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Feelings Are the Source of Consciousness

Antonio Damasio
damasio@usc.edu
Hanna Damasio
hdamasio@usc.edu
Brain and Creativity Institute, Dornsife College of Letters, Arts and Sciences, University of Southern California, Los Angeles, CA 90089-2921, U.S.A.

In this view, we address the problem of consciousness, and although we focus on its human presentation, we note that the phenomenon is present in numerous nonhuman species and use findings from a variety of animal studies to explain our hypothesis for how consciousness is made.

Consciousness occurs when mind contents, such as perceptions and thoughts, are spontaneously identified as belonging to a specific organism/owner. Conscious minds are said to have a self that experiences mental events. We hypothesize that the automatic identification that *associates* minds and organisms is provided by a continuous flow of homeostatic feelings. Those feelings arise from the uninterrupted process of life regulation and correspond to both salient physiological fluctuations such as hunger, pain, well-being, or malaise, as well as to states closer to metabolic equilibrium and best described as feelings of life/existence, such as breathing or body temperature. We also hypothesize that homeostatic feelings were the inaugural phenomena of consciousness in biological evolution and venture that they were selected because the information they provided regarding the current state of life regulation conferred extraordinary advantages to the organisms so endowed. The "knowledge" carried by conscious homeostatic feelings provided "overt" guidance for life regulation, an advance over the covert regulation present in nonconscious organisms. Finally, we outline a mechanism for the generation of feelings based on a two-way interaction between interoceptive components of the nervous system and a particular set of nonneural components of the organism's interior, namely, viscera and circulating chemical molecules involved in their operations. Feelings emerge from this interaction as continuous and hybrid phenomena, related simultaneously to two series of events. The first is best described by the terms *neural/representational/and mental* and the second by the terms *nonneural/visceral/and chemical*. We note that this account offers a solution for the mind-body problem: homeostatic feelings constitute the "mental" version of bodily processes.

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1 What Consciousness Is and How Feelings Contribute to It

The problem of consciousness—what it is, how it is produced, where and how it operates—continues to attract the attention of biologists, physicists, and philosophers. The treatment of the problem remains controversial, and to date, no solution has generated consensus (Baars, 1988; Crick & Koch, 1990; Chalmers, 1995; Dehaene & Changeux, 2011; Tononi, 2012; Seth & Friston, 2016; Solms & Friston, 2018). One might even venture that the situation has worsened and that the lack of acceptance of biological treatments of the problem has led to the idea that the solution might actually be found in the realm of physics (Goff, 2019).

A major problem facing consciousness studies is the clarification of what consciousness is and what it achieves. The multiplicity of meanings of the term makes a comparison of proposed solutions and alleged failures difficult at best. It is apparent, for example, that the term *consciousness* is often used to signify *mind* and that the purpose of some alleged consciousness studies is to elucidate processes behind complex mentation such as attention and integration of information.

And yet from our perspective, we believe that what consciousness primarily achieves is distinct and unique. *Consciousness identifies mental contents as belonging to a specific organism and vice versa; it connects a mind with its respective body and establishes mutual ownership*. To be conscious consists of experiencing a correspondence between mental contents and a specific living organism.

In the normal awake state, the identification and connection happen automatically, not as a result of overt reasoning. We hypothesize that for reasons we explain later, homeostatic feelings naturally provide the revealing link between (1) events occurring in the "body" component of the partnership and (2) events experienced as occurring in the "mind" (Damasio, 2021a, 2021b; Carvalho & Damasio, 2021; Damasio & Damasio, 2022). We note that the spontaneous conscious nature of homeostatic feelings is the consequence of physiological conditions that we describe in section 5.

This hypothesis results from placing some established facts in a novel perspective. The first fact is that homeostatic feelings are spontaneously conscious mental events. If homeostatic feelings were not conscious to begin with, they would not have been useful from the standpoint of life regulation. We also suggest that if feelings had not been conscious, they would not have become selected features of life regulation in complex living organisms.

The second fact is that homeostatic feelings continuously express, moment by moment, the overall process of life regulation within the respective organisms: prominent needs (hunger, thirst), alarm signals (pain, fever), opportunities for exploration (well-being). In healthy conditions, feelings tend to hover near homeostatic equilibrium, express the continuity of life, and signify existence. Feelings exhibit qualities that correspond to degrees of

homeostatic efficiency (e.g., pleasant, painful, neutral), as well as to varied intensities. Because feelings occur continuously, they provide an equally continuous mental translation for the dynamics of the organism in which they occur.

In brief, we hypothesize that (1) homeostatic feelings inaugurated consciousness in biological evolution and that (2) they were selected because their spontaneous conscious nature enabled an evolutionary novelty: *a strategy of life regulation based on overt information regarding the current state of life in an organism*. In other words, life regulation became grounded on the "knowledge" provided by continuous homeostatic feelings, a novel cognitive step generated by an affective process.

We also note that prior to the advent of homeostatic feelings, in unicellular organisms as well as in relatively simple multicellular ones, without nervous systems, homeostasis was maintained by covert mechanisms only, relying exclusively on intelligent but nonconscious processes (Damasio, 2018). After the advent of nervous systems and the appearance of feelings, homeostasis also came to rely on the overt knowledge provided by felt experiences. These experiences could operate as incentives or disincentives relative to covert action goals and, eventually, as organisms became more complex, draw on basic reasoning and deliberation to create novel responses. In sum, the arrival of feelings in evolution marked the beginning of a dual strategy for life regulation, now dependent on a flexible combination of covert and overt mechanisms operating as needed to best maintain homeostasis.

2 Distinguishing Consciousness from the Process of Sensing and Detecting

Long before living organisms were capable of consciousness, they had the possibility of sensing the conditions of their environment (which included other organisms) and responding accordingly. This ability to sense/detect is present in prokaryotes and even in plants. The sensing organism does not need to have a nervous system and does not need to generate internal representations of what is sensed or detected. In other words, simpler sensing organisms do not need to create maps and images. We suggest that this is manifestly different from what happens in organisms with consciousness, a process that depends on mapped images generated by nervous systems and where these images come to constitute minds. Sensing/detecting depends on the physiology of cell membranes; still, it should be noted that its simpler machinery is likely to be the foundation for the chain of processes that eventually culminate in consciousness.

In between sensing/detecting and consciousness, we find the process that we call *minding*. Minding consists of generating streams of sensory representations, usually referred to as *images*, which require a nervous system for their creation and display.

In essence, the images that constitute minds are of three kinds. The dominant kind represents the world that surrounds each organism and includes other living organisms and all varieties of objects and physical structures and their interactions. These images are based on *exteroceptive* processes such as vision, hearing, touch, smell, and taste. They correspond to an extraordinary repertoire of objects and actions arising from the world external to living organisms.

The second kind of images is less dominant but no less important. These images are obtained via *interoceptive* channels and contribute to *homeostatic feelings.* These images represent aspects of viscera and visceral states, such as the heartbeat, the flow of air when one breathes, a gut colic, the contraction or dilation of blood vessels in the skin. They map intensity and quality, pleasant or unpleasant, of what is being perceived. But as we explain in section 3 and contrary to the way in which they are usually referred to, interoceptive images are not mere perceptions.

A third perceptual channel represents muscular and skeletal structures and the movements they execute. This channel, known as *proprioceptive*, also contributes to homeostatic feelings but to a far lesser degree.

3 Explaining Consciousness

The essence of consciousness is the identification of a particular mind with a particular organism. This "knowledge" is provided by the continuous experience of homeostatic feelings generated by the ongoing process of life regulation as the organism attempts to maintain operations in the homeostatic range. These include salient feelings such as pain, as well as the subtle feelings of existence that are generated continuously in the awake state.

When we feel pain or hunger or well-being, we are necessarily conscious of each of those particular states. Each homeostatic feeling is itself spontaneously and automatically conscious. Our mind is offered important and conscious information about how life is progressing inside the organism and about what the organism needs. Based on that qualitative and graded knowledge, we can respond accordingly by making helpful corrections; for example, pain signals the possibility of tissue damage, while hunger signals the need for additional energy sources; well-being indicates that the organism can engage in exploration. If feelings had not been spontaneously conscious, they would not have been able to assist the process of curating life.

It is likely that homeostatic feelings were the inaugural phenomena of consciousness in evolution and that they were selected because the knowledge was a major evolutionary advantage. The knowledge available to conscious homeostatic feelings made deliberate life regulation possible.

Homeostatic feelings are conscious inherently, and they make consciousness possible for other sensory material, such as exteroceptive sensory

images. But we can be conscious of those images only when the feelings that they generate are also present. No additional mechanism is needed to provide consciousness for large arrays of contents. Consciousness emerges from the homeostatic feelings of the subjective owner as triggered by few or many imagetic contents on any theme.

Consciousness cannot be found in inanimate objects, regardless of how complex they may be. It is found instead in the minds of living organisms capable of constructing sensory representations of components or states of their own bodies. We propose that consciousness cannot be found in organisms limited to sensing/detecting and not provided with nervous systems.

Because nervous systems are necessary for true consciousness to emerge, we caution against the idea that nervous systems would be solely responsible for consciousness. Consciousness requires a partnership of nervous systems with the bodies they serve. It does not depend on nervous systems alone.

4 Generating Homeostatic Feelings

Attributing consciousness to homeostatic feelings might appear as a distraction from the fundamental problem and leaving the mystery unaddressed. We believe, however, that it is possible to address the question of how living organisms generate homeostatic feelings: as the result of a two-way interaction between the nervous system and nonneural components of the organism (Damasio, 2021a, 2021b; Carvalho & Damasio, 2021). Homeostatic feelings are a novel kind of process that generally describes aspects of visceral anatomy but also documents the qualities and intensity of the phenomena that take place in viscera—for example, the duration and intensity of pain localized to a particular sector. Feelings are not the consequence of plain perceptual processes but rather the result of hybrid interactions between neural and nonneural bodily events. The continuous representations of the state of the organism identify the living organism in which they emerge, and let the mind know of their origin.

The physiological setting of interoception is distinct from that of exteroception and helps explain the nature of feelings. Whereas exteroception attempts to produce detailed maps of structures and events occurring outside the organism, interoception describes structures and events inside those organisms. Interoception allows nervous systems to produce mapped representations of internal structures and events. Neural and chemical signals travel from viscera to the brain and produce "imagetic" representations, but the brain can respond to such signals. We find no equivalent to this process in the world of exteroception. This particular physiological setting suggests that the nature of the feeling imagery produced by interoception is different from the exteroceptive variety.

Table 1: Contrasting Interoceptive and Exteroceptive/Cognitive/Motor Structures.

	Interoceptive Structures	Exteroceptive/Cognitive/ Motor Structures
Type of axon	Unmyelinated (Aδ/C) or poorly myelinated	Well myelinated (Aα/Aβ)
Mode of transmission	Predominantly nonsynaptic	Predominantly synaptic
Timescale	Mostly slow (sec/min/hours)	Very fast (μsec – millisec)
Specific processes	Interoception, feelings, emotions	Fine perception, learning and memory, reasoning, math, language
Blood-brain barrier	Absent or with major gaps	Continuous
Main neural transmitters, neural modulators	Monoamines (dopamine, noradrenaline, serotonin), ACh, neuropeptides	Glutamate, GABA

Just as important, the neural elements responsible for interoceptive interactions are also quite distinct. For example, interoceptive axons are not insulated by myelin and make frequent nonsynaptic contacts. Moreover, interoceptive neurons are not systematically protected by a blood-brain barrier. The consequence of these physiological conditions is that components of the body's interior, such as viscera and circulating chemical molecules, can have direct access to interoceptive neurons because of the protective barriers provided by myelin and the blood-brain barrier are absent.

5 The Physiology of Interoception Is the Enabler of Consciousness

The core physiology behind interoception is quite different from the paradigmatic exteroceptive physiologies behind visual, auditory, and tactile perception, and even from proprioception (the perception of the movements executed by striated muscles in the limbs and trunk). The interoceptive processes behind homeostatic feelings and consciousness rely on a merging and comingling of elements in nonneural body structures with elements in neural structures capable of generating a novel class of hybrid phenomena (Carvalho & Damasio, 2021). This is the origin of the "double face" of feelings, which are "physical" processes and yet yield subjective "mental experiences."

The anatomical and physiological features responsible for the functional novelties introduced by interoception are summarized in Table 1, where we list some of the key differences between interoceptive and exteroceptive processes relative to (1) types of axons, (2) mode of signal transmission, (3) timescales, (4). absence or presence of blood-brain barrier, and (5) main chemical molecules engaged in the process. The following sources were

used in compiling the supportive facts: Foley & DuBois, 1936; Hoffman & Schnitzlein,1961; Friede & Samorajski, 1967; Lieberman, 1976; Mantyh, 1982; Vizi, Gyires, Somogyi, & Ungváry, 1983; Leslie, 1986; Prechtl & Powley, 1990; Amir & Devor, 1996; Syková & Chvátal, 2000; Bokil, Laaris, Blinder, Ennis, & Keller, 2001; Craig, 2002; Oh & Weinreich, 2002; Moalem, Mulpuri, Damasio, & Spigelman, 2005; Syková, 2005; Lang & Grafe, 2007; Jimenez-Andrade et al., 2008; Fields, 2011; Nieuwenhuys, 2012; Damasio & Carvalho, 2013; Carvalho, Mulpuri, Damasio, & Spigelman, 2019; Arcilla & Tadi, 2020; Stakenborg et al., 2020; Tsakiris & de Preester, 2020).

6 The Hard Obstacles in Consciousness Studies

We suggested that one reason that current solutions for the problem of consciousness fail to generate consensus is the lack of agreement on the definition of consciousness itself. Yet another hurdle comes from the conventional and virtually universal view of the problem, which calls for the nervous system alone to provide the answer. That is a most unlikely prospect. Being conscious is an inherently cooperative state, that connects a nervous system and the mind process it generates, with a nonneural entity, the organism or body, for short.

The unusual physiological features that enable feelings, and thus consciousness, depend on the presence of a nervous system *but not on an isolated nervous system*. Organisms without nervous systems, capable of taking intelligent actions to regulate their lives but not able to represent such actions or their consequences, appear to be nonconscious. Their intelligences are covert. But conscious organisms such as ours are remarkably different: (1) they are able to represent in mind the actions they take as well as their consequences, (2) they have feelings, and (3) they can overtly represent the consequences of those feelings (Damasio, 2018).

In our proposal, the generation of homeostatic feelings relies on both neural and bodily processes, specifically on features such as phylogenetically old neurons (which, thanks to poor or absent myelination are open to nonsynaptic contacts and comingle the nonneural flesh with the nervous system) and on the fact that the body and the brain compartments of the organism cross-signal abundantly. As a result, although neural interoceptive channels generate body representations within the central nervous system, those representations are themselves the target of ongoing body processes that can modulate them. The central nervous system can react to the presence of those representations by altering the body states that originated them and consequently altered their subsequent representations. Rather than merely perceiving the body, the brain participates in a comprehensive dialogue with structures that harbor, surround, and support the body. Of note, spinal cord and brainstem nuclei are far more involved than the cerebral cortices in this dialogue (Parvizi & Damasio, 2001, 2003).

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