5. Knowing How and Knowing That

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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