

ON THE PERSISTANCE OF DUALISM IN OUR SO-CALLED UNIFIED NEUROSCIENCES: THE CASE OF THE AUTONOMIC NERVOUS SYSTEM

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In the present paper, the historical overview of descriptions of the autonomic nervous system (ANS) is applied as a case study to serve the demonstration of the persistence of dualisms in our current framework of neurosciences. First, the four main views on the ANS are briefly summarised, with an emphasis on the latest one, being the neurovisceral integration perspectives, striving for an integrative view on cognition, emotion regulation and physiological adaptation. Second, an explanation is offered on why we are so reluctant to give up the explanatory framework of dualisms, based on both developmental psychology accounts and postmodernism philosophy. To conclude, an attitude based on positivism and epistemological anarchism is suggested for scientists.

Unified neurosciences

The last decades of the XXth century have seen a growing scientific community in the field of what has been termed “neurosciences”, namely how the brain enables the mind, and whether the mind can shape the brain. The term itself found its origin on the back of a New York cab in the 70s. Gazzaniga and Miller were headed for a working dinner at the Algonquin Hotel in New York, where scientists from Rockefeller University and Cornell would be gathering to discuss how the brain indeed enabled the mind, and this topic needed a name. From this taxi ride emerged the term *cognitive neurosciences*, which has imprinted the field ever since (Gazzaniga, Ivry, & Mangun, 2002). The following decades saw an exponential growth of boundary-crossing research, with psychophysiology, neurophilosophy, biological psychology, cognitive neuroscience and the likes becoming full-fledged scientific disciplines. In the clinical field, the biopsychosocial model has become a mainstream frame of thought in pathophysiology. Even the precedence of emotion over cognition, or vice versa, has come to be viewed as obsolete.

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An alien reader of our neuroscientific literature might thus conclude we have reached a holistic and integrative view of human functioning, conciliating physiology, cognitive psychology, affective and emotional elements, in other words, mind, body, and even soul. So all is well in our brave new holistic world? Asking the question is a stylistic bypass to state quite the contrary, which we can describe by a case study, namely the scientific views on the autonomic nervous system.

The autonomic nervous system

The usual textbook description (e.g., Carlson, 2001) of this part of the peripheral nervous system is that of two antagonising branches innervating the same effector organs, which status is always a result of the shifting balance between both. Both branches are the sympathetic and the parasympathetic nervous system, where the action of the sympathetic is usually described as activating, whereas the parasympathetic is considered the inhibiting, or relaxing mode. The interaction of both has been described as responsible for the homeostasis, the fact the human body was designed to warrant a constant *milieu intérieur*, a concept dating back to Claude Bernard (1857).

The previous is a very summarised, simplified view on the working of the ANS, however, it is still the essence of what both medical and psychology students may remember from their undergraduate courses.

Along the twentieth century, there have been important shifts in paradigms, with regard to the description of the ANS. The first description was called the classical view, and was coined by Cannon (1915). This was derived from Claude Bernard's concept of homeostasis, and thus emphasised the necessary balance between both branches, the sympathetic and the parasympathetic, as reciprocal forces, the first one activating, anabolic and energy expending; the second one inhibiting, catabolic, and energy restoring. Despite the initial emphasis on the reciprocal character of the relation between both branches, the focus soon moved to the sympathetic nervous system. Indeed, Cannon's (1915) first description of the "fight-or-flight" response and Selye's (1956) work on the General Adaptation Syndrome both put the stress response in the spotlight, with the "emergency function" of the ANS as the centre of gravity, and more specifically the sympathetic part, ensuring energy mobilisation. In physiology research, this view described stress as a neural circuit (hypothalamus-adrenal medulla) on top of the hormonal one (pituitary-adrenal cortex) (Öhman, Hamm, & Hughdahl, 2000). Psychology applied the concept to behavioural energetics, describing the psychophysiological integration of the stress response. This was an impor-

tant stepping stone to the motivational concept of generalised drive. After Moruzzi and Mangoun's (1949) description of the reticular activating system, the ANS was seen as the "peripheral core" of the arousal and activation dimension (Malmö, 1959). Thus, the use of ANS innervated organs status (e.g., heart rate) measures in psychophysiology was seen as an indicator for an underlying one-dimensional concept of arousal and activation, thus providing information about the motivational status of the organism.

To summarise, the view on the ANS was seen mainly from the activation perspective, which could be represented as the organism's panic button to raise activation and mobilise resources.

A parallel evolution saw other researchers (Eppinger & Hess, 1915; Wilder, 1931, cited by Geenen & Vandevijver, 1993) describing the ANS as a more balanced function between sympathetic and parasympathetic branches. These authors considered the fact that the *vagus* preceded the SNS in evolution to state that the parasympathetic component could not be reduced to a lesser branch, emphasising the balancing function of the reciprocal relation between SNS and PNS. With regard to psychological constructs, individuals were described on a trait level as being more sympaticotonic or more vagotonic, to encompass a trait-like characteristic of overall activation. This view thus rejected regarding the SNS as the more prominent branch, and suggested a one-dimensional construct, defined by its extremes, namely sympathetic on the one hand and parasympathetic on the other.

The next shift in view of the ANS was described in a paper from 1991, by Berntson, Cacioppo, and Quigley. These authors argued that the, at that time prevailing, view of a one-dimensional construct should shift to a two-dimensional space. They questioned the historical doctrine about the two branches of the ANS constituting functionally opposing systems, based on experimental data showing independent or reciprocal activation or inhibition of sympathetic and parasympathetic nervous system. This novel view was noteworthy in more than its intrinsic scientific value. Indeed, this concept was outlined by psychophysiologicalists, and went by relatively unnoticed in the physiology literature. In medical schools, the one-dimensional construct with an emphasis on SNS continued to be taught. Despite the fact that the importance of the PNS emerged from clinical studies, showing for example that recovery from acute myocardial infarction or post-transplant recovery were linked to respiratory sinus arrhythmia (RSA), which is an expression of the coupling between respiratory and cardiac frequencies, and one of the components of heart rate variability (HRV), and which is a reflection of the parasympathetic regulation of heart rate (for a review, see Berntson, Bigger, Eckberg, Grossman, Kaufmann, Malik et al., 1997), the dominant model in the description of ANS remained the one of functionally opposed branches.

The last step so far in these functional descriptions of the ANS is the

emergence of the neurovisceral integration perspectives (Thayer & Lane, 2000; see also Thayer & Brosschot, 2005; Friedman, 2007). These models encompass the integrative regulation of cognitive, emotional and physiological response, and emphasise the need for a flexible regulation to allow for optimal adaptation of an organism to changing environmental demands, and thus for optimal functioning. The system's stability and coherence emerge from apparently random behaviour, where healthy organisms are seen as a set of loosely yoked bio-oscillators. The description of these non-linear dynamics is based on chaos theory, and postulates that the loss of non-linear variability is associated with pathology, which, to stick to the example of heart rate variability, has been shown as early as 1989 (Pool). The concept of homeostasis, with its ideal of internal stability, where labile physiology is an indicator for pathology, is replaced by allostasis, stressing the fact that different circumstances demand different allostatic set points (and thus that there is no single optimum value for each physiological parameter), and that the integration and regulation of this variability thus needs to happen at a systemic, and not a local level. Rather than a stable *milieu intérieur*, these models emphasise healthy functioning as a dynamic steady state, where the constant physiological variability allows for a stable outcome, through a constant adaptation of the organism. Moving away from the traditional representations of the ANS, this integration of physiology and psychology takes the form of a state space, being the spatial representation of all possible states a variable can assume in a system defined by n dimensions. Extended to psychological variables, the steady state as outcome could be viewed as behaviour, which is achieved through a healthy variability of the emotional response repertoire. According to Friedman (2007), emotions can be seen as attractors defined by a motivational dimension of approach versus avoidance, and an energetic dimension, encompassed by valence and arousal. An anxiety disorder, for example, is thus seen as a rigidification of the emotional response, which is paired with a pathological behavioural outcome, and a similar physiological rigidification (similar to the lack of heart rate variability, which has been described in a range of anxiety disorders).

To summarise this briefly outlined evolution of the description of the ANS, we moved from a “panic button” vision with regard to the emphasis on the SNS, over a one-dimensional construct defined by its extremes, to a two-dimensional space, and eventually an n -dimensional system integrating visceral, hormonal and behavioural dimensions. To quote the editorial of a 2006 issue of *Clinical Autonomic Research*: “Autonomic neurology is emerging as a key nexus of cognitive neuroscience, behavioural neurology, and neuropsychiatry” (Goldstein & Silverman, 2006). Thus, one might be under the impression that all is well in our brave new holistic world.

Dualisms, and why are we so reluctant to give them up

Despite the scientific literature showing indeed plenty of evidence of a paradigm shift, there is still no shortage of mind traps with regard to dualism(s). The most ancient one, the mind/body opposition, which could be termed the original sin of cartesianism, is still very vivid in everyday medical practice. Not in the enlightened views expressed on an abstract level by medical practitioners, but in the very practical organisation of medical curricula (the very small number of hours in psychology taught, and the lack of interest for the cognitive and social neuroscience in these teachings) and in the structure of health care (the fact that, in Belgium, the title of psychotherapist is not protected by law, and that the social security system does not cover psychotherapeutic treatment if not performed by a psychiatrist, thus a medical doctor). This is further noticeable in the gap between medicine and psychology, which, both on a conceptual and a practical level, is very vivid in the hierarchy of health care. With regard to psychological research, some dissociations are still hard to eradicate. Considering for instance the cognition/emotion antagonism: since approximately two decades, the ruling dualism in cognitive psychology about “pure” information processing and the less well defined field of human emotions may be considered obsolete. Even the historical debate between the primacy of affect versus the cognitive appraisal has settled considering alternative definitions of “cognition” regarding the conscious level of processing. Thus, in contrary to Gardner’s view (1985) that “emotion is a factor which may be important for cognitive functioning but whose inclusion at this point would unnecessarily complicate the cognitive-scientific enterprise”, the last years have witnessed a growing body of psychological work regarding the application of cognitive science and related experimental paradigms to the study of the processing of emotional information, with emotion regulation being the new train everyone is eager to hop on. The pioneering work of Damasio (1994) was a milestone in this regard. In his perspicacious observation that being in want of emotion jeopardises, or even devastates typically human rationality, Damasio attempted to steer us clear of further Cartesian errors. And yet... reading Dalgleish’s (2005) reply to Algom, Chajut, and Lev’s (2004) tentatively implacable argument about how the emotional Stroop is not a Stroop effect at all, one cannot help but wonder whether emotion is really a full-scale partner yet in the field of hardcore cognitive science.

In psychophysiology, the field which, above all others, should strive for integration, we see a new emerging dualism, created by the available investigation techniques. The sophisticated MEG, fMRI and full cap EEG, with their ever increasing time and space resolutions, hold the risk to allow us to forget that below the brainy human head lives a body, with a whole range

of function that involve brain processing. Again, a practical example is that the activity in the anterior cingulate cortex is not only linked to response conflict in cognitive paradigms, or to emotion regulation in negative emotion inductions, but is one of the most important parts of an ensemble of cortical and subcortical structures that has alternatively been termed the Central Autonomic Network (CAN), or the Anterior Executive Regio (AER) (Thayer & Lane, 2000; see also Thayer & Brosschot, 2005; Gianaros & Sheu, 2009). And yet, as subscribed by Cacioppo and Tassinary (1990) in a nearly two decades old paper, psychophysiologicalists still make the mistake of looking for one-to-one relationships when inferring psychological significance from physiological signals, overlooking the well-known multifactoriality of physiological variance.

So how come we have so much trouble giving up on dualism(s)?

Considering the inherent nature of the human mind, and the fact that it is the only reflexive form of intelligence, it means that, whenever thinking, the mind needs to be duplicated: the thinking mind, and the mind thinking about itself thinking – and therefore the ability to state that “I think, therefore I am”, but that is another story, for another day... Which is why intelligence is said to be reflexive, thus offering a reflection, not unlike a mirror. Brains still have no mind, proclaimed Damasio (1994), if they do not meet an essential condition, to wit, an ability to display images internally and to order these images in a process called thought, as in a stage play with the self as an audience distributed throughout the body. The very process of human thought is thus based on a dichotomy, starting in early childhood development. The first stage of the perception of identity is the differentiation between self and others, the arising of intersubjectivity. An individual thus starts to perceive him or herself on a dual mode. And maybe there is some reluctance to give up the binary order that formed the very first organisation of our perceptual world. However, to go beyond the neatly categorised structuralistic vision, we need to overcome dualism, in other words: we need postmodernism. Indeed, as stated by Lyotard (1979): “Postmodernism means working without rule, in order to find out the rules of what you’ve done”. And this is, in fact, the most basic roots of empiricism. However, how compatible is it with hypothesis-driven research, considering the well-known confirmation bias? Referring to the descriptions of the autonomic nervous system summarised earlier on, this is exactly what Berntson et al. (1991) did when challenging the one-dimensional view of reciprocal forces within the ANS. We thus need to deconstruct dualism. Deconstruct, as in peeling away like an onion, the layers of constructed meanings, which is where we need to refer to Derrida. The philosopher who fought a one-man deconstructionist war against the entire Western tradition of rationalist thought. The one who dared to defy Cartesianism and defined reason as “the dishonest pur-

suit of certainty, dominated by a metaphysics of presence” (Caputo, 1997). According to Derrida, this certainty of reason is a tyranny which can only be sustained by repressing or excluding what is uncertain, what does not fit in, what is different. How very opposed to the essence of the scientific process this exclusion seems. And yet, how sadly close it sounds to the caricature of science that is sometimes performed under the conformity pressure of the whole grant-writing-reviewing-publishing-or-perishing that is the bread and butter of a researcher’s life. Many have criticised Derrida, and postmodernism altogether (for a review, see Norris, 1993) for the apparent void in knowledge and lack of structure this argument opens. However, fighting the certainty of reason does not mean giving way to relativism and irrationalism, for that would be replacing the rational certainty by irrational certainty. Derrida does not reject reason, only the representation of itself as timeless certainty. He is criticised for paving the way of cultural relativism, as if nothing is real because everything is only a cultural, linguistic or historical construct, whereas he states nothing is less real for being cultural, linguistic or historical, especially if there is no universal or timeless reality to which it can be compared. He has been accused of holding out meaning, for saying there is an infinite number of meanings, thereby rendering them all equally worthless, whereas he only just poses there is never just one. And finally, he has been criticised for stating everything is of equal value, sweeping the streets with years of intellectual tradition, whereas he only stated that the question of value must remain an open one (for an insightful summary and graphical representation of the previous, see Appignanesi & Garatt, 2003).

To conclude, considering the intellectual history of Western tradition offering very viable alternatives, both at the philosophical and conceptual level and the most practical, research-operationalised level, how come we are so reluctant to give up dualisms? Maybe because uncertainty is by definition uncomfortable to humans, and even more so in our present time, where our knowledge economy tolerates it even less, where medicine is not an art anymore but a science, where decisions are made based on algorithms derived from “evidence-based” data-analyses.

Perpetual schizophrenics?

The question thus remains whether we are doomed to be perpetual schizophrenics, to simultaneously embrace the “enlightened” integrative views, the biopsychosocial model of psychopathology and the rigid somatic views of hyperrationalist medicine. Our methods (and maybe our inherent limitations) force us to reductionism, whereas our ambitions – unified neurosciences – require postmodernism. Or to put it in the words of the most

famous epistemological anarchist: “The only principle that does not inhibit progress is: anything goes (...) Without chaos, no knowledge. Without a frequent dismissal of reason, no progress (...) For what appears as ‘sloppiness’, ‘chaos’ or ‘opportunism’ (...) has a most important function in the development of those very theories which we today regard as essential parts of our knowledge (...) These ‘deviations’, these ‘errors’, are preconditions of progress” (Feyerabend, 1975). Based on the previous account, postmodern science is, or should be, in a condition of anarchy. This holds quite strong reminders to one of the most passionate writings in American literature, namely Henry David Thoreau’s (1849/1980) “Civil disobedience”. Indeed, maybe our twenty-first century scientist’s conscience has dozed off, and we need to be reminded we have a duty to keep doubting, keep playing devil’s advocate, keep looking for the truth, fully aware we will never find it, but may achieve a very close call in the end.

It took his Nobel lecture (an occasion where one has the biggest ever wildcard to play as far as speeches go) for Richard Feynman (1965) to state: “We have a habit in writing articles published in scientific journals to make the work as finished as possible, to cover all the tracks, to not worry about the blind alleys or describe how you had the wrong idea first, and so on. So there isn’t any place to publish, in a dignified manner, what you actually did in order to get to do the work”. The major danger is to start believing the tales we tell...

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