replace reasoned responses (ibid.)."

5. Expertise. "The proficient performer, immersed in the world of his skillful activity, *sees* what needs to be done, but must *decide* how to do it. The expert not only sees what needs to be achieved; thanks to a vast repertoire of situational discriminations he sees immediately what to do. Thus the ability to make more subtle and refined discriminations is what distinguishes the expert from the proficient performer. […] What must be done, simply is done (ibid.)."

According to the Dreyfus brothers, experts simply do not follow any rules, and that is the reason why knowledge engineers who try to develop perfect expert systems are bound to fail. Knowledge engineers use textbook knowledge and try to get experts to articulate their rules and principles for both bodily and intellectual actions – but what the experts or masters of a discipline are really doing is discriminating thousands of special cases. Now, the five Dreyfus-stages give a good description of how things look like from the point of view of the consciousness of the performer. But in itself the description of the last stage begs the question whether or not the brain and the body, unknowingly to the performer, are following extremely complicated rules and are the causes of the actions that are personally experienced as not being instances of rule-following.

(Let us here add that our earlier remarks about 'creative proficiency' have an interesting consequence. Traditionally, the philosophy of tacit knowledge is surrounded by an authoritarian

aura. Even if an expert sometimes has to say to people on lower stages ‘I cannot tell you why, but this is simply the way we have to act!’, it may turn out that the latter because of creative proficieny was right and the expert wrong.)

The proof of the pudding is in the eating. The limits of the artificial chess players, of the medical expert systems, and of what actions robots can perform are probably to be found empirically. If there will be robots that can bike, then the constructors have to program them to take account of the centrifugal forces that we earlier mentioned.

Simulators and computerized programs may probably in the future be fruitful means when medical novices develop into medical experts; they are already used in certain specialties such as anesthesia and surgery. Also, simulators and computerized programs may be used as time saving tools for the experts. But so far we have not seen any computers that can replace medical experts, be these clinicians or researchers.

5.5 Tacit knowledge and fallibilism

At the end of the nineteenth century, there arose in many Western societies a strong and widespread belief that science affords us certain knowledge, that science progresses linearly, and that the scientific mode of thinking should be generalized to all areas of life. When this ‘scientism’ became shattered in the late 1960s, some people tried to still their quest for certainty by starting to rely on tacit knowledge instead of science. If science is fallible, they seem implicitly to have argued, we have to rely completely on common sense, practical people, and our own spontaneous feelings of what to do. However, these knowledge sources are equally fallible. As knowing-thats can be more or less truthlike and even completely false, knowing-hows can succeed more or less and even fail completely. If biomedically trained clinicians can – based on expertise know-how – make false diagnoses and give wrong treatments, this is surely equally true for homeopaths and acupuncturists that regard themselves as having know-how expertise within their respective field (compare Chapter 6.4). There is no other way out then to get rid of the quest for absolute certainty. When this is done, one can in a new way retain the trust in both science (knowing-that) and tacit knowledge (know-how). Both, however, have to be regarded as fallible kinds of knowledge.

At the beginning of Chapter 4 on scientific argumentation, we said that we regard *arguments from perception* as a kind of zero point for empirical-scientific argumentation. Later, we have claimed that such arguments rely on structured perceptions that, in turn, rely on fallible tacit knowledge. Knowing-that by means of perception is a kind of know-how. Induction schema and abduction schema, we have also said, are mere forms for inferences that cannot transfer truth from premises to conclusion. Put briefly, observations are theory-laden and dependent on fallible tacit knowledge, and generalizations are empirically underdetermined and dependent on fallible inductions and abductions. Fallible tacit knowledge seems to be relevant also for inductions and abductions. Such knowledge from experienced scientists can fill the inference schemas with content and in each particular case make them more reasonable, but it cannot possibly take fallibility away.

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