Tacitly thinking

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Abstract

Since the 1960s there has been an alternative move within theory of science towards an understanding, according to MacKenzie & Spinardi (1995) that techno-scientific knowledge is no longer to be viewed as objective – in the sense of being "subject independent"; neither is it context independent, and it is not determined by the rule of scientific method. Instead scientific knowledge is *situated*, it happens *locally*, it is *person-specific*, and *scientists do not follow rules but specific courses of action determined by the specific research environment and epistemic culture in which they are included* (MacKenzie & Spinardi 1995:44). In this paper, I will discuss this view with specific emphasis on mind its *tacit* nature with regard to knowledge, i.e. what the tacit of "tacit knowledge" is and how it is embodied in technoscientific practice – I will thus attempt to shed light on the mind and in particular the act of *thinking* that takes place before and during the formation of knowledge. However, the messy task of *dealing with mediations* may be a means to access that peculiar *pre-conscious act* we call thinking, which grounds rationality, and is a ground common to us all.

1. *Science, technology, technoscience*

Today most sciences are technological practices. One example of a technoscience practice is radiology. The relationship between technological practices and sciences is obvious where several sciences overlap like for instance in "space-travel nanomedicine" where engineering, physics, and chemistry, pharmaceutics, and medicine come together

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in the endeavor to create solutions for osteoporosis, cancer, and other illnesses that astronauts will be facing when they eventually are cruising towards Mars spending years in weightlessness and in an environment heavy with radiation (Nanoappsmedical.com). What connects technology and sciences are practices applied when technologies are needed as an extension of human action, like human perception can be extended through the use of fMRI or telescopes in space. What also connects is the specificity of skilled knowledge necessary for the practitioner to decode the mediation such technologies generates.

Henryk Skolimowski stated in 1963 that science concerns itself with what *is* – and technology with what *is to be* (Franssen et al. 2013). Mario Bunge said that technology is *applied* science: technology is about action, action that is born out of theory (ibid), and this differentiates technology from the arts and crafts and is therefore of equal importance with science. Today it is, according to Franssen, not easy to distinguish between theoretical researches whether it is science or engineering. Technological research has become just like pure science (ibid). However, philosophy has only relatively recently become interested in engineering practices – especially analytical philosophy of technology. History of philosophy and science show us that sciences grew out of the philosophizing of people like Bacon and Boyle pairing mathematical description and empirical investigation and experimentation – introducing various devices and instruments (Rossi 2000). In our time, we say with Ihde, that "sciences are instrumentally embodied" (Ihde 2013), however, *differently so in different sciences*. Michael Polanyi wrote in 1958 that science and technology is sharply divided by the distinct domains which form the transition between them. Technical processes that are so called applications of scientific knowledge do not contribute to science. A lot has been going on since Polanyi with the onset of sciences with different instrumental embodiments. Don Ihde has written extensively about a number of these different sciences, one example being modern astronomy, which is "outfitted with … 'smart' adaptive optics, very large arrays …illustrates one style of instrumentally embodied science – technoscience" (Ibid). As Bart Gremmen states, "the interaction between scientific work and technological practice cannot not be limited to a mere exchange of results" (Gremmen 2013).

So the question is: what *facilitates* the transition between science and technology for it to become an instrumentally embodied science practice? The short answer is: since modern science has become instrumentally embodied (Ihde), then sciences also consist of mediations in need of *interpretation*. This presupposes *skill-making*, and *know-how* and it also clearly presents us with the presence of a tacit preconscious thinking, which is operating within perceptions. In the following we shall endeavor to go into a few different approaches to the tacitness of preconscious thought in order to understand a couple of the complex processes of mind during the interpretation of technoscientific meditations.

2. Creating content through interpretation

Human interaction with reality is necessarily perceptual. What we encounter in our mind, what we understand is an *interpretation*, an *enactment*; it is a *model* of the outside world.

Perception is not necessarily a process in the brain only – it is a skillful activity performed by us as whole beings, and involves bodily movement and the entire nervous system (Noë, 2004:2). We acquire know-how, which we apply effortlessly to create interpretative models of what is "out-there". Models are suggestions of how reality may look like. All interpretative models are kind of "work in progress" since people are in a dynamic interplay with their surroundings at all times: we continuously move around, touch, smell, hear and see things from various perspectives and framings.

Hence, perception is often described as the capacity for comprehension, i.e. comprehension of a given environment based on the sensory information. However, this comprehension is not purely sensory as perception is more complex than being reduced to passive reception of stimuli from our senses. What we perceive through our senses is filtered through layers of memory, expectations and learning, thus linking perception to previous and present interpretations which reflects back on how perception of reality is interwoven with our knowledge, language and history, with our personal fears and bias, with *befindtlichkeit* (Heidegger) and with *doxa* (Plato).

Hermeneutics can fruitfully be partnered with a concept of perception within the context of a dialogue. In a meeting between two or more people, the process of understanding hinges not only on speech, on spoken words, but on mimic, body language, silence, multi-sensory and intellectual reactions, knowledge, and the physical surrounding.

This will assist us in learning to make what is implicit explicit, to better decode what we perceive, enhance our perceptions whereby we can gather more knowledge from what we look at and participate in and identify signifiers prevalent in the dialogue. It can finally help open an experience of presence, of being-Now – since only the present, the now of just being, is the *actual real*. This is always the *moment* when interpretation and sense-making happens.

First of all, we find a hermeneutical structure at the core of human interactions and human meaning-making. Our activities of daily living reveal continuous attempts at understanding everything that surrounds us. In order to work a computer, we need an operational understanding of the software program we use.

Second of all, the physical human body cannot be detached from our interactions and interpretations. This includes using all the senses of the body and allowing ourselves to be informed this way. Our world is an embodied world from which understanding, knowledge, or know-how cannot be isolated or viewed as separate entities devoid of contextuality, intentionality, and physicality. Interpretations are incarnate. We are born interpreters. Thus, hermeneutics is more than a speech act or text analysis – we navigate reality already equped with the ability to interpret: infants immediately begin probing their environment for comfort and nourishment. Our bodily existence plays a crucial role in the production of meaning; we perceive meaning as we are producing it.

Scientific perceptual habits have changed over the last 200 years. The reason for this may be that we are – as scientists or radiologists – looking at different things. We are trained differently, our practices are different. In relation to scientific imaging we do not apply illustrative drawings anymore; we develop our perceptual skills by repeated interpretative readings of images (Daston & Galison 2007; Friis 2015). Scientific observations, both before and after image technologies, are incommensurable activities partly because objectivity and subjectivity has, according to Daston and Galison, changed places. However, according to Heidegger and Gadamer, subject and object, instead of changing places, are merging during the process of interpretation. This is because the specific historicity of the interpreter becomes a necessary precondition for the understanding of the object at hand. This is a change from the artist-empiricists' naïve notion that the content of visual perception is directly given. One reason for this may be that we are culturally programmed to use our eyes and focus our gaze in certain ways when we look at things. Another reason may be that we have become genetically enabled through the long history of human evolution to interpret the environment perceptually. Thus, a relativizing aspect enters together with the individual observer and his or her specific situated perspectives, that is to say, how he interprets depends on his acquired skills, i.e. his upbringing, training and cultural background. How the observer is geared to apply his ability to interpret depends on his individual mix of biological programming and skills acquired through cultural integration. This can be understood the following way.

The eye is an interface between mind and object (environment/event/image). As such, the eyes are part of a complex processing unit to trace and identify change, features and form. What we are programmed to interpret is from a biological perspective a three-dimensional environment. Contour, texture and regularity are invariant properties; these properties, which are invariant under different perspectives, allow us to single out objects and experience them as constant and as something that exists separate from us (Barry 1997). There are of course an unknown number of perceptual properties or abilities on which culturally acquired skills rest. The phenomenon of "filling-in" is probably the best known of them. How important filling-in is can be explained by pointing to the time lag that exists between "actually happening" and "experienced as happening." In order to compensate for the temporal gap between the actual event and the awareness of it, the brain has to fill-in information to act on from past experiences. As Barry writes: "What the brain does (…) is to utilize billions of synapses to access the whole of memory and to instantly recognize invariance, integrate it, generalize from it, and extend itself through analogy" (Barry 1997). In other words, filling-in is thus an aspect of the act of interpretation; it is an *intuiting* of what is in actuality *happening* based on experience, i.e. deep neural memory.

If we now add technologies – with the accompanying technological "noise" adding artifacts such as white spots or shades into the image – and in addition changing cultural frameworks such as personal interests, political ideology, religious beliefs, school and influence from teachers and parents, socio-economic background, relatives and friends, literature and media, and scientific training, we can begin to fathom the variety of external influences on interpretation (in all of this, it is necessary to include theory-ladenness and non-relevant bias). All of these relativizing aspects are influencing the perceptions of the scientific observer, the clinician or the radiologist. These individually varying influences constitute an addition to the experiential background referred to by

Barry – there must be a horizon for experiences to guide awareness in order to act – there is no one conductor conducting the symphony of synaptic charges, but only the neurological symphony in its fullness and, perhaps, some sort of synchrony among parts (Barry 1997).

3. The "background" of tacit interpretative knowing

The complex *background* mentioned above that is an integral property of all reflective and analytical thinking, is *non-representational* and *tacit*, and an element in all "data" processing. This stage of pre-conscious thinking is about creating meaning and understanding and is thus *informing* the observer. In other words, it is the actualizing meaning-making "act" *per se* in the mind of the observer. It *precedes* and *establishes* that which is going to appear as specific colors or tastes in conscious awareness. Since there are no "*homunculus* – no internal observer gifted with the capacity to faithfully mirror the 'real'" (Radman 2012), we have no direct perceptible or cognitive access to the physical reality that appears as happening *here and now*. Instead there are multiple cognitions processing information from the senses up against one or more sources (which sources are chosen is immanent to the process itself). In agreement with Radman – and Kant, we somehow "start from the inside", from a more or less relevant starting "schema" (Ibid). The processing taking place is to discover and recognize the actually given, which requires that we already somehow know how to deal with data, that is, to transform the input to information. We are constantly shaping our perspectives on what is to become our conscious content (ibid).

Pre-conscious processing transcends the rational activity of the self. Yet, preconscious thinking underlies all rational thought as it is the process enabling the content of rational analysis. Rational knowledge is knowledge about how to solve practical or theoretical problems coherent with specific realities like particle physics or the topic of knowledge within analytic epistemology; it is also for instance arrangement and rearrangement of observables. These are operations especially useful in innovation, development, and implementation of technologies; and rational procedures requires a great deal of calculation, imagination, analysis, reflection, planning, and systematization.

Of course, there have been put restrictions on this kind of thinking in order to escape speculation and conjecture – we need only point to the A. J. Ayer (1956; 1973) and his emphasis on the visual aspects of the physical world as the only container of real, i.e. observable, components and which we therefore are *allowed* to operate with in scientific theorization.

Rationality is a matter of applying the correct method. An example of this is Føllesdal's (1979) attempt to replace the hermeneutical method with the hypothetical-deductive method (H-DM). Føllesdal is in this paper particularly critical towards Habermas, which, in his view, is restricting the H-DM to the natural sciences – in Føllesdal's view it can perfectly be applied to meaningful material like texts and works of art (Friis 2016). Even though Føllesdal aim at replacing hermeneutics his interest is the *rationality* of the method and *not the understanding of the event*, which he downplays altogether, perhaps because of Gadamer's insistence that any understanding is itself an *event* that suddenly *happens* and thus escapes rational conscious control and manipulation. Føllesdal believes the process of "interpretation" must be controlled by logic, in Føllesdal's case, the logic of *decision theory*, *H-DM*, and *game theory* – "(…) no satisfactory study of man can take place without game theory" (Føllesdal 1979).

Føllesdal does not believe that humans are irrational or that there are any reasons to think that persons are driven by unconscious powers. Human agents act as rational agents in the sense of decision theory (Føllesdal 1979; Friis 2016). First a person considers the alternatives which he believes to be possible in the situation at hand. Thereafter he chooses from among these alternatives one which in view of his values and beliefs concerning probabilities maximizes his expected utility (Føllesdal 1979). The deduction or conclusion takes place within the context of decision theory analyses, a rational affair with no unknowns – and where the hermeneutical circle – which is, according to Gadamer (2007), where and when during the interpretation the dichotomy between subject and object dissolves – is replaced by the gradual testing of test implications following logically from the proposed hypothesis (Friis 2016). In other words, to have a rational interpretation of a person's actions, it is required that "(…) a rational individual who is placed between a number of alternatives to be realized at time *t*, *makes* his choice according to transitive preferences at *t*" (Føllesdal 1979). In order to be able to conclude, then, we expect a person's preference to be consistent over time. This means not, says Føllesdal, that a person does not change his preferences; we would like to understand *why* he changes them. Rationality demands that preferences are guided not only by present desires (Føllesdal's own word), but by his concerns of his own future (Friis 2016).

The one-sidedness of rationality, as exemplified above, worried Martin Heidegger. Heidegger had since his 1929 lecture *What is Metaphysics* critically confronted Western philosophical and scientific culture for its cultivation of rationality. Its understanding of human thinking is one-dimensional and dualistic. Western culture has forgotten how to think. Rationality is nothing but a peculiar framing of the mind – like a straitjacket is a certain kind of forced "framing" of the body. The way we in the West have become accustomed to think about thinking is equal to forgetting what thinking really is about.

Modernity's notion of thinking means method. Rational thinking is, as seen in Føllesdal, a means to an end. We don't ask, like Heidegger, what *should* we think? This peculiar thinking dismisses everything that falls outside of formalisms and logic (Robbins 2014). According to Robbins – and Heidegger, rational thinking inevitably becomes circular: it becomes part of the *Gestell* – the ordering of resources for the development and use of technologies in the pursuit for progress and prosperity.

Heidegger must have had some experience of the development and effects of technologies during both of the two World wars – technologies that were developed and enhanced continuously to exterminate and destroy. The frenzied rebuilding after WWII introduced another destructive aspect of technological innovation – the speed of development, and the loss of control of the consequences. In his last interview – in *Der Spiegel*, conducted in 1966 but published five days after his death in 1976 – Heidegger said that "technicity increasingly dislodges man and uproots him from the earth (…). We don't need atomic bombs at all – the uprooting of man is already here. All our relationships have become merely technical ones." Heidegger also referred to the French poet Rene Char that in a conversation had told to him "… the uprooting of man that is now taking place is the end (of everything human), unless thinking and poetizing once again regain (their) nonviolent power" (*Der Spiegel* 1976).

In philosophy nothing really changes, the metaphysics is still intact – one-dimensional rationality is still inherently part of the school curriculum, of philosophical and scientific thought. In his time Heidegger focused his attention on meditative thinking, that is, a thinking that cannot be separated from Being, that which *is*. It is this reality of "non-separation" in the "*is*" of the actual reality of thinking and Being that has been forgotten. The actuality of the living present, that which *is* and *thinks* and *meditates* and which is *attunement* and *engagement*, in other words, the reality which just *is* that is forgotten.

To *forget* of this "ground" we all stand on as living and breathing beings, is to *withdraw* from Being, which is to withdraw from that *thinking* which *is*, and instead it becomes reflective. This is thinking that has become blind to its preconscious ground, and that has made it – not impossible – but difficult for itself to be a *purposeless thoughtfulness*, that is, a thinking *"without why"* (Caputo 1971). It is the inevitable transformation of the background of the individual human by an increasing technological dependency that Heidegger feared. A one-dimensional thinking in oblivion of its ground, trained in calculative data-processing, finds itself preoccupied with technologies. A thinking that is designing, building, calculating, systematizing, and computing have become a "device to operate on a world of things already reified into a network of ends" (ibid). What has been brought into scientific thinking is an understanding of a mind whose activity is directed towards the world and the mastery of it. In Heidegger's view, it is the practical and solution oriented scientific and technological rationality that draws the curtain. What was worrying for Heidegger was the unbridled optimism among natural scientists, that the natural sciences were the only way forward. For Heidegger, it was the objectifying, instrumental, and impersonal approach towards nature that constituted the threat to the future of humanity, as John Steffney writes "traditional rationality (metaphysics) has been concerned with beings and not with the illumination process as such, with ontic matters at the expense of ontological ones" (Heidegger 1966; Steffney 1977).

Heidegger's critical view on rationality and its role in technological development and science creates both challenges and opportunities. One objection to Heidegger could be that we may be blinded but only temporarily so: we are perpetually tapping into the primordial ground of mind itself – we are in so many way always informed by it as it is always the present itself and thus is also the actuality generating faculty of mind. Now and then we all of a sudden become aware of its existence.

There is a certain "dualism" present in Heidegger's thinking since he is operating within the dichotomy of *either* calculative thinking *or* meditative thinking – the first one bad the second good, without trying to integrate the intertwined parallelity of these two modes of thinking during processing or interpretation. It seems that Heidegger, it has been argued for instance by Steffney (1977), was not able to overcome the metaphysics he aspired to transcend. Yet Heidegger's insight on the matter, his difference from traditional philosophy, his rather mystical approach to the relation between Being and thinking may build upon other sources than even meister Eckhart: "foundational thinking starts only when we have experienced that reason (…) is the toughest obstacle to thought" (ibid). Heidegger's insight thus rest on his personal experience, his enlightenment or satori, and not forget, the influences of Hinduism, Theravada Buddhism, Mahayana Buddhism – especially Zen Buddhism and the Daoism of Lao Tzu (Caputo 1971; Steffney 1977; Scharff 1978; May 1996; Lin 2008).

In the paper by John D. Caputo (1971) we can see that Heidegger situates his own sense of thinking within an understanding of man as not only preoccupied by being but also that he has an intimate relation to Being: "thinking must only stay 'open' to being and be ready for the advance in which it will disclose itself to man. Dasein must neither seek nor question but only wait." In opposition to this fundamental act or non-act of openness, Heidegger places Kant, which operates with Being "subjugated to the categories and prescriptions of rational thought and therefore to the 'demands' – or 'wishes' – of the thinking subject." This openness in Heidegger's perception of "the most concrete reality" is in Nishida's thinking termed "nothing" – a reality which we "forget" through our constant objectifications and abstractions (Krummel 2017). This is Heidegger's *Being*. In both thinkers this is nothing but a possibility and simultaneously also an act *open to* and in fact, as act, *closing* or *overcoming* the gap of otherness in order to know the object. This is pure experience in the sense that here we have to do with mind – which is Being perceived as the originary pre-cognitive primal non-distinction, which is before the advent of reflection where the dichotomy of subject-object takes place (ibid). Thus it is, according to D.T. Suzuki, "(t)he power of dichotomizing (that) has made us *forgetful* of the source in which it preserves its creative potentialities" (Steffney 1977), and as Iris Murdock puts it: "(…) we have an 'unconscious mind' (…) there is no general chart of that lost continent. Certainly not a 'scientific' one" (Murdock 1973). The dichotomy between conscious rational knowledge and tacit knowledge, like the subject-object duality, is in Heidegger's opinion something we must transcend – as Suzuki states "knowable knowledge is relative, while unknown knowledge is absolute and transcendental and is not communicable through the medium of ideas" (Steffney 1977), in other words rational knowledge is relative but pre-conscious mind is not – especially when we become aware that we have "something" that is thinking for us and that we have no conscious control over it! We cannot with our will change that which appear before us as it is already determined. We can only give in to it. We are now aware of its absolute presence. Tacit knowledge is practical in the sense that it always is applied to the actual and immediate real – we don't have to reflect, its knowledge simply presents itself to us through action, feeling, or skill-performance.

Many neuroscientists, like Donald Hoffman, also claims that there is no such thing as a direct perceptual access to reality – all perception is itself *mediation of something* and that *something* is not a truthful representation of the contents of the world independent of us – everything we think we see, *is* the result of evolutionary and cultural pre-programming of the brain and the nervous-system. So, in view of the accelerated technological innovation and development – we may have to concede to Heidegger and admit that *what* we let ourselves in on with the technologies will in turn influence our lives in a way we are not ourselves always aware of when interacting with them. Through this perspective, all we see and relate to – whether it is nature, people, thoughts, conversations, or information – are mediations or rather interpretations originating within the dual aspects of our thinking tacit as well as analytically. What has been brought over from the technical handling of tools is the ability to handle the tools in a way that does not strain our capacity to perceive, to move around, and to think. This is the tacit way of the mind – veiled and in the background – it is *that which thinks for us* and on which our lives depend.

This *background* is a directedness of the cognitive system at work – which are all our experiences, motivations, expectations, necessary in order to make sense of whatever stands in front of us as – it is a "precondition for shaping a perspective on what is going to turn out to be mental content" (Radman 2012:226). Most of what we do we do effortlessly, whether it is something physical or mental. Many actions are automated. All knowledge-processes are also, fundamentally speaking, automated in that they are always informed from the *background*.

When Nietzsche stated that there are no facts, only interpretations, he was unknowingly pointing to psychology, in his own time only a promise yet a promise that according to Richard Tarnas was about "that … unconscious part of the psyche (that) exerts decisive influence over human perception, cognition, and behavior (…)" (Tarnas 2010:422). Tarnas is of course referring to the grand masters of modern psychology, Freud and Jung. And since Freud it has become a quite common place understanding of mind and ego as something we do not have any conscious control over (ibid). It is true that Freud took Kant further by recognizing that appearances are not necessarily objective and that these appearances are unconsciously determined by the human observer and that which conditions him. According to Tarnas, Freud's "discovery of the unconscious collapsed the old boundaries of interpretation … Kant was correct when he saw that human experience … was permeated by a priori structures (even though they were) to narrow and simplistic" (Tarnas 2010:423).

Also Cormac McCarthy has written about the unconscious: "the unconscious is a machine for operating an animal" (McCarthy 2017). He continues to say that all animals have an unconscious. The unconscious is a biological system of approximately 2 million years (for humans), whereas the ability to use language and think analytically is about 100.000 years. The term unconscious has a psychological ring to it; to term it the "pre-conscious" is better since *pre*-conscious emphasizes it as an activity *prior* to that which appears in consciousness. The process of thinking is mainly a pre-conscious affair. It solves math problems without using paper and pencil, without using numbers – we just don't know *how* – yet. This process is in McCarty's words "a mystery opaque to total blackness" (ibid). The neural storage of information, of experience, and of knowledge is enormous. We have read numerous papers and books and we can discuss these (not all but some) without having to remember the wording of the text, we remember images – the favored presentation mode of the pre-conscious (ibid).

4. Psychology and the Modes of Information Processing and Corresponding Memory Systems

In spite of what Heidegger, Suzuki and others say about the impossibility of science to even getting close to an explanation or description of the preconscious mind, it must be stated that science has at least tried to explain some of the phenomena of preconscious mind. However, the more technical sounding notions of "knowing how" (non-articulated/impossible-to-articulate knowledge) and "knowing that" (propositional knowledge) were first taken up by the Analytical philosopher Gilbert Ryle in 1949. However, it was Michael Polanyi (Polanyi 1958) who later developed the notion of "knowing-how" and termed it "tacit knowledge", and subsequently also made it a central characteristic of technology. Although "tacit knowledge" in the analytical sense is a practical and effortless "thinking", it definitely taps into that unknown territory we here have termed the *preconscious*, and by others *nothing* (Nishida), *Being* (Heidegger), or *unknown knowledge* (Suzuki).

Interestingly, the two forms of *knowing* can be seen in relation to recent psychological research on two distinctly different processing modes of mind, which is, the *fast thinking* and the *slow thinking* that synchronizes with *two memory systems*. One system slowly learns general regularities, whereas the other is a sudden grasp of unique events (Smith and DeCoster, 2000). Generally speaking, there is activity prior to the knowing-how; this is a complex of activities needed in order to know and to act. One is a quick and effortless processing, which rests on embodied prior associations; the second is an effortful processing mode (ibid). To be more explicit, the reason we humans have two memory systems is to tackle two functionally conflicting and incompatible demands (Ibid; McClelland et al., 1995; Sherry & Schacter, 1987). One demand is to "store" information slowly so that memory as a whole reflects a large sample of experiences. Smith and DeCoster explains that the reason for this is that long-term knowledge and experiences can at least partly be based on typical properties of the environment. To accomplish this, we need a slow-learning memory system. The other demand is for fast learning of new information. This is to remember new experiences perhaps after only one occurrence. The fast-learning memory system is important because one sole experience on the slow-learning memory system would not be enough for it to keep and retrieve that information on a future occasion. The fast-learning memory system rapidly constructs episodic memories in order to connect information about different aspects of an object in its context (Smith and DeCoster, 2000). Memories that are mediated by this system are explicit and conscious. The most notable difference between the two systems is the speed of learning and conscious access to memories, another difference that has to do with their different functions is that slow-learning and fast-learning accesses different types of information – for instance is slow-learning concerned with regularities, the fast-learning system, on the other hand, records details of events that are new and interesting, attending more to the unexpected (ibid).

There is interaction between the two systems. MacClelland et al (1995), states that consolidation is the most important one, which means that new memory is transferred by repetition from the fast-learning to the slow-learning system. Consolidation itself is slow so that new information will become integrated in the slow-learning system without disrupting previous learning (MacClelland et al., 1995; Smith and DeCoster, 2000). This is what is referred to as skill-making and tacit knowledge.

The two memory systems relate to two different modes of thinking. The two modes of cognitive processing draw on the memory systems in very different ways. One form of thinking is by Smith and DeCoster called associative processing, others call it "system 1" (Kahneman 2011), or "automatic human information processing" (Schneider & Shiffrin 1977). Common for them is the distinction between the two processing systems. Associate processing or system 1 is drawing information directly from the slow-learning system. It performs as an automated response, it is fast and pre-conscious and inherent within the perceptual pre-conscious processes of pattern-completion, recognition, and filling-in. For instance, after many experiences of certain type of similar phenomena inductive knowledge is formed, this knowledge is used to fill in information about characteristics that has previously been experienced rapidly and automatically in situations that resemble the current one (Smith and DeCoster, 2000). This mode of thinking draws from the slow-learning memory system and performs intuitively, effortlessly and tacitly.

Heidegger would express the context dependency differently – he is not talking about automated responses, although in his *What is Called Thinking* (1968), man possesses the possibility to think because man is only capable to think if he is inclined to do it – the issue here is that it depends on the context, what inclines man to think: "Memory is the gathering of thought. To what? To what holds us, in that we give it thought precisely because it remains what must be thought about." Automated response is what happens when we incline toward what in itself is to be thought about, as Heidegger states: "Only then are we capable of thinking" (ibid).

The analytic and reflective system 2, the rule based processing mode, is slow and applies rules to manipulate problems and find solutions. This mode of thinking uses both memory systems (Smith and DeCoster, 2000). Smolensky (1988) writes that this analytically reflective mode of thinking uses knowledge transmitted by culture and represented through symbols as its "program". It is based within language, which draws on both underlying memory systems.

Another take on system 1 and system 2 is Daniel Kahneman. He states that problems at hand may be so difficult that system 1 and the slow-learning memory system cannot come up with a skilled solution; system 1 still comes up with an answer but an answer to a simpler and related experience of the original problem at hand. The solution could then be to act on likes and dislikes. In other words, emotions are not only a surrogate solution, the next best thing when there is no corresponding experiences or skills to act out; it is a reason to act in itself and have survival value. We act on likes and dislikes, fear or love, we decide and act within the context of the situation that happens, intuitively, sometimes an adequate response sometimes, as Kahneman points out, an easier decision on a related situation in the absence of that particular corresponding experience within the slow-learning memory system. The thing is, according to a new theory by a group of neurology and psychology researchers lead by psychologist Ezequiel Morsella, is that *it is the result of thinking and not the process of thinking, which suddenly appears in consciousness – the activity of the mind is never conscious* (Miller, G.A. 1962; Lashley, K.S. 1956; Morsella et al 2015). This means, according to these researchers, that consciousness itself is not in possession of any activity, it is a passive frame for that pre-conscious process that just interactively took place in the brain and the nervous system. This means that *at every moment new mixtures of content will be present in the conscious field* (Morsella et al 2015). The information is context specific and arises automatically in a "no-self-generated manner" (ibid). Contents have various sources, some come from top-down processes, other from unconscious intersensory interaction, and these contents may not have anything to do with each other or to the ongoing event. Consciousness therefore appears as a continuous feed, this feed is necessary in situations of conflict, however, it is still on when there is no conflict – and not to forget, these objects and needs that arise are perceptual-like (ibid). The content of consciousness thus is constructed only by pre-conscious action, as options.

5. The "tacit" in clinical-technological practice

Specific skills that are necessary in a technoscientific practice are, as shown above, often just as much limitations *on* as they are necessary preconditions *for* interpreting the technological output. Skills are usually transmitted from person to person (MacKenzie & Spinardi 1995). MacKenzie & Spinardi claim that "science rests upon specific, hard-to-acquire, tacit skills" – which in a sense makes science a local endeavor and scientific knowledge local knowledge (ibid). This impertinent claim becomes obvious when we observe radiologists, which have to learn from older and more experienced colleagues, then their practice comes to embody a species of share methodology and that has enabled the radiologist to identify patterns and irregularities. This specific kind of methodology or interpretative systematics is always learned at the workplace by tediously copying the practice of the person in charge of the training (Friis 2016). The same goes for skills needed to communicate diagnosis. How to formulate a report, and what language to use, is something that is copied from archived reports and from more experienced colleagues at the ward – and so it is at most hospitals, they all have similar although somewhat locally diverging epistemic cultures where skills and know-how are transmitted through learning-by-doing and never-ending practice. If skills are not practiced they will be lost (MacKenzie & Spinardi 1995).

Interpretation in radiology is a detail-focused observation method. The interpretation or *systematics* is about recognizing and identifying patterns in the image. The tacitness of interpretation in radiology is specialized in comparison to the general ability of pre-conscious interpretation. Its specific tacitness – the systematics, the visual cues, pattern recognition – is underlying all practice, from the reading of the image itself to discussions with peers and reporting of findings. This specific tacitness or type of interpretative performance includes at least two important elements. To be a bit more specific, technologies – the scanner or x-ray machines, the software used to manipulate the image, the RIS for patient data, the PACS or picture archiving communication system to actually see the images and to file the oral report that is sent for transcription. The mediation undergoes thus several processes before it reaches the eyes of the radiologist as a visual 2D or 3D image – and the radiologist can use the PACS to zoom, add light, background contrast, and other qualities in order to enhance the performance of the interpreter (Friis 2015).

MRI scans provide a completely different type of visual information than x-rays. The MRI image is a sequence of a much larger area of the body – and the view is from inside the sequence. By right-clicking the mouse and move the cursor over the image, the radiologist can "travel" up and down through the sequenced body (ibid). The radiologist selects several image sequences from the same patient, compares and then describes what he sees. If there is doubt he will call one of his colleagues to discuss the images.

The radiologist typically begins to have doubts when patterns appear that do not immediately look right. Then the image is "teasing", which is to say that the image harbors shadows that the radiologist suspects gestalts abnormally, i.e. creates an illusion.

These shadows can also be exterior to the image, i.e. "artifacts in the image" created by the position of the patient who might have moved himself a little during the shot. In such cases is the experience of the radiologist essential (ibid).

The other element is, as seen, the *systematics*. Konstantinou et al (2012) holds that it is important to painstakingly follow the acquired systematics because we neglect to pay attention to objects when there are many other objects occupying our attention. It is simply not good enough to have the sought for object in plain view in order to actually *see* it. Only a few objects need to be present to dislocate our attention completely, we stop paying attention to the object in front of us. Even trying to remember what we have noticed is enough to blunt our attention towards the visual field during the interpretation process (Friis 2015).

During this process of interpretation, the perception is not a one-way system that transports information from the senses to the brain. According to psychologist E. Bruce Goldstein the case is rather that we are involved in an active explanation process that in all respects is hermeneutic, that is to say, that the perceptual process is cyclical. The visual system is thus generating a continuous stream of feedback and interaction between the various parts of the visual system: stimulus-experience-reaction. There may be some form of visual representations but also activity founded on embodied skills and practices. In other words, we are talking about a perceptual-bodily activity that probably is involved in all intelligent behavior (Friis 2015). The human visual system is accordingly an intelligent interpretive, opinion and order-generating system (Goldstein 1989; Barry 1997; Noë 2004).

So, what facilitates the transition between science and technology? The adaptable human mind and its ability to reshape out-look and know-how. Our mind has been and is adapting to an increasingly more complex world, where handling all sorts of technologies become skill-based and tacit, and using these technologies does not require much effort. Sciences themselves are nowadays multidisciplinary – technologies have become the backbone to its practice and thus a necessity to the outcome (Friis 2015).

It may come a time when mankind will better understand what makes humans think in ways we today only can speculate about. We could for a starter push ourselves towards an awareness of what may happen to our minds as we continue to consolidate our dependency on technologies – our unavoidable partners, instruments and the *technics* deflect our attention away from what happens to ourselves. Shannon Vallor, in her great book *Technologies and the Virtues* states, writes that we will need more than just better technologies. We will need better *humans*. Hence, we end up with Heidegger and his postulation "*we forget to ponder*." Like him we can only point to *that which informs our thinking and actions* and pursue the disclosure of this ground as a possible theme for future research within philosophy of science & technology.

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