I Move, Therefore I Am. Neuroscience Meets Process Thinking

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In this brief essay, we will argue that modern neuroscience and Whitehead's process thinking arrive at rather similar conclusions about the essence of human experiences. Important issues evolving from neuroscientific research, specifying the identity of human beings, are explained as resulting from the development and stepwise changes of highly dynamic neuronal networks. These conclusions appear to fit the (meta)physical concepts developed by Whitehead, who claims that the elucidation of immediate experience, proceeding from objectivity to subjectivity, is the sole justification of our thought. Both lines of thought assume that our bodily experience, emerging from the perception of various bodily organs, is the basis of our existence.

Keywords: our first perceptions, movement, atomistic experiences, process thinking, A. N. Whitehead

1. Our First Perceptions

Modern neuroscience has proposed that the first and most elementary perceptions of young human beings involve the notion of *movement*. In fact, it is one of the very first stages in the formation of an "I," and it is likely the beginning of the delight of the child in the world of the senses. Our perception of our living environment involves movement, perhaps still more fundamentally *change*, and at the same time automatically a notion of space and time is created in which the change takes place.

Thus, movement of our body is an everyday, but ingenious solution to master to some extent the problem of time and space—as a universally connected fundamental entity—on the surface of the planet earth. Spatial richness is an important issue for the human brain. In our human view, space is needed to perform and experience a movement. But the idea of movement has equally no meaning if there is no perception of time. Space and time—in the human experience—are inseparable and are "one thing," but still the human brain, serving as the center of the nervous system, has a tendency to take them apart and make a sharp distinction between time and space. The brain is organized such that the perception of space is understood much easier than that of time (Beudel et al. 2009) and movement is an excellent "instrument" to seemingly effortlessly bridge these two. We hardly notice our wrestling with time since we, almost without exception, translate time issues into spatial alterations. And indeed, solely measuring time is an abstraction. In practice, we "fix" time on the circular plate of a clock and "watch" the positions of two arms to indicate time around the world. The clock gives time a place. As humans, we like to have a safe position in life and all change is experienced either as a negative tension or as a positive excitement, but always carries some unpredictable risk. Also our use of

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language refers preferably to concrete spatial images in order to “understand” changes in simple or complex systems. In science, it is common practice to depict a function (change in time of a variable) in a graph in which time is fixed in a two-dimensional plane—leaving the x-axis to “quantify” time—to make the function “visible on paper” through alterations in space along the y-axis. We like to have a stable “overview” of changes.

It is relevant here to note that mastering of time through movement of our body has nothing to do with the well-known biological clock which is a bodily response to external time indicators like the turning of the earth around its axis.

The awareness of time as alluded to here is rather a complicated function of the brain which uses responses of nerve cells (neurons) as a measure of time (Weber and Weekes 2009). The time span of this neuronal interaction is around 60 msec. Apparently the brain compares the spatial changes not as a continua but it detects them between each period of 60 msec in a step-wise manner (“internal clicks”) and thus calculates by spatial forward projection where the body or part of it needs to be in a supposed point in time (Beudel 2008). The prehenders in our sensory system are grasping prior events and are passing them to subsequent events (Griffin 2001).

Our senses transform these physical notions into the “language of our central nervous system.” In this way, it is possible that most fundamental information, provided by our senses, is interpreted, integrated and, in part, stored.

2. Subjectivistic Experiences

When we think, in our subjectivistic way, about the world around us, experiences of subjects and events are the only relevant sources of information. In fact, we have no other option than being 100% subjectivistic. Every experience and subsequent thought is centered within the ego as every human being has evolved into. The development of the ego, the “me”-experience or the Self, is a slow but amazing process starting after the fertilization of a fertile ovum. It takes a number of years to grow into what we usually call an individual human being. The bodily sensations are an essential part of this process and we get so used to this that we are naturally led to believing that our identity is intrinsically connected to our body. Thus it leads to accepting that everything within and around us can be labeled either as me and/or the rest of the world. The mental capacities which are the consequences of the human growth process are then also easily seen as part of “me” and the cognitive functions are thus belonging to me. Also a very important feature of projection: attributing features of myself (e.g., thoughts) to other persons or objects, can be viewed in this way. From this perspective, it is not amazing that we, as human beings, easily consider a dichotomy of mind and body whilst, in fact, there is “only” a body, an extremely complicated one, with all the features as we can observe them, anthropocentric in an absolute sense.

There are two remarks to be placed here. *First*, the integration of all the bodily senses into “oneness” of oneself requires the constant comparison of the varying sensory input into a sensation of completeness and correctness. The universal neuronal language within the brain (a heavily regulated transmission process of signals through billions of synapses) allows, for instance, to merge the visual input with the somatosensory information from all body parts and provides an immediate answer to the question where I am in relation to the surface of the earth, a continuous fundamental question throughout life. Thus, comparison of the influence of gravity, positions of body parts and visual determination of what is going on around us, will immediately

provide the necessary stimulus to determine what I should do next. This is also in the context of needs, motivations, and previous moments (see below: memory). Neuroscientific experiments have shown that when the brain is being tricked into matching the wrong image of one's own body in comparison to the actual bodily information, the "me" may perceive foreign objects as really own body parts (see the rubber hand syndrome, Renersmann 2013). Also the perception of oneself outside one's own body can be relatively easily achieved by mismatching the various types of sensory information using goggles and videos of one's own body projected in front of oneself. The brain apparently always compares the result with what it is used to and thus draws the wrong conclusions. The fascinating fact is that the "me" as portrayed by the brain accepts as reality the false fusion of information. The "me" thus is convinced that "I" am standing somewhere in front of me whilst it argues from the actual position of the body. So, what is the "me" then at such a moment? A subjectivistic misconception?

Second, essential in these processes—as in all biological processes—is the phenomenon of *memory*. Here the features of the various memory forms will not be discussed, but a fact is that somehow the brain fixes the content of moments and uses this to form ideas about oneself and the world around us. It is not clear how the brain can store the enormous bulk of data which is accumulated during the development of one's life. However, it is clear that our memory not only encompasses those facts which everyone can remember easily, but it is surmised that the majority of memories are never retrieved consciously. And still it is likely that everything which is fixed by the brain may play a role in the countless comparisons which "automatically" are being performed when we go along life. It would indeed be very impracticable if we had to think about everything consciously. But it is surmised here that for whatever we—trivial or not—experience, many comparisons are being made to check the present feeling of our body and related features to what we had fixed before and then to draw the conclusion whether things are right or not. The result of that brain work will give us the position to take actions or not. Thus, we try to master time by making use of the many frozen time points from our past to make a valid projection of what will happen within the next few seconds, minutes, years. We carry each of our personal history with us as a result of many processes, both qualitatively and quantitatively. The personal history is the unique reflection of one's life time.

3. Process Thinking. A. N. Whitehead

There is no subject or actuality without experience. We are living in a universe of experiences. We just suggested that change is the most elementary perception of our environment. Interestingly, it is the mathematician and process thinker Alfred North Whitehead (1861-1947) who claims that all actualities around us have to be viewed as essentially *in passage* (Whitehead 1929; 1933). These ultimate facts of reality, which he calls "actual occasions" or "actual events," are prone to endless change and transformations, leading to the production of novel actual occasions. In Whitehead's words, "actual occasions are throbs of experience, complex, and interdependent" (1929). Herewith, the assumption of the dualism of mind and matter and also of fact and value has been resolved. Whitehead also considers individual facts of togetherness among many actual entities, called nexus. Apart from actual entities and nexus, all else is, for our experience, derivative abstraction.

This process, or better, this *creativity*, is the ultimate metaphysical category, and can be characterized by the principle of novelty, which is part of the creative advance of nature. These notions of the highest generality, applying to all details of practice, become already naturally imposed on the mind of a young baby looking around and thereby vaguely experiencing motion and change. The young human being is for the first time

mentally confronted with the ultimate metaphysical categories of change and time. As Whitehead says, “the most primitive perception is feeling the body as functioning” (1929). And later, the more sophisticated perception is “feeling the contemporary world.”

The basics of Whitehead’s process thinking, very briefly summarized above, contrast with Descartes’ view that *extension* is the primary attribute of physical bodies (Weber and Weekes 2009). His philosophy is still echoed in our modern and popular material realism that describes actualities as collections of *fixed* material facts and issues. Recently, however, process thinking is gradually replacing material or scientific realism, in microsystems, macrosystems, and in the complicated living systems. Realism is merely an abstraction since natural existence is best analyzed and understood in terms of processes, physical, organic, and psychological, instead of things, and as a scala of changes rather than as collections of fixed material matter and facts. Everything in our universe is in a constant process of change and becoming. Thus, our world should not ultimately be experienced as composed of small parts of matter, but should be viewed as composed of “organisms” (Whitehead 1929), actualities that are not passive but characterized by emerging and perishing, and perhaps most importantly, by prehensions of each other. These prehensions are the connecting complex elements in the processes of becoming; they are determining the way how actual entities are part of each other’s actuality and how they condition each other. Whitehead assumes that these actualities are bound together by a general relatedness which constitutes the world into an extensive “organic” continuum (1929). This relational approach in process thought emphasizes the reality of a process of becoming and changes over static being and is made possible by a flux of energy.

In the following, an attempt will be made to show that Whitehead’s metaphysics can afford a coherent and adequate explanation for fundamental issues of perception and, ultimately, of consciousness. The experiences enjoyed by an actual entity are what the actual entity is, for itself. Everything we encounter in our conscious experience, of the world around us and particularly what we experience as common sense, are implicit in Whitehead’s metaphysical theory and possess a direct relevance for understanding neuronal processes. Depth of experience is gained by concentrating emphasis on the systematic structural systems in an ordered environment, and discarding individual variations (Whitehead 1929; 1933).

As argued in the book edited by Miller (2015), the problem of understanding the biological basis of consciousness has largely shifted from a philosophical question to a scientific one. A modern development is the proposal of neural networks, rather than individual cells, which are able to form physiological units and can generate emergent functional properties and states (Yuste 2015). This is in strong contrast with the classical thinking of René Descartes, in which it is assumed that body and mind are entirely made of different stuff. But these views of the dualists and materialists, distinguishing the mind and the brain, have been severely criticized. A major issue is, however, the difficulty to understand how the nonphysical mind can affect the physical body (Griffin 2001). Whitehead made an important step forward and implied that all individuals possess perception, but that consciousness, as a highly developed form of experience, is only enjoyed by sufficiently developed actual entities.

Whitehead (1929) proposes that there are four phases in a conscious occasion of experience. The *first* phase embodies the physical phase, by feeling the previous actual occasion through reception of the efficient causation of prior events into itself. The physical phase is always prior to the mental phase. In the *second*, *mental* phase, relevant, pure possibilities are felt, appetitively and/or conceptually. These possibilities are called eternal objects, pure potentials for the specific determination of fact, of forms of definiteness. They have no

concrete existence of their own. Any actual entity obtains its specific characteristics from the ingression of eternal objects. In the *third* phase, propositions are felt resulting from the fact that the eternal objects are conjoined with the actual entities felt in the physical pole of the actuality. Finally in the *fourth* phase, these propositions are brought into contact with the original physical feelings, producing “intellectual feelings,” which involve a contrast between a fact and theory (proposition), between something that “is” and something what “might be.” This allows for self-creation, making a subjective creative advance into novelty. Thus, consciousness might be described as awareness of both a definite fact and potentialities. Consciousness involves references to definiteness, affirmation, and negation. Whitehead says “consciousness is the crown of experience, only occasionally attained, not its necessary base” and “consciousness presupposes experience, and not experience consciousness.” This abstract scheme has been further developed but for the present purpose we will not go into further detail.

An important further question is, of course, should experience, and perhaps also conscious experience be attributed to all things in the universe? Whitehead’s answer is “yes” (1929), but he notes immediately that consciousness is a very high-level form of experience, only enjoyed by rather few individuals. But the issue can be considered by distinguishing two types of genuine individuals: (1) simple individuals, the elementary building blocks of nature (quantum wavecles), viewed as actual entities, and (2) compound individuals, composed of simple individuals. On July 7, 2012, a group of neuroscientists in Cambridge signed a document entitled “The Cambridge Declaration on Consciousness.” They declared that all mammals, birds, and many other animals, including fishes, and even the octopus, possess consciousness. But recent research has shown that bees, plants, insects, and jellyfishes also have a primitive type of experience. They can learn, have synapses, and produce endorphines after tissue damage. Even bacteria have a rudimentary memory. And leading quantum physicists, including David Bohm (1980), have suggested that the behavior of elementary particles, as governed by space, time, and energy, exhibits aspects that remember us of human mentality. Therefore, Whitehead concludes: “Our actual world is composed of creative, experiential, physical-mental events” (1929).

It is important to stress that actual entities are spatio-temporal, momentary events that have only a finite inner duration, roughly between 10^{-9} and 10^{-1} second for human experiences. Experimental neuroscientific experiments have indicated (Blackmore 2002) that our mental experiences may not occur in a fully continuous stream but in a sequence of fast, separate events. This has been called an “atomicity” of experiences. The mind, that set of cognitive faculties that enables consciousness, perception, thinking, judgement, and memory, may be viewed as a serially ordered society of distinct (albeit intimately interconnected) occasions of experience (Griffin 2001). We notice here an important similarity in neuroscientific thought and in process thinking.

Process thinking is, fundamentally, a metaphysics, and proposes issues that cannot be further explained. This is, of course, a critical situation, and one should ask whether these metaphysical concepts are in agreement with what we experience in the world around us (Ford and Kline 1983).

We feel that, on the basis of experimental neuroscientific evidence, delineated above, this is indeed the case. This is an important conclusion and further thinking along these lines appears worthwhile.

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